ALAN PLUMMER ASSOCIATES, INC.
ENVIRONMENTAL ENGINEERS • DESIGNERS • SCIENTISTS

EXECUTIVE SUMMARY

CITY OF AMARILLO
MARTIN ROAD LAKE
Storm Water Master Plan Project

Project No.: 0458-022-01

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INTRODUCTION

Martin Road Lake is a collection of two playa lakes, divided by Martin Road, located northeast of downtown Amarillo. Martin Road Lake also serves as the focal point of Martin Road Park; a City of Amarillo operated park facility that includes 12 picnic areas, baseball fields, a tennis/basketball court, and a skate park. The drainage area of Martin Road Lake is approximately 2.73 square miles (1,750 acres), and includes 13 outfalls, over 100 inlets, 7 channels, and more than 3 miles of storm sewer. Figure 1 shows the general area of Martin Road Lake.

Figure 1. Martin Road Lake Aerial Photo

Previous modeling and historical data indicated a potential for flooding in the park and the areas surrounding the park. Due to the fact that the previous hydrologic analysis was more than 20 years old, and that a comprehensive condition assessment of the drainage basin had not been conducted in the past, Martin Road Lake was selected for a master plan project.

The purpose of this project was to:

1. Determine the extent of existing, localized flooding around Martin Road Lake by updating the existing playa lake models. These results were compared to another method of hydrologic modeling, which was developed for this project.
2. Evaluate the condition of the storm sewer conveyance structures within the drainage basin in order to prioritize maintenance projects and potential CIP projects.
3. Consider alternatives to reduce or eliminate flooding around Martin Road Lake.
4. Perform preliminary design and prepare a preliminary opinion of construction cost for the selected alternative.

In addition to these primary tasks, several ancillary tasks were performed, including a geotechnical analysis, limited collection of survey information around the lake, CCTV of storm sewers within the drainage basin, capacity evaluation of one of the storm sewer systems, and preparation of a maintenance manual for the playa lakes.

The project was broken into two phases in order to be able to deliver information quickly for City CIP planning and then to follow on with more detailed analysis, preliminary design, and cost estimates. Phase 1 of the project included an examination of the existing flooding issues and preliminary development of alternatives. Phase 2 provided more detail on the selected flood mitigation alternative (design and cost estimates) and an overall project phasing plan. The final phase of the Martin Road Lake project will be to provide final design and construction services of the selected alternative under a separate contract.

PHASE I ANALYSIS

Phase 1 determined the extent of existing, localized flooding and evaluated the condition of the storm sewer conveyance structures within the drainage basin. Phase I also determined planning level costs to address these items so that the City could include selected modifications to the system in the 2014 CIP, if desired. A comparison of the updated model to a different, standard hydrologic method (HEC-HMS) was also performed in Phase I in order to verify applicability of either or both approaches to the drainage basin.

The Amarillo Simulation Analysis of Playa Performance (ASAPP) model was developed by HDR in 1993 to assess the performance of playas and playa pumping systems. The ASAPP model considers daily inflow, direct precipitation, infiltration, evaporation, lake drainage area, runoff conditions, lake geometry,

and pumping rates in its calculations. The existing ASAPP model was updated to include the most current climatic data (precipitation and evaporation) and other drainage basin characteristics, such as drainage area size, runoff coefficient and the lake geometric information. The drainage area and lake geometric information was determined using contours developed from the topographic survey associated with this project.

The United States Army Corps of Engineers (USACE) hydrologic modeling program HEC-HMS was used to verify the runoff and flood storage elevation calculations proposed by the updated ASAPP model. While the ASAPP model uses historical precipitation and evaporation data, the HEC-HMS model determines runoff and lake storage based upon mathematical models of the various hydrologic processes in the watershed. The results of this analysis indicated that HEC-HMS consistently predicted a slightly lower water surface elevation in all but the 2-year storm and approximately 1.9 feet less for the 100-year event.

A third method of estimating water surface elevations was also performed using field gage data. More than 1,300 days of field-measured water surface elevations (from 1984 through 2012) were collected and compared to the updated ASAPP model output as a form of calibration. In general, the ASAPP model appeared to duplicate the trends of the actual peak recorded levels, but appeared to over predict the amount of water leaving Martin Road Lake in dry periods (either through evaporation or pumping operations).

These three methods to determine the 100-year water surface elevation of Martin Road Lake were compared. The results of the initial modeling showed that the ASAPP model calculated water surface elevations approximately 2 feet higher than the HEC-HMS model. In addition, the highest recorded level in the 29 years of field data was significantly lower than both ASAPP and HEC-HMS results (although there is no verification that the recorded elevation was a 100-year event). It was initially recommended that the City use the ASAPP model results for subsequent analysis for this project since the 2013 ASAPP model appeared to provide a more conservative prediction of the storm event water surface elevations than HEC-HMS and the ASAPP model is a FEMA accepted model that has historically been utilized for all playa lakes within the City of Amarillo. However, during the Phase 2 analysis, a discrepancy was noted in the ASAPP model that affected the calculation of the water surface elevation when the storage volume of the lake was altered for the recommended project. A subsequent sensitivity analysis showed that the ASAPP model did not appear to be properly accounting for the volume within Martin Road Lake, especially in the more severe storm events. After discussing this issue with the City, the Phase 1 results were revised using HEC-HMS, which appeared to more accurately model the volume and changes to the volume within the lake. Therefore, while the initial ASAPP analysis was used in to guide the Phase 1 analysis, the HEC-HMS analysis was used in the Phase 2 work and in conceptual design. Table 1 below includes the results of this analysis. It should be noted that the elevations included in this table and throughout this project (unless expressly noted) are tied to the NAVD88 vertical datum.

Table 1. HEC-HMS Results (NAVD 88)

Event	%Chance	Elevation (feet) Existing	Elevation (feet) Ultimate
2-year	50%	3615.9	3616.2
5-year	20%	3620.9	3621.2
10-year	10%	3623.6	3623.8
25-year	4%	3625.7	3625.9
50-year	2%	3627.9	3628.0
100-year	1%	3629.5	3629.6

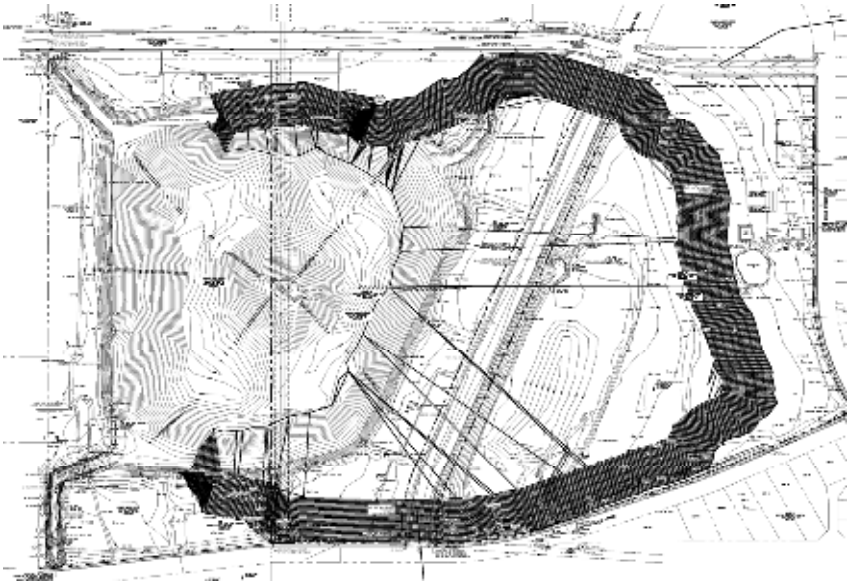
Tab 1 includes a detailed description of the methods and programs used to evaluate the water surface elevations. As noted above, some of the information included in Tab 1 is superseded in Phase 2.

Storage Deficiency Solutions

The results of the storage modeling showed that the lake had insufficient volume to contain the 100-year event. The hydrologic model indicated that 145 structures are below the 100-year calculated water surface in the Martin Road Lake area. Therefore, options to lower the water surface elevation by providing additional storage to the lake area were reviewed with the goal of reducing the water surface elevation sufficiently to affect all of the 145 structures (reduction to elevation 3625).

Two options were evaluated to lower the floodplain in the area surrounding Martin Road Lake: the first assumes that Martin Road itself can be removed so that the two lake areas could be combined into one. The second option assumes that the removal of Martin Road is not viable.

Figure 2. Option 1 Graphical Description



Option 2 was divided into two sub-options: 2a and 2b. Option 2a included excavating portions of the eastern and western lake as shown in

Figure 3. Option 2b included all excavation from Option 2a with additional, off-site excavation to the southeast of Martin Road Lake shown by the parcel map in Figure 4.

Figure 3. Option 2a Graphical Description

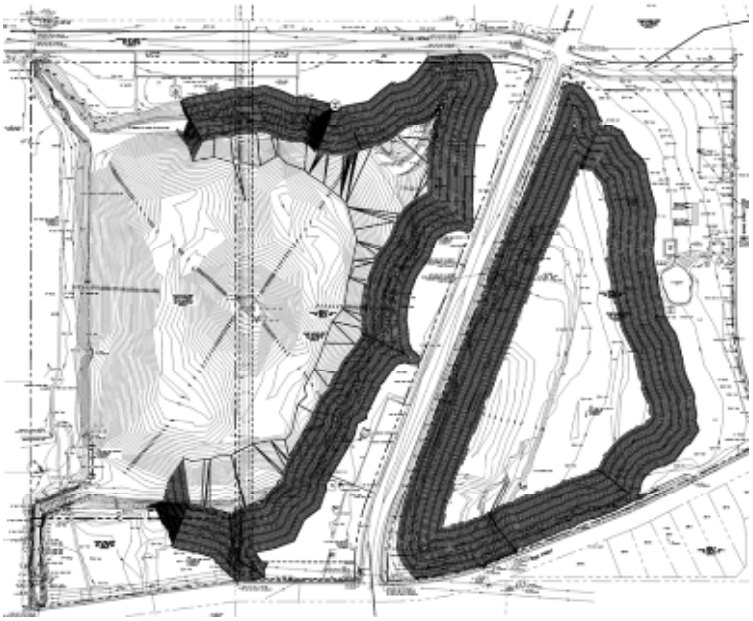


Figure 4. Option 2b Offsite Parcels

In addition to these options, off system storage and modifications to drainage basin patterns were both considered when developing these solutions. An obvious location for off system storage (beyond the distance and scope of Option 2b) in the Martin Road Lake watershed was not feasible. Modifications to the drainage basin patterns were initially considered, but did not appear to be justified based on cost considerations.

The preliminary options were reviewed and discussed with the City of Amarillo. Option 2a was selected as the most feasible alternative for Phase 2 analysis and design refinement based on the estimated costs and the extent of the additional lake storage. The additional discussion and analysis to address the ASAPP volume issue described above also played a role in this decision. Detailed information regarding the evaluation of alternatives can be found in **Tab 1**.

Condition Assessment

Phase 1 of the Martin Road Lake Master Plan also included a risk-based assessment of the drainage structures located throughout the drainage basin. A risk-based approach to asset management provides the condition information required to make project recommendations and an overall ranking of each asset. This ranking is intended to be used to group assets by improvement needs and to aid in developing phased solutions to drainage problems. Assets evaluated under this task included outfalls, inlets and channels, the existing pump station, the storm sewer system, and the lake embankment and park area.

The condition assessment of the outfalls, inlets and channels was quantified by developing a spreadsheet to illustrate the parameters included in the assessment. This spreadsheet allows the user to sort and filter according to specific parameters such as risk score, erosion failure, structure, and location. The spreadsheet can be found in **Tab 1**.

The evaluation of the pump station at Martin Road Lake showed that the current conditions of the pump station are fair; the pump station is in working order and Amarillo staff does not anticipate any impending mechanical failures. Minor erosion at the base of the fence on the north side of the pump station was also observed.

The CCTV inspection of the storm sewer system determined that the system is generally in good condition. There were some sections of line that were inaccessible due either to trash in the line or inlet configuration that did not allow access. There were some locations in the storm system where damage was observed due to adjacent utility work.

The lake (and immediate surrounding area) was reviewed for stability and condition and found to be operating well. There are isolated areas of rill and overland erosion near the water surface of the western

lake. These areas do not appear to require immediate attention, but should be monitored to ensure that they are stable. Other physical facilities of the lake area were covered under separate assessments.

The projects identified in the condition assessment were divided into three phases based on the asset scores: Phase 1 projects, which consist of the top 10% of the asset scores, were considered short term priority (1 year time period) and indicate immediate improvements are required. Phase 2 projects, which consist of the top 50% of the asset scores, are considered medium term priority (1-5 year time period). Phase 3 projects, which consist of the remaining assets where improvements may be needed in the future, should be considered in the 5+ year time period. Table 2 includes the results of this assessment (updated to include selected alternative and other information from the Phase 2 Analysis).

Table 2. Asset Costs Ranked by Risk Categories

Category	Phase			Total	Notes
	1	2	3		
Inlet	$21,000	$40,000	-	**$61,000**	See detailed listing of inlets for condition and notes in Appendix A.
Outfall	$24,000	$41,000	$26,000	**$91,000**	
Channel	$180,000	$77,000	$116,000	**$373,000**	
Pump Station	$8,000	-	$1,000	**$9,000**	Visual inspection showed no obvious signs of hydraulic degradation or condition failures. Costs are for more detailed evaluation of pump performance and detailed condition/inspection.
Playa Condition	-	-	$6,000	**$6,000**	No uncategorized issues detected: costs are for future, ongoing inspections.
Playa Flood Control	$4,989,000	-	-	**$4,989,000**	Assuming **Option 2a**.
Storm Sewer Condition	$10,000	$5,000	-	**$15,000**	Costs are placeholders for small/spot repairs.
Storm Sewer Capacity	-	-	-	**-**	Issues noted but should be included as part of separate project costs (roadway reconstruction or others).
Total	**$5,232,000**	**$163,000**	**$149,000**	**$5,544,000**	

Phase 1 Short Term Priority - 1 year time period. Top 10% of assets or immediate improvements required
Phase 2 Medium Term Priority - 1-5 year time period. Top 50% of assets or improvements required.
Phase 3 Long Term Priority - 5+ year time period. Improvements may be needed.

Detailed information regarding the condition assessment, including spreadsheet information for the storm sewer assessment and risk and ranking scores is included in **Tab 2**.

Playa Maintenance Manual

In order to assist with the planning and maintenance of the assets in and around the playa lakes, a draft maintenance manual was also developed as part of this project. This manual includes guidelines and practices for maintenance of the storm drainage systems, outfalls, and the lake areas. Per the scope of the project, several sections of the manual were left for future completion with additional requirements. This manual can be found in **Tab 3**.

PHASE 2 SERVICES

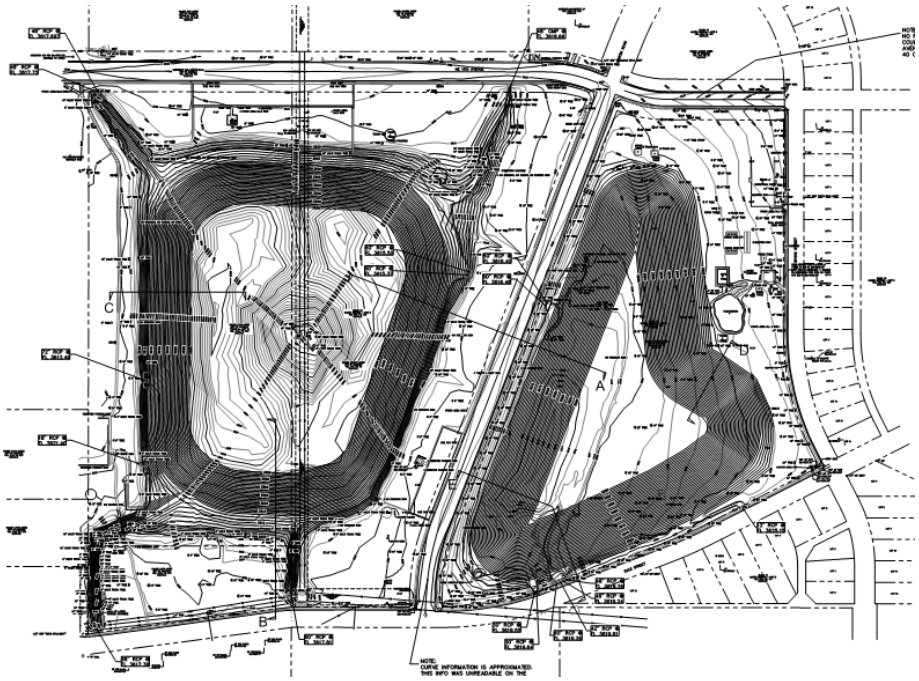
Phase 2 of the Martin Road Lake Master Plan was performed in order to refine the costs and preliminary layout of the recommended alternative, assess the hydraulic capacity of one storm sewer system discharging into the lake, provide a feasibility level assessment of proposed changes to several outfalls draining to the lake, and provide a geotechnical evaluation of subsurface conditions and slope stabilization solutions.

Refinement of Recommended Alternative

As noted earlier, the alternatives for adding storage to Martin Road Lake and thus removing structures from the flooded area included two primary options. Option 2a was selected by the City in a meeting on April 15, 2013. APAI proceeded to further refine the ASAPP flood model and identified that the model was not responding correctly to the volumetric changes to the pond. APAI discussed this discrepancy with the City and a decision was made to perform the lake modeling using HEC-HMS. APAI then refined the Phase 1 modeling of the lake area using HEC-HMS and other updated information that had been collected. The results of this modeling are reflected in the tables included in this Executive Summary.

APAI proceeded to identify options for excavation that would remove all structures from the area inundated by the 100-year floodplain by lowering the water surface elevation to 3625 feet. It was determined that this could be accomplished by excavating the east lake to elevation 3586 and by expanding the lake's footprint. The west lake would also be excavated and expanded to the south, east and north. Figure 5 shows the layout of the expanded and deepened lakes (a refinement of Option 2a).

Figure 5. Proposed Lake Layout



In addition to the excavation, the conceptual design requires installation of another connector between the east lake and the west lake. Table 3 shows the conceptual construction costs for the refined alternative.

Table 3. Conceptual Cost Estimate

Item No.	Description	Quantity	Unit	Unit Price	Total Price[1]
1	Excavation	380,000	CY	$ 9	$ 3,420,000
2	30-Inch RCP pipe	80	LF	$ 75	$ 6,000
3	Headwalls for 30-inch Pipe	2	EA	$ 2,500	$ 5,000
4	Adjustments of Existing Headwalls	8	EA	$ 8,000	$ 64,000
5	Sidewalk Repairs	200	LF	$ 25	$ 5,000
6	Concrete Flume Repairs	40	LF	$ 45	$ 1,800
7	Storm water Management Plan	1	LS	$ 10,000	$ 10,000
8	Irrigation Repairs	1	LS	$ 15,000	$ 15,000
9	Riprap	45	CY	$ 95	$ 4,275
10	Traffic Control Plan	1	LS	$ 10,000	$ 10,000
11	Force Main Connection to Pump	1	LS	$ 5,000	$ 5,000
12	FM to Drain West Lake	1100	LF	$ 200	$ 220,000
13	Trash Collection Trap at outfalls	6	EA	$ 12,000	$ 72,000
				Subtotal	**$ 3,838,075**
14	Contingency (30%)	1	LS		$ 1,151,423
				Total Construction Cost	**$ 4,989,498**

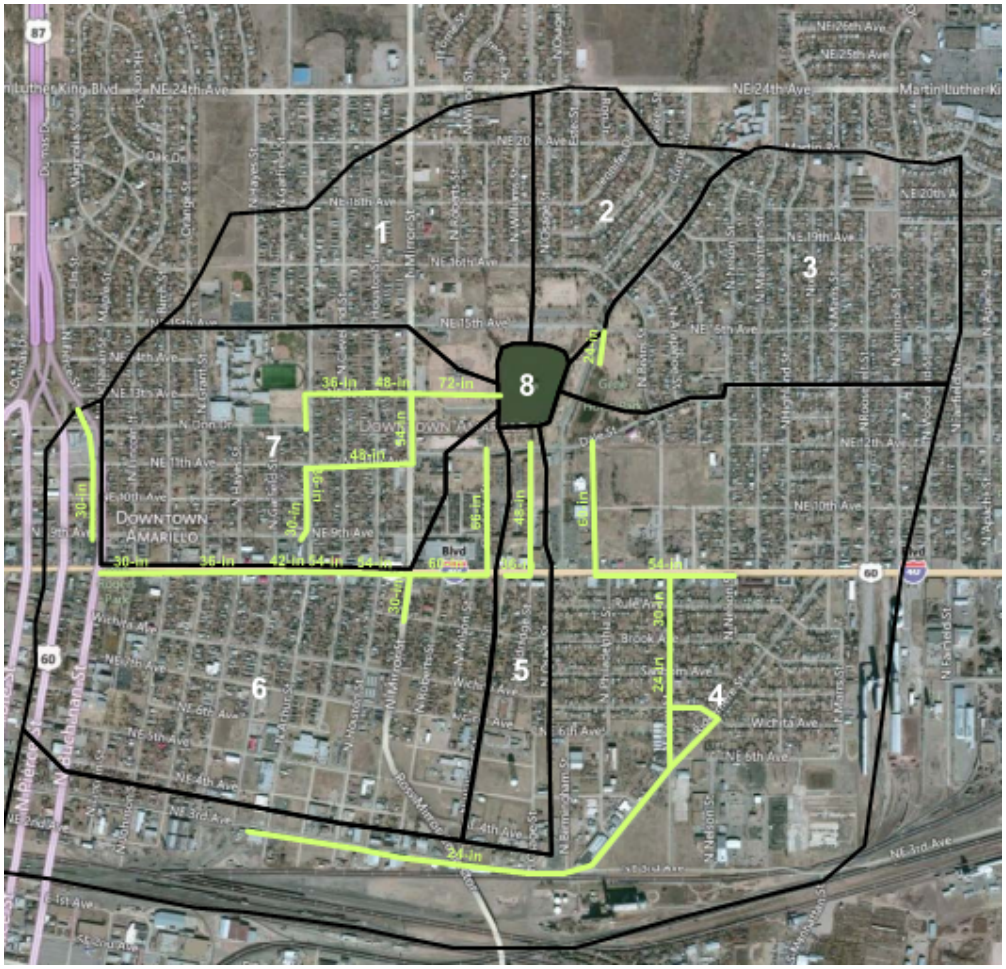
[1] The total price does not include any backfill or piping of the channels in the west portion of the lake. That cost is discussed in another memorandum.

Based on the revised lake modeling and the associated engineering analysis, the recommended design option is to excavate the lake to lower the 100-year flood elevation below 3625 feet. It is also recommended that the City request a Letter of Map Revision from FEMA, once the design is complete, to revise the flood plain of Martin Road Lake. More information on this analysis is included in **Tab 4**.

Storm Sewer Hydraulic Assessment

The purpose of this task was to create a hydraulic model of a portion of the storm sewer system discharging to Martin Road Lake. The western drainage basin, drainage area seven, encompassing about 195 acres was selected for modeling. This drainage basin is primarily residential, although it also includes Palo Duro High School and some light commercial businesses north along East Amarillo Boulevard. Figure 6 below shows the general area of the system studied with all sub-basins draining to Martin Road Lake.

Figure 6. Martin Road Lake Drainage Basins



The storm sewer system serving sub-basin seven is comprised of 20 inlets, almost 5,600 LF of storm sewer pipe, and has the largest outfall (72-inches) into the lake. APAI developed a StormCAD hydraulic model, which required drainage area calculations and hydrologic inputs. The majority of the geometric and connectivity information was taken from construction drawings of the system provided by the City and verified with the City's GIS contour and aerial data sets.

Model results were evaluated against the City's drainage criteria manual for the minor (2-year) and major (100-year) storm events. The conveyance capacity of the storm drain pipes, the inlets to the system and the streets, which convey overflows from the system, were all reviewed in the StormCAD model. Key findings included the following:

- The Q/q (pipe flow/pipe capacity) analysis showed that not all pipe capacity is being utilized in the 2-year storm event. This coupled with the amount of bypassed flow at inlets for the 2-year event shows that the system could use more inlets to capture and convey flow through the storm sewer

system. Since this area is well established, it is recommended that adding inlets only be done if other upgrades or street construction are taking place or if the City becomes aware of localized flooding issues that could be alleviated.

- The amount of flow bypassing the inlets often exceeds the street and right-of-way capacity, sometimes by a whole order of magnitude. It is recommended that the City consider any localized flooding issues at the locations where the bypassed flow exceeds the street/right-of-way capacity by the greatest margin. A more detailed evaluation of these areas could be performed using two dimensional modeling techniques. An evaluation of the right-of-way grade to street in these areas would also be useful to determine if the capacity assumptions used in this evaluation are accurate and if the near-by structures are located sufficiently above the 24-inch allowable water depth above the gutter elevation for the 100-year storm event.

In general, due to the factors noted above, major storm sewer capital projects were not recommended for this system but, if street projects are proposed, the storm drainage system should be included as noted. A detailed discussion of this assessment is included in **Tab 5**.

Outfall Piping Feasibility

During the October 10, 2013 review meeting, the City requested that a feasibility study be performed to evaluate the option of piping flows from the four inlet locations (the four corners) of the western lake. APAI performed three tasks in response to the City's comments during the meeting, including determining the existing capacity of the outfalls, whether these outfalls could be extended to the toe of the lake, and determining the general size of a drainage swale on top of the extended outfall that could be used to convey the 100-year flows into the lake.

The results of the feasibility study showed that changes to the existing outfalls would be necessary to convey the design flows required by the City's drainage criteria into the lake. In order to contain the required flows within the pipes, they typically needed to be significantly upsized in order to provide sufficient capacity once they were extended to the lake. Several options for increasing the conveyance of these extended outfalls were presented, typically by increasing the slope from the outfall into the lake. In addition, it was determined that all four sites could convey the 100-year peak flow with a reasonably sized drainage swale using a slope from the existing drainage structure outfall to the lake's water surface.

A conceptual cost estimate was prepared to estimate the cost of the necessary changes to the four outfall locations to meet City drainage criteria. The cost to upsize 3 of the 4 the existing outfall storm sewers, extend them to the lake, backfill existing channels and construct surface swales for overflows was estimated to be approximately $1,200,000. Several factors may increase or decrease the cost, including the slopes of the pipes, the level of service (if the City requires more conveyance than outlined in the current drainage manual), or if the Parks Department desires complete conveyance of the runoff within pipes rather than allowing overflows through surface swales. Additional evaluation during the design

phase will be necessary to verify the design parameters of these piped systems and the cost implications of each option. Detailed information on this feasibility assessment is included in **Tab 6**.

Geotechnical Evaluation

A geotechnical evaluation of the area at and around Martin Road Lake was performed by CMJ Engineering, Inc. The report provided general subsurface and slope stability recommendations. These recommendations were considered in the refinement to the recommended alterative. A copy of the geotechnical evaluation is included in **Tab 7**.