BROOKS & SPARKS, INC.
CONSULTING ENGINEERING

Dale Brown

JERSEY MEADOWS GOLF COURSE DRAINAGE ANALYSIS

Prepared for:

City of Jersey Village

16501 JERSEY DRIVE
JERSEY VILLAGE, TEXAS 77040-1999
(713) 466-6159

Incorporated 1956

A Texas Star Community

OCTOBER 2003

BROOKS & SPARKS, INC.
PROJECT NO. 537-0046

EXECUTIVE SUMMARY

INTRODUCTION

After numerous instances of flooding of the surrounding residential areas, Brooks & Sparks, Inc. was retained by the City of Jersey Village to conduct a study of the drainage system that serves the Jersey Meadows Golf Course. The scope of this study includes investigation of the existing drainage conditions and infrastructure, evaluation of the proposed solutions and cost estimates for the recommended improvements. As part of the analysis, a detailed topographic survey was performed to define the existing drainage pattern.

Jersey Meadows Golf Course is located in the central section of Jersey Village and is bounded by Jersey Meadows Drive and Village Drive to the south, Jones Road to the west, Rio Grande Street to the east and HCFCD Unit E135-00-00 to the north.

EXISTING CONDITIONS

Jersey Meadows Golf Course was designed such that all rain falling within its perimeter flows through a series of ponds to a single 36-inch outfall located in the southern most pond. However, runoff has been observed flowing from the golf course onto Rio Grande Street increasing the flow that storm sewer system has to convey contributing to flooding in the area. The field investigation conducted as part of this study revealed a lack of storm sewer inlets on Rio Grande Street to collect runoff. Additionally, the survey of the golf course indicated low areas along the north property line adjacent to White Oak Bayou (HCFCD Unit E135-00-00) that allow additional runoff to flow onto the golf course from the bayou. After rainfall events, areas of ponding have been observed along the back fence line of the patio homes and on the driving range.

RECOMMENDED IMPROVEMENTS

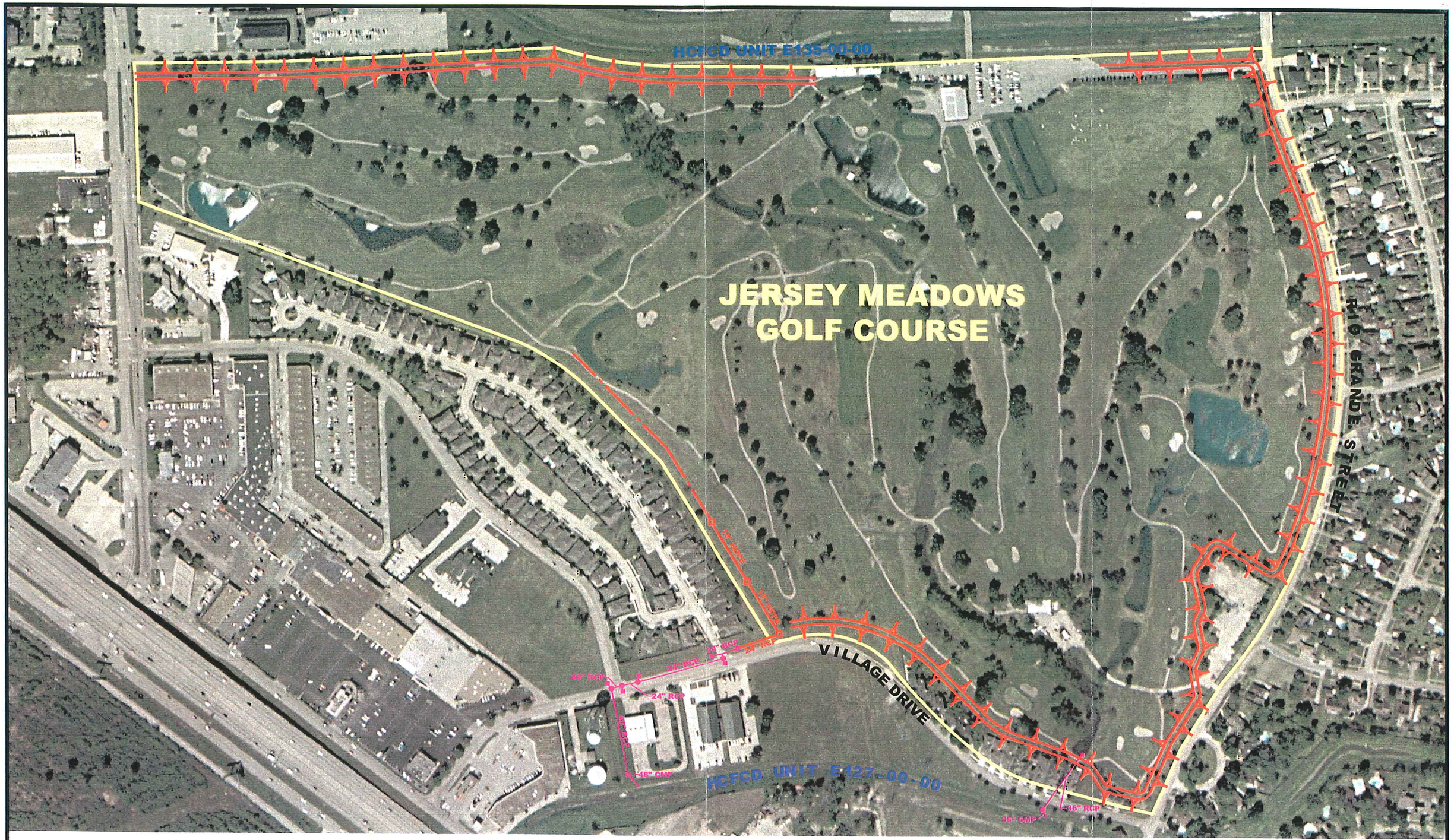
It is recommended that the City take several steps to reduce the amount and severity of flooding of the areas surrounding the golf course. First, a berm should be constructed along the northern, eastern and southern perimeter of the golf course with a top elevation of approximately 111.5 ft. This berm will serve to maximize the amount of rainfall retained on the golf course by providing approximately 115 acre-ft of storage volume. As part of construction of the berm, the outfall at the southernmost pond will be modified to provide an emergency outfall to ensure that runoff does not over top the berm and flood adjacent homes. Additionally, the berm will serve to limit the amount of additional runoff entering the golf course from the adjacent White Oak Bayou (HCFCD Unit E135-00-00). Second, a system of gravity storm sewer piping, inlets, swales, and trench drains should be constructed to drain the portion of the golf course adjacent to The Park at

Jersey Village to the existing storm sewer system located on Village Drive. The recommended improvements are depicted in the exhibit attached to this summary.

It is also recommended that the City perform a detailed study of the Rio Grande, Wall, Smith and Koester Street storm sewer system. During the field investigation a lack of inlets and storm sewer piping to convey runoff from the area was observed.

CONSTRUCTION COST

The estimated construction cost for the recommended improvements is $683,400.00 as detailed in the attached table.



GOLF COURSE BOUNDRY
PROPOSED TRENCH DRAIN
PROPOSED STORM SEWER
PROPOSED STORM SEWER INLET
FILL DIRT/ BERM AREA

EXISTING STORM SEWER MANHOLE
EXISTING STORM SEWER INLET
EXISTING STORM SEWER

KEY MAP: 409 K,L

300 0 150 300 600
SCALE: 1"=300'

EXHIBIT 4

BROOKS & SPARKS, INC.
CONSULTING ENGINEERING

PROPOSED IMPROVEMENTS

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Includes Xref(s):

TABLE 1
CONSTRUCTION COST ESTIMATE

ITEM NO.	DESCRIPTION	UNIT	QTY	UNIT PRICE	TOTAL PRICE
1.	Mobilization	L.S.	1	$30,000.00	$30,000.00
2.	Site Grading	L.S.	1	45,000.00	45,000.00
3.	Site Restoration	L.S.	1	90,000.00	90,000.00
4.	Traffic Control and Regulation	L.S.	1	5,000.00	5,000.00
5.	Trench Safety	L.F.	575	5.00	2,875.00
6.	Construct Proposed Berm with Imported Fill	L.F.	9000	35.00	315,000.00
7.	18-inch HDPE Storm Sewer	L.F.	430	35.00	15,050.00
8.	24-inch RCP Storm Sewer	L.F.	145	55.00	7,975.00
9.	Grate Inlet	E.A.	3	1,500.00	4,500.00
10.	Connection to Existing Storm Sewer	E.A.	1	2,000.00	2,000.00
11.	Outfall Structure	E.A.	1	10,000.00	10,000.00
12.	Trench Drain	L.F.	700	60.00	42,000.00
				Subtotal	$569,400.00
				Contingencies	$57,000.00
				Engineering	$57,000.00
				TOTAL	**$683,400.00**

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SECTION 1

INTRODUCTION

1.1 Scope

Brooks and Sparks, Inc. was retained by the City of Jersey Village to conduct a study of the drainage system that serves the Jersey Meadows Golf Course after numerous instances of flooding of the surrounding residential areas during both minor and major rainfall events. The scope of this study includes investigation of the existing drainage conditions and infrastructure, evaluation of the proposed solutions for drainage relief, and recommendations for improvements to mitigate the severity of flooding in the area. This report provides the City of Jersey Village with specific information regarding the causes of flooding on the golf course and the surrounding areas and solutions which will improve the drainage system serving the area.

As part of the analysis, a detailed topographic survey was performed to define existing golf course and street drainage patterns and to confirm the size and location of existing underground drainage facilities in this area.

Each solution was evaluated and considered, based on effectiveness and construction cost only. Evaluation of the benefit/cost ratios for these solutions was not a part of this study.

1.2 Project Location

Jersey Meadows Golf Course is located in the central section of the City of Jersey Village, Texas, north of Highway 290. The project area is bounded by Jersey Meadows Drive on the north, Jones Road on the west, Village Drive and Parkway Place on the south, and Rio Grande Street on the east. The total area consists of approximately 122 acres of recreational land use as shown in Exhibit 1.

SECTION 2

EXISTING CONDITIONS

2.1 Jersey Meadows Golf Course

The golf course was designed such that runoff would sheet flow into a series of ponds which generally follow an old natural channel that was filled in when the course was construction. Exhibit 2 illustrates the existing drainage area on the golf course. These ponds are interconnected by various pipes and eventually outfall through a 36-inch corrugated metal pipe (CMP) in the southernmost pond into White Oak Bayou (HCFCD E127-00-00) adjacent to Village Drive. The water level in these ponds is maintained by adding water as necessary and controlling the outfall rate. Water is added to the ponds by a well at the "upstream" end of the pond system. As the first pond fills it overflows to the adjoining ponds until all are filled with a sufficient amount of water. A valve in the 36-inch outfall pipe at the southern most pond controls the discharge rate into White Oak Bayou. If this valve is closed during minor rain events, the storm water will accumulate in the ponds throughout until they overflow and sheet flow across the golf course. During heavier rain events the ponds can overflow even if the valve is open to the outfall.

The aerial photograph of the site shows the old natural channel running through the middle of the golf course. At some point in the past it appears the channel connected White Oak Bayou on the north side of the course to White Oak Bayou on the south side of the course. When the golf course was constructed, this natural channel was incorporated into the golf course pond system and used as water hazards on various holes. The amount of water maintained in the pond system limits the amount of excess rainfall that they can contain. Thus, a small amount of rainfall can cause the ponds to overflow steadily flooding the entire course. As the golf course floods, excess runoff has been observed flowing through low areas around the perimeter of the course and flooding the surrounding roadways, notably Rio Grande Street.

After rainfall events, an area of ponding has been observed along the back fence line of the patio homes located on the southwest side of the golf course; see Exhibit 2. There are no existing inlets in this area to drain off the excess standing water along the fence and thus it has become a nuisance to the residents. An additional area of ponding is located on the northeast side of the golf course, on and adjacent to the driving range. The survey of the golf course shows this area to be lower than the surrounding areas allowing rainfall to accumulate. When the elevation of the water on the driving range exceeds the high-point elevations of the course perimeter adjacent to Rio Grande Street, excess runoff enters the Rio Grande storm sewer system and floods the adjacent streets.

The survey of the golf course showed an area along the perimeter, west of the clubhouse, with elevations that allow storm water to flow onto the course from the adjacent HCFCD channel. When the water surface elevation in the channel rises above the natural ground elevation at the golf course perimeter, water flows out of the channel onto the golf course.

This contributes a large, unexpected amount of storm water into the golf course drainage system increasing flooding of the course and surrounding areas.

2.2 Existing Storm Sewer System

The existing storm sewer system for Rio Grande Street includes inlets and manholes connected by underground storm sewer piping. The system collects storm water runoff from the Jersey Meadows Golf Course which increases the flow that the system has to convey. Investigation of the area revealed a severe lack of inlets to collect the runoff on Rio Grande and in the adjacent neighborhood. The small number of inlets heavily contributes to flooding in the area. The Rio Grande storm sewer discharges in to HCFCD Unit E135-00-00 to the north and HCFCD Unit E127-00-00 to the south.

The existing Village Drive drainage system includes inlets and manholes connected by underground storm sewer pipes. The Village Drive storm sewer system collects runoff from the patio homes along Parkway Place and Village Green Drive and discharges it into HCFCD Unit E127-00-00. The existing storm sewer system is shown in Exhibit 3.

2.3 White Oak Bayou

Rainfall that accumulates on the Jersey Meadows Golf Course and the surrounding areas flows into either White Oak Bayou or a tributary to the bayou. On the north side of the golf course is the HCFCD Unit E135-00-00. According to the Federal Emergency Management Agency's Flood Insurance Rate Maps, and the current Harris County Flood Control Model for this section of White Oak Bayou, the 100-year flood level elevation in this bypass channel is 111 feet above sea level. Another tributary to the bayou on the south side of the golf course is HCFCD Unit E127-00-00. This channel has 100-year flood elevations ranging from 109 to 115 feet above sea level. Both tributaries carry additional storm water to the White Oak Bayou main channel.

SECTION 3

ANALYSIS OF EXISTING SYSTEM

3.1 Storm Water Flow Methodology

Storm water is conveyed from a drainage area by two methods: 1)the storm sewers carry most of the runoff from a rainfall event of minimal intensity (usually a 2 year frequency storm) to the bayou; and 2) once the storm sewer capacity is exceeded, the streets carry the remaining runoff to the bayou. Our analysis of the Jersey Meadows Golf Course drainage area begins with the surrounding storm sewer systems.

The hydraulic analysis of the existing storm sewer system encompasses hydraulic calculations which model the existing system and preliminary design calculations for alternative solution proposed. The methodology for both components includes determination of rainfall/runoff for the project area using the Rational Equation below:

$$Q = CiA$$

In this equation, **Q** is the flow in cubic feet per second (cfs), **C** is the runoff coefficient (0.55 for residential districts with lots less than ¼ acre), **i** is the rainfall intensity in inches per hour (in/hr), and **A** is the cumulative area in acres.

3.1.1. Area - The Proposed Drainage Area Map, shown in Exhibit 4, delineates each area for which the sewer systems convey storm water flow. The drainage areas are based on the direction of flow due to the natural ground elevations and contours.

3.1.2. Intensity - Storm intensity and time of concentration for the 2-year and 100-year storm frequencies used to evaluate the system are based on City of Houston Storm Drainage Requirements which are complemented by Harris County Flood Control District design criteria. These values were based on Figure 9.1 City of Houston IDF Curves from the City of Houston Department of Public Works and Engineering Infrastructure Design Manual.

The storm intensity used to model the existing system is based on a storm localized over the entire project area. Using this same intensity for each subarea more accurately represents average conditions as opposed to peak flow conditions. Calculations showing the derivation of the time of concentration and intensity used to model the existing storm system are shown in Appendix A.

The hydraulic gradient for the existing Village Drive storm sewer system was calculated for both a 2-year and 100-year design storm with varying water surfaces in HCFCD Unit E127-00-00. This analysis indicates that the ability of the existing system to effectively convey excess rainfall to White Oak Bayou is greatly effected by the water surface elevation in the Bayou. As the water surface elevation in the bayou increases, the hydraulic gradient in the storm sewer also rises until it is no longer below the street elevation causing flooding of the streets.

SECTION 4

RECOMMENDED IMPROVEMENTS

It is recommended that the City take several steps to reduce the amount and severity of flooding in areas surrounding Jersey Meadows Golf Course. The first recommendation is to construct a berm around the northern, eastern and southern perimeter of the golf course. The second is to install a system of gravity sanitary sewer piping, inlets, swales, and trench drains to relieve the area behind the patio homes. It is also recommended that the City perform a detailed study of the Rio Grande, Wall, Smith, and Koester Street storm sewer system. See Exhibit 5 for locations of the recommended improvements.

4.1 Construction of Berm

The proposed berm will serve to maximize the amount of rainfall retained on the golf course by providing approximately 115 acre-feet of storage volume. This will reduce the amount of runoff transferred to Rio Grande Street and Wall Street. The berm will also limit the amount of additional runoff entering the golf course from the adjacent White Oak Bayou (HCFCD Unit E135-00-00).

Data obtained from the survey shows numerous areas where the natural ground elevation is approximately 2 to 3.5 feet lower than the average elevation. To raise the ground elevations around the perimeter, we propose to construct a berm of fill dirt with a minimum side slope of 4:1 on the exterior side and 5:1 side slope on the golf course side. The top of the berm will have a flat, 5-foot wide crown with a peak elevation of approximately 111.5 feet. The typical berm cross section for areas adjacent to the bayou is illustrated in Exhibit 6 and the detail for areas adjacent to the roadways is shown in Exhibit 7.

By preventing runoff from leaving the golf course, excess rainfall will be stored on the course and slowly released into White Oak Bayou via the pond system and outfall.

4.2 Drainage Improvements Adjacent to The Park at Jersey Village

To reduce ponding in the area of the golf course adjacent to The Park at Jersey Village, we propose to construct a system of gravity storm sewer piping, inlets, swales, and trench drains to relieve the area.

The proposed system will consist of 430 linear feet of 18-inch HDPE storm sewer along the fence line of the patio homes adjacent to the golf course within The Park at Jersey Village. Additionally, 145 feet of 24-inch RCP gravity storm sewer will be constructed within the right-of-way of Village Drive. Combined with the 18-inch HDPE, three grate inlets and trench drains will be constructed along the patio homes. Some regrading of the surrounding area and excavation of swales will be required in order to flow the runoff to

the inlets and to the trench drains. Trench drains installed in the system will serve to in drainage areas directly after rainfall events in areas that are prone to standing water.

4.3 Cost Estimate

The estimated construction cost for the recommended improvements is $683,400.00. A detail of the construction cost estimate is included in Table 1.

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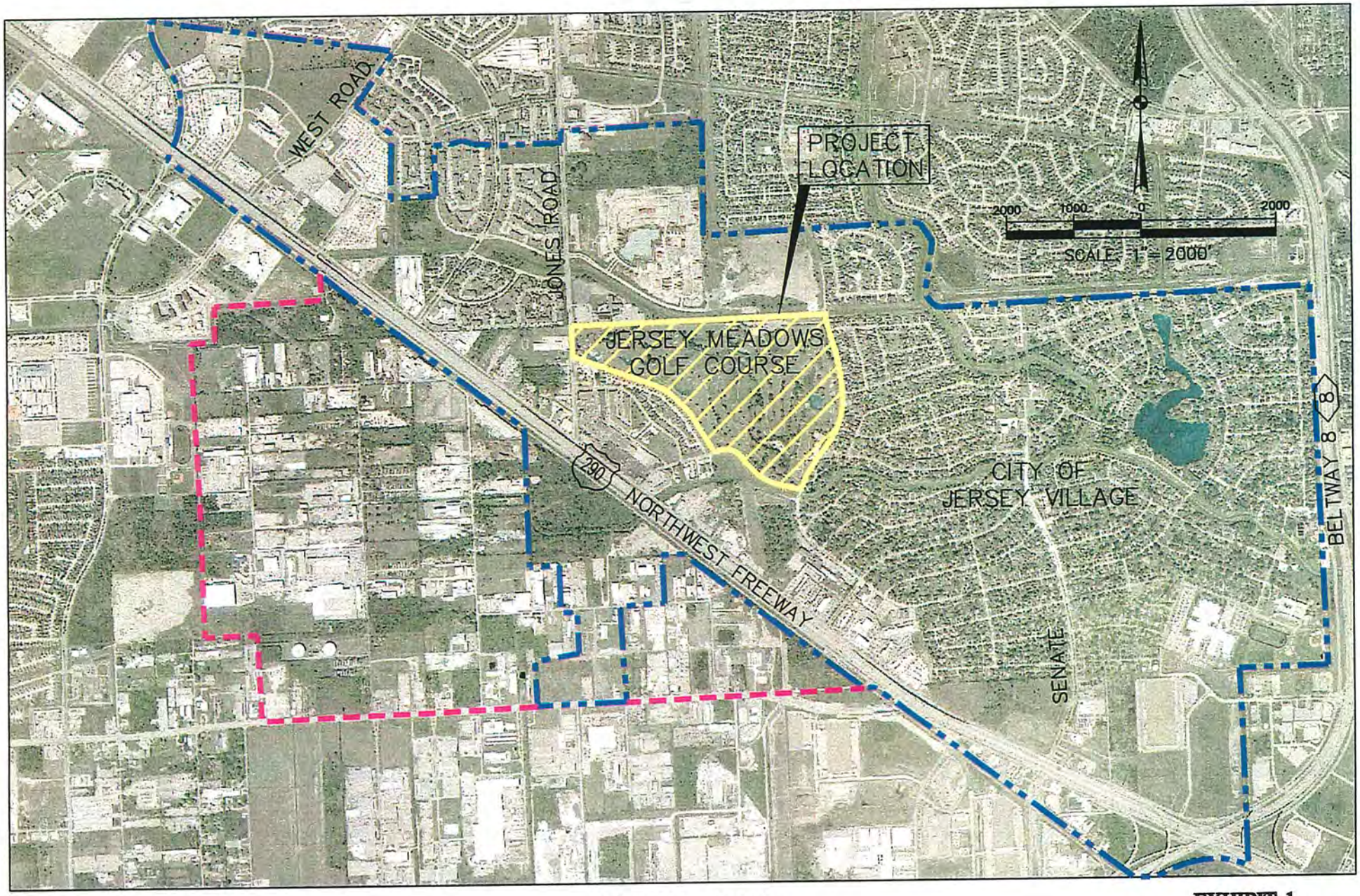

KEY MAP: 409 K,L

CITY LIMITS

ETJ

EXHIBIT 1

BROOKS & SPARKS, INC.
CONSULTING ENGINEERING

PROJECT LOCATION MAP

HCFCD UNIT E135-00-00

LOW AREA WHERE STORM WATER ENTERS THE GOLF COURSE

JERSEY MEADOWS GOLF COURSE

JONES ROAD

RIO GRANDE STREET

VILLAGE DRIVE

US 290

HCFCD UNIT E127-00-00

36" RCP

36" CMP

AREAS OF PONDING

DRAINAGE AREA BOUNDARY

KEY MAP: 409 K,L

EXISTING STORM SEWER MANHOLE
EXISTING STORM SEWER INLET
EXISTING STORM SEWER

300 0 150 300 600

SCALE: 1"=300'

EXHIBIT 2

BROOKS & SPARKS, INC.
CONSULTING ENGINEERING

EXISTING DRAINAGE AREA MAP

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▪ EXISTING STORM SEWER INLET

● EXISTING STORM SEWER MANHOLE

— EXISTING STORM SEWER

KEY MAP: 409 K,L

300 0 150 300 600

SCALE: 1"=300'

EXHIBIT 3

BROOKS & SPARKS, INC.

CONSULTING ENGINEERING

EXISTING STORM SEWER SYSTEM

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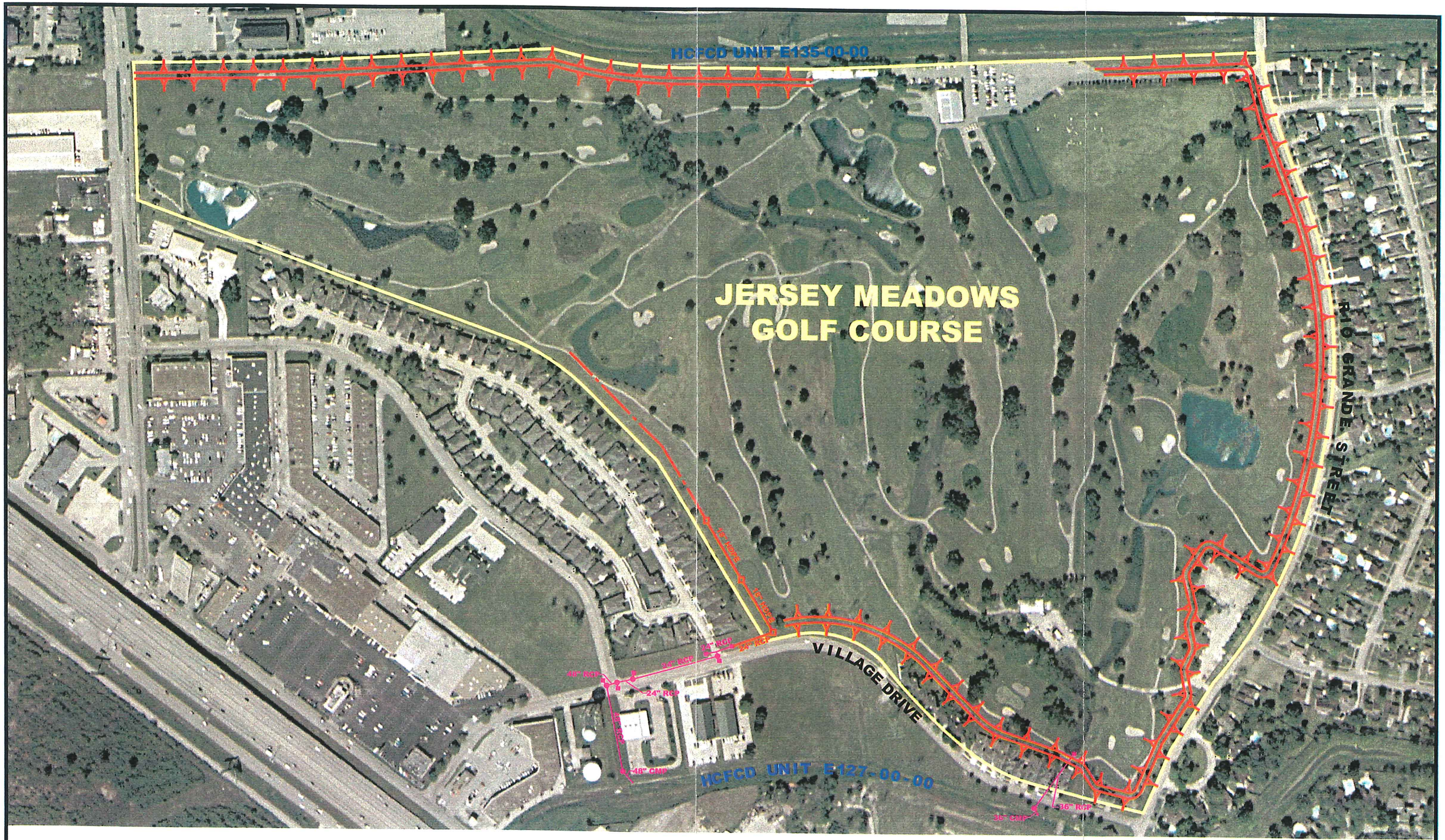

EXHIBIT 4

BROOKS & SPARKS, INC.
CONSULTING ENGINEERING

PROPOSED IMPROVEMENTS

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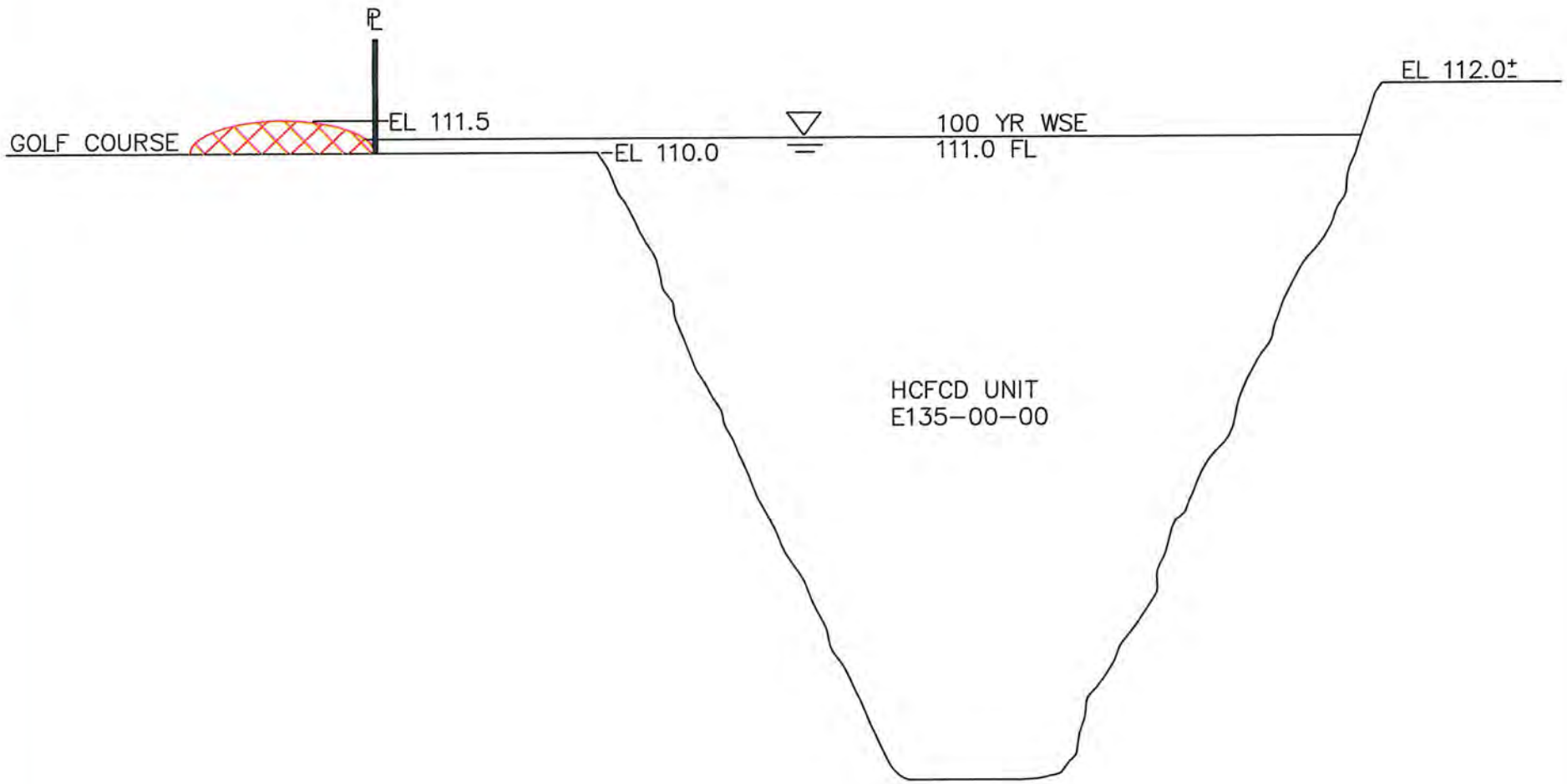


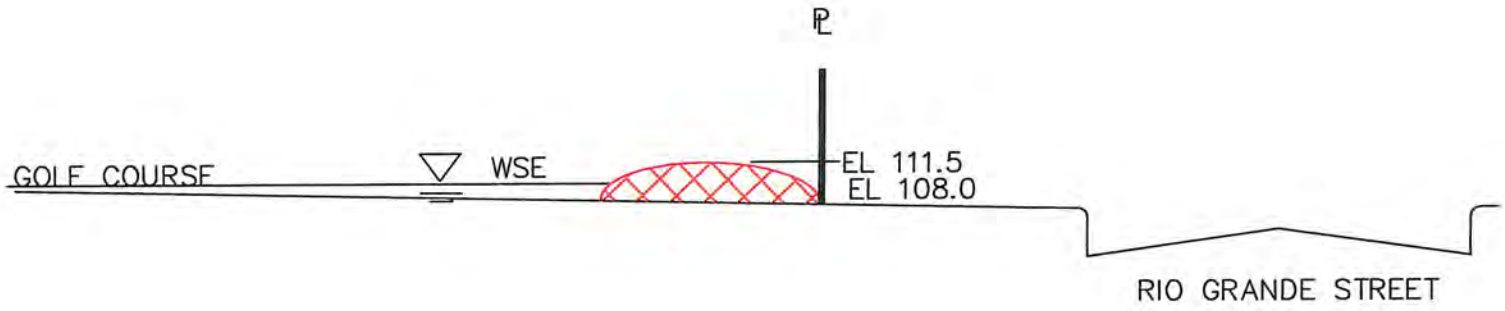
FILL DIRT/ BERM AREA

N.T.S

EXHIBIT 5

BROOKS & SPARKS, INC.
CONSULTING ENGINEERING

TYPICAL BERM SECTION
AT DITCH



FILL DIRT/ BERM AREA

N.T.S

EXHIBIT 6

BROOKS & SPARKS, INC.
CONSULTING ENGINEERING

TYPICAL BERM SECTION
AT RIO GRANDE STREET

TABLE 1
CONSTRUCTION COST ESTIMATE

ITEM NO.	DESCRIPTION	UNIT	QTY	UNIT PRICE	TOTAL PRICE
1.	Mobilization	L.S.	1	$30,000.00	$30,000.00
2.	Site Grading	L.S.	1	45,000.00	45,000.00
3.	Site Restoration	L.S.	1	90,000.00	90,000.00
4.	Traffic Control and Regulation	L.S.	1	5,000.00	5,000.00
5.	Trench Safety	L.F.	575	5.00	2,875.00
6.	Construct Proposed Berm with Imported Fill	L.F.	9000	35.00	315,000.00
7.	18-inch HDPE Storm Sewer	L.F.	430	35.00	15,050.00
8.	24-inch RCP Storm Sewer	L.F.	145	55.00	7,975.00
9.	Grate Inlet	E.A.	3	1,500.00	4,500.00
10.	Connection to Existing Storm Sewer	E.A.	1	2,000.00	2,000.00
11.	Outfall Structure	E.A.	1	10,000.00	10,000.00
12.	Trench Drain	L.F.	700	60.00	42,000.00
				Subtotal	$569,400.00
				Contingencies	$57,000.00
				Engineering	$57,000.00
				TOTAL	**$683,400.00**

APPENDIX A

Hydraulic Calculations
for
Existing Storm Sewer System

Project Information

Project: Golf Course Drainage
Job No.: 537-0046-00
System:
Designed: AKM Date: 9/15/03
Checked: SPR Date: 9/15/03

HGL Starting Elev. (ft): 108
Design Storm: 2
b = 75.01
d = 16.2
e = 0.8315

FROM M.H.	TO M.H.	Area (acres) Reach / Addl. / Cum.	Dist. (ft) Start / Reach / Cum.	C	Tc (min) Area / Pipe / Total	I (in/hr)	Flow (cfs) Reach / Addl. / Cum.	Diam. or Rise (in)	Span (in)	Slope (%)	n	Design Flow (cfs)	Design Velocity (ft/s)	Actual Velocity (ft/s)	Change in HGL (ft)	Flowline Down Elev. (ft)	Ground Down Elev. (ft)	HGL Down Elev. (ft)	Flowline Up Elev. (ft)	Ground Up Elev. (ft)	HGL Up Elev. (ft)
Outfall		0	0		33.83		0.00														
		0	45	0.55	2.82	2.77	0	48		0.5	0.024	55.17	4.39	4.40	0.23	105.04		108	105.27	112.7	108.23
	A-1	36.32	742		36.64		55.33														
A-1		1	45		33.83		1.53														
		0	291	0.55	2.62	2.78	0	48		0.15	0.013	55.78	4.44	4.28	0.41	105.27	112.7	108.23	105.7	111.3	108.63
	A-2	36.32	697		36.44		53.80														
A-2		1.9	336		33.73		2.92														
		0	38	0.55	2.42	2.79	0	24		0.15	0.013	8.79	2.80	16.20	1.91	105.7	111.3	108.63	105.76	111.02	110.54
	A-3	35.32	406		36.15		50.89														
A-3		0.92	374		33.55		1.43														
		26.8	48	0.55	1.81	2.83	41.67	24		0.22	0.013	10.64	3.39	16.54	2.52	105.76	111.02	110.54	105.87	111.05	113.06
	A-4	33.42	368		35.36		51.96														
A-4		5.7	422		28.59		9.64														
		0	320	0.55	1.79	3.08	0	24		0.17	0.013	9.35	2.98	3.07	0.58	105.87	111.05	113.06	106.42	110.3	113.64
	A-5	5.7	320		30.38		9.64														

Project Information

Project: Golf Course Drainage
Job No.: 537-0046-00
System:
Designed: AKM Date: 9/15/03
Checked: SPR Date: 9/15/03

HGL Starting Elev. (ft): 108
Design Storm: 100
b = 125.40
d = 21.8
e = 0.7500

FROM M.H.	TO M.H.	Area (acres) Reach / Addl. / Cum.	Dist. (ft) Start Reach / Cum.	C	Tc (min) Area / Pipe / Total	I (in/hr)	Flow (cfs) Reach / Addl. / Cum.	Diam. or Rise (in)	Span (in)	Slope (%)	n	Design Flow (cfs)	Design Velocity (ft/s)	Actual Velocity (ft/s)	Change in HGL (ft)	Flowline Down Elev. (ft)	Ground Down Elev. (ft)	HGL Down Elev. (ft)	Flowline Up Elev. (ft)	Ground Up Elev. (ft)	HGL Up Elev. (ft)
Outfall		0	0		33.83		0.00														
		0	45	0.55	2.82	5.93	0	48		0.5	0.024	55.17	4.39	9.43	1.04	105.04		108	105.27	112.7	109.04
	A-1	36.32	742		36.64		118.51														
A-1		1	45		33.83		3.27														
		0	291	0.55	2.62	5.95	0	48		0.15	0.013	55.78	4.44	9.17	1.86	105.27	112.7	109.04	105.7	111.3	110.90
	A-2	36.32	697		36.44		115.24														
A-2		1.9	336		33.73		6.24														
		0	38	0.55	2.42	5.97	0	24		0.15	0.013	8.79	2.80	34.70	8.77	105.7	111.3	110.90	105.76	111.02	119.68
	A-3	35.32	406		36.15		109.00														
A-3		0.92	374		33.55		3.05														
		26.8	48	0.55	1.81	6.03	88.91	24		0.22	0.013	10.64	3.39	35.29	11.47	105.76	111.02	119.68	105.87	111.05	131.14
	A-4	33.42	368		35.36		110.87														
A-4		5.7	422		28.59		20.25														
		0	320	0.55	1.79	6.46	0	24		0.17	0.013	9.35	2.98	6.45	2.55	105.87	111.05	131.14	106.42	110.3	133.69
	A-5	5.7	320		30.38		20.25														

Project Information

Project: Golf Course Drainage
Job No.: 537-0046-00
System:
Designed: AKM Date: 9/15/03
Checked: SPR Date: 9/15/03

HGL Starting Elev. (ft): 111
Design Storm: 2
b = 75.01
d = 16.2
e = 0.8315

FROM M.H.	TO M.H.	Area (acres) Reach / Adtl. / Cum.	Dist. (ft) Start / Reach / Cum.	C	Tc (min) Area / Pipe / Total	I (in/hr)	Flow (cfs) Reach / Adtl. / Cum.	Diam. or Rise (in)	Span (in)	Slope (%)	n	Design Flow (cfs)	Design Velocity (ft/s)	Actual Velocity (ft/s)	Change in HGL (ft)	Flowline Down Elev. (ft)	Ground Down Elev. (ft)	HGL Down Elev. (ft)	Flowline Up Elev. (ft)	Ground Up Elev. (ft)	HGL Up Elev. (ft)
Outfall		0	0		33.83		0.00														
		0	45	0.55	2.82	2.77	0	48		0.5	0.024	55.17	4.39	4.40	0.23	105.04		111	105.27	112.7	111.23
	A-1	36.32	742		36.64		55.33														
A-1		1	45		33.83		1.53														
		0	291	0.55	2.62	2.78	0	48		0.15	0.013	55.78	4.44	4.28	0.41	105.27	112.7	111.23	105.7	111.3	111.63
	A-2	36.32	697		36.44		53.80														
A-2		1.9	336		33.73		2.92														
		0	38	0.55	2.42	2.79	0	24		0.15	0.013	8.79	2.80	16.20	1.91	105.7	111.3	111.63	105.76	111.02	113.54
	A-3	35.32	406		36.15		50.89														
A-3		0.92	374		33.55		1.43														
		26.8	48	0.55	1.81	2.83	41.67	24		0.22	0.013	10.64	3.39	16.54	2.52	105.76	111.02	113.54	105.87	111.05	116.06
	A-4	33.42	368		35.36		51.96														
A-4		5.7	422		28.59		9.64														
		0	320	0.55	1.79	3.08	0	24		0.17	0.013	9.35	2.98	3.07	0.58	105.87	111.05	116.06	106.42	110.3	116.64
	A-5	5.7	320		30.38		9.64														

Project Information

Project: Golf Course Drainage
Job No.: 537-0046-00
System:
Designed: AKM Date: 9/15/03
Checked: SPR Date: 9/15/03

HGL Starting Elev. (ft): 111
Design Storm: 100
b = 125.40
d = 21.8
e = 0.7500

FROM M.H.	TO M.H.	Area (acres) Reach / Addl. / Cum.	Dist. (ft) Start / Reach / Cum.	C	Tc (min) Area / Pipe / Total	I (in/hr)	Flow (cfs) Reach / Addl. / Cum.	Diam. or Rise (in)	Span (in)	Slope (%)	n	Design Flow (cfs)	Design Velocity (ft/s)	Actual Velocity (ft/s)	Change in HGL (ft)	Flowline Down Elev. (ft)	Ground Down Elev. (ft)	HGL Down Elev. (ft)	Flowline Up Elev. (ft)	Ground Up Elev. (ft)	HGL Up Elev. (ft)
Outfall		0	0		33.83		0.00														
		0	45	0.55	2.82	5.93	0	48		0.5	0.024	55.17	4.39	9.43	1.04	105.04		111	105.27	112.7	112.04
	A-1	36.32	742		36.64		118.51														
A-1		1	45		33.83		3.27														
		0	291	0.55	2.62	5.95	0	48		0.15	0.013	55.78	4.44	9.17	1.86	105.27	112.7	112.04	105.7	111.3	113.90
	A-2	36.32	697		36.44		115.24														
A-2		1.9	336		33.73		6.24														
		0	38	0.55	2.42	5.97	0	24		0.15	0.013	8.79	2.80	34.70	8.77	105.7	111.3	113.90	105.76	111.02	122.68
	A-3	35.32	406		36.15		109.00														
A-3		0.92	374		33.55		3.05														
		26.8	48	0.55	1.81	6.03	88.91	24		0.22	0.013	10.64	3.39	35.29	11.47	105.76	111.02	122.68	105.87	111.05	134.14
	A-4	33.42	368		35.36		110.87														
A-4		5.7	422		28.59		20.25														
		0	320	0.55	1.79	6.46	0	24		0.17	0.013	9.35	2.98	6.45	2.55	105.87	111.05	134.14	106.42	110.3	136.69
	A-5	5.7	320		30.38		20.25														