FINAL

STORMWATER MASTER PLAN

FOR

CITY OF SATELLITE BEACH

E100-2-48
JANUARY 2001

ORJ

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CITY OF SATELLITE BEACH
MASTER STORM WATER PLAN
PROJECT NO. E100-2-48

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INTRODUCTION

The City of Satellite Beach is located on the barrier island in Central Brevard County, Florida. The city limits consist of single family residences averaging 3,500± square feet, commercial business mostly along State Road A1A and South Patrick Drive which respectively are the east and west limits of the City and governmental complexes. The City is approximately 96% built out which leaves only a few small undeveloped parcels.

Hydrographic studies have identified degradation of the groundwater quality due to development. The degradation is the result of irrigation wells, wells for water to air air-conditioning and a continued increase in runoff due to development. Therefore, the City of Satellite Beach in conjunction with St. Johns River Water Management District have authorized this study in an effort to improve the water quality discharge condition of the drainage outfalls to the Indian River Lagoon System as much as is reasonable.

The City of Satellite Beach between South Patrick Drive and State Road A-1-A contains approximately 990 acres in 7 basins which are as follows from south to north:

(1.) South Ditch Basin

(2.) Desoto Parkway Basin

(3.) Cassia Boulevard Basin

(4.) Lori Laine Shopping Center Basin

(5.) Park Avenue Basin

(6.) Roosevelt Avenue Basin

(7.) Grant Avenue Basin

All seven (7) basins discharge through five outfalls as shown in Table I in the overall System Summary.

The following sections of this report provide a detailed description and analysis on a basin by basin basis.

OVERALL SYSTEM

SUMMARY

Outfalls exist at Desoto Parkway, Cassia Blvd., Lori Laine Shopping Center, Roosevelt Avenue and South Ditch (Satellite Ditch). Table I indicates the location, outfall size, the capacity each is limited to, tributary drainage areas and estimated limiting discharge for the 5-year-24-hour storm of 5.5" rainfall.

TABLE I

LOCATION OF OUTFALL ALONG SOUTH PATRICK DRIVE	EXISTING OUTFALL SIZE	AVAILABLE OUTFALL CULVERT CAPACITY IN CFS	DRAINAGE AREA ACRES	BASIN EXISTING DISCHARGE CAPABILITY CFS***
South Ditch (Satellite Ditch)	3-5'X6' Box Culverts	180	157	70
Desoto Parkway	4'X8' Box Culvert	128	296	26
Cassia Blvd.	4'X9' Box Culvert	144	156	10
Lori Laine Shopping Center(Incl. Park Ave.)	42" R.C.P.	35	184	10
Roosevelt Avenue (Incl Grant Avenue)	5'X10' Box Culvert	185	193	70

***With Current Street Flooding and
Existing Drainage System Configuration**

METHODOLOGY

The drainage infrastructure for Satellite Beach was constructed in the 50's and 60's which is prior to present stormwater-treatment rules and current standards for water quantity and quality. The development of Satellite Beach has continued over the last half of the 20th Century and yielded a condition where

45 percent of the area is impervious (asphalt, sidewalk, building, etc.), 15 percent of the area is directly connected impervious area (DCIA) and the runoff coefficient C=0.57. The above listed information is higher than the average for the State of Florida and was obtained by detailed review and analysis of the electronic aerial photography data collected as part of this project.

The City of Satellite Beach has seven Basins and five outfalls which discharge to the Indian River Lagoon and the Banana River. The attached plan in Appendix "B" delineates the existing basin limits and the outfalls. Table II shows the existing basin data.

TABLE II

Basin #	Existing Basin	Total Area (AC)	Imp. Area (AC)	DCIA %	Runoff Coefficient
1	South Ditch	157.44	78.72	19.05	0.55
2	Desoto Parkway	295.97	130.86	15.59	0.57
3	Cassia Blvd.	156.27	66.26	12.34	0.55
4	Lori Laine Shopping Center	153.82	73.01	14.08	0.58
5	**Park Avenue	30.55	14.65	14.97	0.59
6	Roosevelt Ave.	54.15	24.50	15.05	0.57
7	***Grant Avenue	138.82	60.38	13.97	0.50
	TOTAL	**989.02**	**448.38**	**15**	**0.57**

**Park Avenue flows south along South Patrick Drive and outfalls via the existing 42" culvert at Lori Lane Shopping Center.

***Grant Avenue flows south to Roosevelt Avenue via an existing 42" RCP.

SECTION I

SOUTH DITCH BASIN

The South Ditch Basin contains 157.44 acres of residential development in the southern most area of Satellite Beach. The Basin consists of 22.2% institutional use and 77.8% residential use. All the runoff from the basin flows south via overland flow and existing piped flow to an existing conveyance system along the south city limits. The flow is collected and carried west to an existing ditch. The outfall into the ditch is via a 52" x 39" CMP culvert at the intersection of Wimico Drive and the Satellite Ditch. The existing culvert has a capacity of approximately 60 cfs and the model indicates that the existing system is operating at or above capacity for a 5-year-24-hour event. Therefore, the design capacity of the existing system is approximately a 5-year-24-hour storm.

Since the majority of the streets and properties in this basin are between elevation 6.0' ± and 11.0' ±, the basin does not have significant standing water/flooding except during larger storm events such as a tropical storm or a hurricane. Thus, this basin is not anticipated to require improvements for the stormwater discharge system. However, due to the deteriorated cross-drain pipe at Wimico Drive, the system will require replacement of the 52"x39" CMP with an equivalent 38"x60" RCP.

Further, a discussion has begun between Brevard County, The City of Satellite Beach, The City of Indian Harbor Beach and St. Johns River Water Management District, regarding the possible purchase of (3) parcels of land in the City of Indian Harbor Beach. The discussion involves the old sewer treatment plant site (owned by Brevard County), the Grant Parcel along South Patrick Drive and a parcel southeast of the storm water management pond

installed by FDOT as part of the South Patrick Drive Widening. The objective is to secure as many parcels as practical and economically feasible. The purpose would be to construct a pond or ponds with large permanent pool volumes to maximize the reduction of pollutant load entering the outfall canal. Estimated pollutant load benefits are not part of this analysis. However, the pollutant load reduction is expected to be significant.

It is also expected that exfiltration will be utilized in the eastern most area of this basin to reduce pollutant loads and discharge. The estimated cost of the exfiltration improvements is as follows:

South Ditch Basin

Estimated Cost to Construct Improvements

(1) Wimico Drive

Number	Description	Quantity	Unit	Unit Cost	Total
1	38"x60" RCP	800	LF	$68.00	$54,400.00
2	Inlets	2	EA	$4,500.00	$9,000.00
3	Endwalls	2	EA	$4,500.00	$9,000.00
				Total	$72,400.00

(1) Ditch long Satellite Beach Library Property

Number	Description	Quantity	Unit	Unit Cost	Total
1	Widen Existing Ditch	500	LF	$45.00	$22,500.00
2	Sodding	3,500	SY	$3.00	$10,500.00
				Total	$33,000.00

Exfiltration System

Number	Description	Street Length	Trench Length	Unit Cost	Total
1	Hibiscus Drive From South Limits To Magellan Avenue	2,900	5,800	$60.00	$348,000.00
2	Palm Drive From South Limits To Magellan Avenue	2,900	5,800	$60.00	$348,000.00
3	Atlantic Drive From South Limits To Magellan Avenue	2,900	5,800	$60.00	$348,000.00
4	Inlets		108	$2,500.00	$270,000.00
5	Repairs		1,500	$25.00	$37,500.00
				Total	$1,351,500.00

Subtotal	$1,456,900.00
10% Contingency	$145,690.00
Design Contingency	$218,535.00
Grand Total	**$1,821,125.00**

SECTION 2

DESOTO PARKWAY BASIN

The Desoto Parkway Basin consists of 296 ± acres of which 5.2% is institutional use (i.e., schools, etc.) and 94.8 percent is residential. The Desoto Basin extends from 1000' east of South Patrick Drive east to State Road A-1-A and from Maple Drive south to Trinidad Drive. All runoff from this basin flows north and south via existing piped culverts and overland flow to a conveyance system in the median of Desoto Parkway. The conveyance system then carries the runoff west to South Patrick Drive where discharge is via an existing 4'x8' concrete box culvert. The capacity of the outfall culvert is 128 cfs and the model clearly demonstrates that the existing system can only convey 26 cfs to the outfall. The existing culverts within the basin and along Desoto Parkway are undersized and their condition is deteriorated to the point of needing replacement.

The analysis of the existing system and proposed master plan improvements indicates the flooding conditions as shown in Table III for the 5 year-24 hour rainfall event using the FEMA 100-year event for the level of tail water (elevation 1.5' 1988 Datum). Also, the 25-year-24- hour event results are shown for the proposed master plan improvements.

TABLE III

DESCRIPTION/LOCATION		DEPTH OF STANDING WATER		
DESOTO BASIN		EXISTING SYSTEM 5 YEAR-24 Hour	MASTER PLAN 5 YEAR-24 hour	MASTER PLAN 25 YEAR-24 Hour
1	Maple Drive & Temple Street	7"	0"	7"
2	Cherry Drive & Temple Street	6"	0"	10"
3	Holly Drive & Maple Drive	4"	4"	9"
4	Elm Avenue & Royal Park Blvd.	14"	12"	20"
5	Elm Avenue & Temple Street	18"	12"	24"
6	North End of Verbenia Court	2"	2"	10"
7	Carissa Drive ½ Block East of Temple Street	10"	0"	0"
8	Rosada Street & Carissa Dr.	15"	0"	4"
9	Desoto Parkway & Jamaica Blvd.	10"	0"	0"
10	Desoto Parkway & Kingston Blvd.	10"	0"	0"
11	Desoto Parkway & Temple St.	18"	6"	18"
12	Desoto Parkway ½ Block East of Temple Street	6"	0"	0"
13	Desoto Parkway & Rosada St.	6"	0"	0"
14	Kingston Rd. & Jamaica Blvd.	6"	0"	0"
15	Caribean Drive & Kingston Rd.	6"	3"	10"
16	Maria Drive & Caribean Drive	11"	6"	15"
17	Maria Drive & Jamaica Blvd.	6"	2"	4"
18	Bimini Rd. & Camin St.	5"	3"	10"
19	Trinidad Dr. & Caribean Dr.	11"	6"	20"
20	Trinidad Dr. & Trinidad Ct.	6"	0"	12"
21	Lynn Avenue & Jamaica Blvd.	6"	0"	4"
22	Trinidad Drive & Jamaica Blvd.	6"	0"	0"

The recommended approach to reduce the level of standing water/flooding is to replace the infrastructure as follows:

(1.) Construct box culvert and open box culvert along Desoto Parkway from Desoto Lane east to Verbenia Drive.

(2.) Construct 48" RCP through 60" RCP along Jamaica Boulevard from Desoto Parkway to City of Satellite Beach Library/ Soccer Field Parcel.

(3.) Construct three (3) wet detention ponds at the City of Satellite Beach Library/Soccer Field Parcel with outfall to the Satellite Ditch along the west Property Line of the Soccer Field Parcel.

When the Jamaica Boulevard system is installed, the pollutant loads are decreased as follows:

Description	% Reduction
TSS (Total Suspended Solids)	89
TN (Total Nitrogen)	29
TP (Total Phosphorous)	49

In addition to the structural approach, the easternmost part of the Basin lends itself to exfiltration of runoff to the ground water table by constructing additional inlets and piping to retain as much runoff as possible.

The following are the Engineer's estimated construction cost for the above recommended improvements.

Desoto Parkway Basin

Estimated Cost to Construct Improvements

(1) Desoto Parkway - From West Basin Limit to Verbenia Court

Number	Description	Quantity	Unit	Unit Cost	Total
1	10'x4' Open Box Culvert	730	LF	$200.00	$146,000.00
2	10'x3'-6" Open Box Culvert	815	LF	$180.00	$146,700.00
3	8'x4' Open Box Culvert	1,096	LF	$170.00	$186,320.00
4	8'x3'-6" Open Box Culvert	851	LF	$150.00	$127,650.00
5	6'x3'-6" Open Box Culvert	430	LF	$120.00	$51,600.00
6	30" RCP	72	LF	$36.00	$2,592.00
7	Inlets	17	EA	$5,500.00	$93,500.00
				Total	$754,362.00

General Construction Items

Number	Description	Quantity	Unit	Unit Cost	Total
1	Pavement Repair	4,200	SY	$25.00	$105,000.00
2	Curb Repairs	800	LF	$20.00	$16,000.00
3	Sodding	6,800	SY	$2.25	$15,300.00
4	Subsurface Drains	7,300	SY	$27.00	$197,100.00
5	Conflict Manholes	10	EA	$5,500.00	$55,000.00
				Total	$388,400.00

Jamaica Boulevard - From Desoto Parkway to Satellite Beach Library

Number	Description	Quantity	Unit	Unit Cost	Total
1	Landscape Removal & Replacement	1	LS	$30,000.00	$30,000.00
2	48" RCP	1,340	LF	$70.00	$93,800.00
3	54" RCP	240	LF	$80.00	$19,200.00
4	60" RCP	130	LF	$100.00	$13,000.00
5	Inlets	10	EA	$4,500.00	$45,000.00
6	Pavement Repair	72	LF	$25.00	$1,800.00
7	Wet Dentention Pond	1	LS	$250,000.00	$250,000.00
8	Endwalls	4	EA	$6,000.00	$24,000.00
9	Sodding	6,000	SY	$2.25	$13,500.00
				Total	$490,300.00

Exfiltration System

Number	Description	Street Length	Trench Length	Unit Cost	Total
1	Coconut Street from Desoto Parkway to Royal Palm Blvd.	1,200	2400	$60.00	$144,000.00
2	Royal Palm Boulevard From Elm Avenue to North	800	1600	$60.00	$96,000.00
3	Verbenia Court From Desoto Parkway to North End	400	800	$60.00	$48,000.00
4	Inlets		24	$2,500.00	$60,000.00
5	Repairs		960	$25.00	$24,000.00
				Total	$372,000.00

Baffle Box

Number	Description	Quantity	Unit	Unit Cost	Total
1	Baffle Box(small)	4	EA	$8,000.00	$32,000.00
				Total	$32,000.00

Subtotal	$2,037,062.00
10% Contingency	$203,706.20
Design Contingency	$305,559.30
Grand Total	**$2,546,327.50**

SECTION 3

CASSIA BOULEVARD BASIN

The Cassia Boulevard Basin is 156.27 acres of mixed use. The Basin contains 67.5% residential, 19.1 % institutional, 8.6% commercial and 4.9% industrial uses. The Cassia Boulevard Basin includes City of Satellite Beach City Hall, Police Station and Public Works Facilities.

The basin is bounded by Cinnamon Drive on the north, Maple Drive on the south, State Road A-1-A on the east and South Patrick Drive on the west. The existing system flows north and south to a ditch and piped conveyance system along Cassia Boulevard. The conveyance system then flows west where it goes under South Patrick Drive via an existing 4'x9' concrete box culvert. The box culvert has an approximate capacity of 144 cfs and the existing system only discharges 10 cfs from the 5-year-24-hour event. Due to age, inadequate size and deteriorated conditions, the system needs to be replaced and upgraded.

Table IV depicts the standing water/ flooding depth for the 5-year-24-hour storm and the 25-year-24-hour storm event for the master plan improvements. Table IV also depicts the standing water/flooding depth for the 5-year-24-hour storm event for the existing system. The model indicates a significant improvement if the proposed master plan improvements are implemented.

TABLE IV

DESCRIPTION/LOCATION		DEPTH OF STANDING WATER		
	CASSIA BASIN	EXISTING SYSTEM 5 YEARS	MASTER PLAN 5 YEARS	MASTER PLAN 25 YEARS
1	Cassia Boulevard & Thyme Street	11"	1"	6"
2	Cassia Boulevard ½ Block East of Temple Street	12"	0"	0"
3	Ocean Spray Avenue Rosedale Dr.	15"	8"	12"
4	Ocean Spray Avenue & Willow Dr.	12"	8"	18"
5	Ocean Spray Avenue ½ Block East of Temple Street	12"	6"	16"
6	Ocean Spray Avenue 2 Blocks East of Temple Street	18"	6"	19"
7	Greenway Avenue & Temple Street	12"	5"	14"
8	St. John Drive One Block North of Coach Road	12"	2"	10"
9	St. John Drive & Laurel Street	12"	0"	4"
10	St. John Drive ½ Block East of Laurel Street	5"	0"	4"

The recommended approach to reduce the standing water/flooding is as follows:

(1.) Construct slope paved open channel and 10'x4' box culvert along Cassia Boulevard from City Hall to Temple Street.

(2.) Construct 24" and 36" RCP along Cassia Boulevard from Temple Street toward State Road A-1-A.

(3.) Replace existing system on Temple Street, Ocean Spray Avenue and Greenway Avenue with oval RCP.

(4.) Provide interconnect between Cassia Boulevard Basin and Lori Laine Basin at Thyme Street, Kale Street, Temple Street and Tangelo Street via oval RCP.

As with the Desoto Parkway Basin, exfiltration is proposed in the eastern end of the Cassia Boulevard Basin. The objective is to construct inlets, piping and an exfiltration system whose purpose is to retain and exfiltrate to the surrounding soil the maximum quantity of runoff.

Baffle boxes are anticipated for all north/south laterals prior to connection to the outfall.

As shown in Appendix "A", the pollutant loads are reduced as follows:

Description	% Reduction
TSS	18
TN	15
TP	10

The following are the Engineer's estimated cost for the master plan improvements.

Cassia Boulevard Basin

Estimated Cost to Construct Improvements

(1) Cassia Boulevard - From South Patrick Drive to Temple Street

Number	Description	Quantity	Unit	Unit Cost	Total
1	10'x4' Open Box Culvert	740	LF	$200.00	$148,000.00
2	10'x3'-8" Open Box Culvert	1,009	LF	$180.00	$181,620.00
3	8'x3'-6" Open Box Culvert	806	LF	$150.00	$120,900.00
7	Inlets	3	EA	$5,500.00	$16,500.00
				Total	$467,020.00

(2) Thyme Street - From Cassia Boulevard to Norwood Avenue

Number	Description	Quantity	Unit	Unit Cost	Total
1	24"x38" RCP	241	LF	$46.00	$11,086.00
2	24" RCP	573	LF	$32.00	$18,336.00
3	Inlets	9	EA	$3,500.00	$31,500.00
				Total	$60,922.00

(3) Kale Street - From Cassia Boulevard to Norwood Avenue

Number	Description	Quantity	Unit	Unit Cost	Total
1	29"x45" RCP	304	LF	$54.00	$16,416.00
2	24"x38" RCP	229	LF	$46.00	$10,534.00
3	24" RCP	479	LF	$32.00	$15,328.00
4	Inlets	11	EA	$3,500.00	$38,500.00
				Total	$80,778.00

(4) Temple Street & Norwood Avenue - From Cassia Boulevard to Tangelo Street

Number	Description	Quantity	Unit	Unit Cost	Total
1	38"x60" RCP	248	LF	$68.00	$16,864.00
2	34"x53" RCP	288	LF	$60.00	$17,280.00
3	29"x45" RCP	1,029	LF	$54.00	$55,566.00
4	24" RCP	1,636	LF	$32.00	$52,352.00
3	30" RCP	284	LF	$36.00	$10,224.00
4	Inlets	20	EA	$4,500.00	$90,000.00
				Total	$242,286.00

(5) Temple Street - From Cassia Boulevard to Greenway Avenue

Number	Description	Quantity	Unit	Unit Cost	Total
1	48"x76" RCP	442	LF	$96.00	$42,432.00
2	34"x53" RCP	312	LF	$60.00	$18,720.00
3	24" RCP	37	LF	$32.00	$1,184.00
4	Inlets	5	EA	$5,500.00	$27,500.00
				Total	$89,836.00

(6) Ocean Spray Avenue - From Temple Street to the East

Number	Description	Quantity	Unit	Unit Cost	Total
1	34"x53" RCP	276	LF	$60.00	$16,560.00
2	29"x45" RCP	797	LF	$54.00	$43,038.00
3	24" RCP	148	LF	$32.00	$4,736.00
4	Inlets	8	EA	$5,500.00	$44,000.00
				Total	$108,334.00

(7) Greenway Avenue - From Royal Palm Court to Cocoplum Court

Number	Description	Quantity	Unit	Unit Cost	Total
1	24"x38" RCP	1,046	LF	$46.00	$48,116.00
2	24" RCP	317	LF	$32.00	$10,144.00
3	Inlets	13	EA	$3,500.00	$45,500.00
				Total	$103,760.00

General Construction Items

Number	Description	Quantity	Unit	Unit Cost	Total
1	Pavement Repair	6,400	SY	$25.00	$160,000.00
2	Curb Repairs	4,300	LF	$20.00	$86,000.00
3	Sodding	3,500	SY	$2.25	$7,875.00
4	Subsurface Drains	1,000	SY	$27.00	$27,000.00
5	Conflict Manholes	20	EA	$3,500.00	$70,000.00
				Total	$350,875.00

Exfiltration System

Number	Description	Street Length	Trench Length	Unit Cost	Total
1	Elwood Avenue From Slough East to SR A-1-A	500	1,000	$60.00	$60,000.00
2	Glenwood Avenue From Slough East to SR A-1-A	750	1,500	$60.00	$90,000.00
3	Harwood Avenue From Slough East to SR A-1-A	750	1,500	$60.00	$90,000.00
4	Norwood Avenue From Slough East to SR A-1-A	300	600	$60.00	$36,000.00
5	Cinnamon Drive From Slough East to SR A-1-A	500	1,000	$60.00	$60,000.00
6	Cassia Boulevard From Slough East to SR A-1-A	600	1,200	$60.00	$72,000.00
7	Ocean Spray Avenue From Slough East to SR A-1-A	700	1,400	$60.00	$84,000.00
8	Skyline Boulevard From Slough East to SR A-1-A	800	1,600	$60.00	$96,000.00
9	Inlets		31	$2,500.00	$77,500.00
10	Repairs		1,250	$25.00	$31,250.00
				Total	$696,750.00

Baffle Box

Number	Description	Quantity	Unit	Unit Cost	Total
1	Baffle Box(small)	4	EA	$8,000.00	$32,000.00
2	Control Weir(100')	1	LS	$35,000.00	$35,000.00
				Total	$67,000.00

Subtotal	$2,267,561.00
10% Contingency	$226,756.10
Design Contingency	$340,134.15
Grand Total	**$2,834,451.25**

SECTION 4

LORI LAINE SHOPPING CENTER BASIN

The Lori Laine Shopping Center Basin is a 153.82 acre Basin which is 100% residential. The basin is bounded by Park Avenue on the north, Cinnamon Drive on the south, State Road A-1-A on the east and Thyme Street on the west. The runoff from the Basin runs westerly via overland flow and existing culverts and discharges under South Patrick Drive via an existing 42" CMP. The 42" CMP has a capacity of 35 ± cfs and the existing system only discharges 10 cfs from a 5-year-24-hour event.

Table V depicts the standing water/flooding that exist for a 5-year-24-hour storm event with and without the master plan improvements. Also, shown are the standing water flooding conditions for the 25-year-24-hour storm event with the master plan improvements.

TABLE V

DESCRIPTION/LOCATION		DEPTH OF STANDING WATER		
	LORI LAINE BASIN	EXISTING SYSTEM 5 YEARS	MASTER PLAN 5 YEARS	MASTER PLAN 25 YEARS
1	Sherwood Avenue & Lemon Street	20"	18"	30"
2	Sherwood Avenue & Teakwood Avenue	8"	3"	11"
3	Sherwood Avenue & Thyme Street	13"	12"	20"
4	Sherwood Avenue & Kale Street	6"	0"	3"
5	Sherwood Avenue & Temple Street	6"	0"	3"
6	Sherwood Avenue & Magnolia Street	4"	0"	5"
7	Sherwood Avenue & Tangelo Street	6"	0"	5"
8	Hamlin Avenue & Kale Street	18"	6"	9"
9	Temple Street & Elwood Avenue	10"	0"	5"
10	Glenwood Avenue & Harwood Avenue	8"	0"	4"
11	Glenwood Avenue & Thyme Street	12"	0"	5"
12	Glenwood Avenue & Kale Street	18"	0"	9"
13	Glenwood Avenue & Temple Street	10"	4"	11"
14	Harwood Avenue & Thyme Street	12"	0"	7"
15	Harwood Avenue & Kale Street	13"	4"	12"
16	Harwood Avenue & Temple Street	7"	7"	12"
17	Norwood Avenue & Thyme Street	18"	8"	12"
18	Norwood Avenue & Kale Street	11"	0"	0"
19	Norwood Avenue & Temple Street	7"	0"	0"

The recommended approach to reduce the standing water/flooding is as follows:

(1.) Provide oval RCP connection to Park Avenue at Avocado Street and Pineapple Street.

(2.) Replace existing culvert along Thyme Street, Sherwood Avenue, Kale Street, Temple Street, Hamlin Avenue and Tangelo Street with oval RCP.

The master plan improvements demonstrates a significant improvement for the 5-year-24-hour storm event. Therefore, the improvements are recommended.

The estimated mass load reduction due to the above BMP's is as follows:

Description	% Reduction
TSS	6
TN	6
TP	6

The engineer's estimated costs of construction are as follows:

Lori Laine Shopping Center Basin

Estimated Cost to Construct Improvements

(1) Sherwood Avenue - From Avocado Street to Thyme Street

Number	Description	Quantity	Unit	Unit Cost	Total
1	34"x53" RCP	585	LF	$60.00	$35,100.00
2	18" RCP	94	LF	$24.00	$2,256.00
3	Inlets	8	EA	$3,500.00	$28,000.00
				Total	$65,356.00

(2) Thyme Street - From Harwood Avenue to Sherwood Avenue

Number	Description	Quantity	Unit	Unit Cost	Total
1	24"x38" RCP	294	LF	$46.00	$13,524.00
2	29"x45" RCP	393	LF	$54.00	$21,222.00
3	18" RCP	110	LF	$24.00	$2,640.00
				Total	$37,386.00

(3) Sherwood Avenue - From Hamlin Avenue to Kale Street

Number	Description	Quantity	Unit	Unit Cost	Total
1	49"x76" RCP	523	LF	$96.00	$50,208.00
2	24" RCP	320	LF	$32.00	$10,240.00
3	Inlets	7	EA	$3,500.00	$24,500.00
				Total	$84,948.00

(4) Kale Street - From Harwood Avenue to Sherwood Avenue

Number	Description	Quantity	Unit	Unit Cost	Total
1	49"x76" RCP	286	LF	$96.00	$27,456.00
2	34"x53" RCP	325	LF	$60.00	$19,500.00
3	29"x45" RCP	265	LF	$54.00	$14,310.00
4	24" RCP	220	LF	$32.00	$7,040.00
5	Inlets	13	EA	$3,500.00	$45,500.00
				Total	$113,806.00

(5) Hamlin Avenue - From Kale Street to Temple Street

Number	Description	Quantity	Unit	Unit Cost	Total
1	38"x60" RCP	1,032	LF	$68.00	$70,176.00
2	Inlets	4	EA	$4,500.00	$18,000.00
				Total	$88,176.00

(6) Temple Street - From Harwood Avenue to Hamlin Avenue

Number	Description	Quantity	Unit	Unit Cost	Total
1	29"x45" RCP	154	LF	$54.00	$8,316.00
2	24"x38" RCP	479		$46.00	$22,034.00
3	24" RCP	192	LF	$32.00	$6,144.00
4	Inlets	11	EA	$3,500.00	$38,500.00
				Total	$74,994.00

(7) Interconnect on Tangelo Street

Number	Description	Quantity	Unit	Unit Cost	Total
1	24"x38" RCP	220	LF	$46.00	$10,120.00
				Total	$10,120.00

(8) Tangelo Street - From Glenwood Avenue to Ellwood Avenue

Number	Description	Quantity	Unit	Unit Cost	Total
1	19"x30" RCP	292	LF	$40.00	$11,680.00
2	Inlets	4	EA	$3,500.00	$14,000.00
				Total	$25,680.00

General Construction Items

Number	Description	Quantity	Unit	Unit Cost	Total
1	Pavement Repair	6,400	SY	$25.00	$160,000.00
2	Curb Repairs	7,000	LF	$20.00	$140,000.00
3	Sodding	6,900	SY	$2.25	$15,525.00
4	Subsurface Drains(6")	2,000	LF	$27.00	$54,000.00
5	Conflict Manholes	30	EA	$3,500.00	$105,000.00
				Total	$474,525.00

Baffle Box

Number	Description	Quantity	Unit	Unit Cost	Total
1	Baffle Box(large)	1	EA	$20,000.00	$20,000.00
				Total	$20,000.00

Subtotal	$994,991.00
10% Contingency	$99,499.10
Design Contingency	$149,248.65
Grand Total	**$1,243,738.75**

SECTION 5

PARK AVENUE BASIN

Park Avenue Basin is a 100% residential use. The basin is centered on Park Avenue and is bounded by South Patrick Drive on the west and State Road A-1-A on the east. The runoff from the Basin is collected by a piped stormwater management system and routed to South Patrick Drive and flows either south to a 42" CMP at Lori Laine Shopping Center, or north to the 8'x10' concrete box culvert at Roosevelt Avenue.

Table VI shows the standing water/flooding depth for the 5-year-24-hour storm event with and without the master plan improvements. Also, shown are the results for the 25-year-24-hour storm event with master plan improvements.

TABLE VI

DESCRIPTION/LOCATION		DEPTH OF STANDING WATER		
PARK AVENUE BASIN		EXISTING SYSTEM 5 YEAR	MASTER PLAN 5 YEAR	MASTER PLAN 25 YEAR
1	Park Avenue Between South Patrick and Avocado Street	12"	0"	8"
2	Park Avenue & Avocado Street	8"	0"	5"
3	Park Avenue Between Avocado St. and Pineapple Street	15"	12"	15"

The recommended approach to reduce the standing water/flooding is as follows:

(1.) Replace the existing piping system with oval RCP and round RCP.

The estimated pollutant load reduction is as follows (and shown in Appendix "A").

Exfiltration system should be installed in the easternmost 500 feet of the Basin.

Description	% Reduction
TSS	18
TN	18
TP	17

Following is the Engineer's estimated costs for the recommended improvements.

Park Avenue Basin

Estimated Cost to Construct Improvements

(1) South Patrick Drive

Number	Description	Quantity	Unit	Unit Cost	Total
1	5'x8' Box Culvert	608	LF	$400.00	$243,200.00
2	Inlets	8	EA	$5,500.00	$44,000.00
				Total	$287,200.00

(2) Park Avenue - From South Patrick Drive to Pineapple Street

Number	Description	Quantity	Unit	Unit Cost	Total
1	43"x68" RCP	3,734	LF	$82.00	$306,188.00
2	24" RCP	160	LF	$32.00	$5,120.00
3	Inlets	9	EA	$4,500.00	$40,500.00
				Total	$351,808.00

(3) Interconnect at Avocado Street

Number	Description	Quantity	Unit	Unit Cost	Total
1	34"x53" RCP	254	LF	$60.00	$15,240.00
				Total	$15,240.00

(4) Interconnect at Pineapple Street

Number	Description	Quantity	Unit	Unit Cost	Total
1	49"x76" RCP	28	LF	$96.00	$2,688.00
2	Inlets	2	EA	$4,500.00	$9,000.00
				Total	$11,688.00

(5) Park Avenue - From Pineapple Street to Magnolia Street

Number	Description	Quantity	Unit	Unit Cost	Total
1	18" RCP	304	LF	$24.00	$7,296.00
2	24" RCP	707	LF	$32.00	$22,624.00
3	30" RCP	1,267	LF	$36.00	$45,612.00
4	Inlets	17	EA	$3,500.00	$59,500.00
				Total	$135,032.00

General Construction Items

Number	Description	Quantity	Unit	Unit Cost	Total
1	Pavement Repair	15,000	SY	$25.00	$375,000.00
2	Curb Repairs	7,500	LF	$20.00	$150,000.00
3	Sodding	4,000	SY	$2.25	$9,000.00
4	Subsurface Drains(6")	1,000	LF	$27.00	$27,000.00
5	Conflict Manholes	30	EA	$3,500.00	$105,000.00
				Total	$666,000.00

Exfiltration System

Number	Description	Street Length	Trench Length	Unit Cost	Total
1	Park Avenue From Slough East to SR A-1-A	400	800	$60.00	$48,000.00
2	Sherwood Avenue From Slough East to Cul-de-sac	300	600	$60.00	$36,000.00
3	Inlets		7	$2,500.00	$17,500.00
4	Repair		280	$25.00	$7,000.00
				Total	$108,500.00

Subtotal	$1,575,468.00
10% Contingency	$157,546.80
Design Contingency	$236,320.20
Grand Total	**$1,969,335.00**

SECTION 6

ROOSEVELT AVENUE BASIN

The Roosevelt Avenue Basin is a 139 ± acre consisting of a 90% residential, 7% industrial and 3% commercial uses. All runoff flows overland to the piped system along Roosevelt Avenue. Once the runoff has been collected, it is routed west to South Patrick Drive where discharge is via an 8'x10' existing concrete box culvert.

No improvements are anticipated for this Basin with the exception being exfiltration near State Road A-1-A.

The engineer's estimated cost of the master plan improvements is as follows.

Roosevelt Avenue Basin

Estimated Cost to Construct Improvements

Exfiltration System

Number	Description	Street Length	Trench Length	Unit Cost	Total
1	Roosevelt Avenue From Slough East to SR A-1-A	300	600	$60.00	$36,000.00
2	Seawind Drive From Slough East to Cul-de-sac	300	600	$60.00	$36,000.00
3	Inlets		6	$2,500.00	$15,000.00
4	Repair		240	$25.00	$6,000.00
				Total	$93,000.00

Subtotal	$93,000.00
10% Contingency	$9,300.00
Design Contingency	$13,950.00
Grand Total	**$116,250.00**

SECTION 7

GRANT AVENUE BASIN

The Grant Avenue Basin is a 138.82 acre Basin which contains 100% residential use. All runoff flows south and north to an existing conveyance system on Grant Avenue via overland flow and existing pipes. The runoff is conveyed west to South Patrick Drive where flow proceeds south along South Patrick Drive to Roosevelt Avenue.

Table VII depicts the standing water/flooding conditions with and without the master plan improvements for the 5-year-24-hour storm event. Also shown are the standing water/flooding conditions with the master plan improvements for the 25-year-24-hour storm event. The model indicates that the function of the system is significantly improved with implementation of the master plan improvements.

The estimated mass load pollutant reductions are as follows and as shown in Appendix "A":

Description	%Reduction
TSS	36
TN	35
TP	31

TABLE VII

DESCRIPTION/LOCATION		DEPTH OF STANDING WATER		
	GRANT AVENUE BASIN	EXISTING SYSTEM 5 YEARS	MASTER PLAN 5 YEARS	MASTER PLAN 25 YEARS
1.	Jackson Avenue and Pineapple Avenue	5"	0"	4"
2.	Jackson Avenue and Orange Street	4"	0"	8"
3.	Lee Avenue	5"	0"	4"
4.	Grant Avenue and Pineapple Street	12"	0"	2"
5.	Grant Avenue ½ Block East of Orange Street	10"	0"	12"
6.	Wilson Avenue ½ Block East of Orange Street	14"	0"	15"
7.	Sheridan Avenue ½ Block East of Orange Street	12"	0"	10"

The following are the Engineer's estimates of the cost of the master plan improvements.

Grant Avenue Basin

Estimated Cost to Construct Improvements

(1) Avocado Street - From Jackson Avenue to Sheridan Avenue

Number	Description	Quantity	Unit	Unit Cost	Total
1	18" RCP	1,256	LF	$22.00	$27,632.00
2	Inlets	12	EA	$3,500.00	$42,000.00
				Total	$69,632.00

(2) Pineapple Street - From Jackson Avenue to Sheridan Avenue

Number	Description	Quantity	Unit	Unit Cost	Total
1	18" RCP	1,547	LF	$22.00	$34,034.00
2	Inlets	19	EA	$3,500.00	$66,500.00
				Total	$100,534.00

(3) Orange Street - From Jackson Avenue to Grant Avenue

Number	Description	Quantity	Unit	Unit Cost	Total
1	18" RCP	620	LF	$22.00	$13,640.00
2	Inlets	6	EA	$3,500.00	$21,000.00
				Total	$34,640.00

(4) Grant Avenue - From Orange Street to Magnolia Street

Number	Description	Quantity	Unit	Unit Cost	Total
1	30" RCP	1,352	LF	$36.00	$48,672.00
2	Inlets	3	EA	$3,500.00	$10,500.00
				Total	$59,172.00

General Construction Items

Number	Description	Quantity	Unit	Unit Cost	Total
1	Pavement Repair	4,000	SY	$25.00	$100,000.00
2	Curb Repairs	7,500	LF	$20.00	$150,000.00
3	Sodding	4,000	SY	$2.25	$9,000.00
4	Subsurface Drains(6")	1,000	LF	$27.00	$27,000.00
5	Conflict Manholes	30	EA	$3,500.00	$105,000.00
				Total	$391,000.00

Exfiltration System

Number	Description	Street Length	Trench Length	Unit Cost	Total
1	Grant Avenue From Slough East to SR A-1-A	400	800	$60.00	$48,000.00
2	Lincoln Street From Grant Avenue to Lee Avenue	300	600	$60.00	$36,000.00
3	Washington Street From Sheridan Avenue to Grant Avenue	300	600	$60.00	$36,000.00
3	Inlets		8	$2,500.00	$20,000.00
4	Repair		320	$25.00	$8,000.00
				Total	$148,000.00

Baffle Box

Number	Description	Quantity	Unit	Unit Cost	Total
1	Baffle Box(large)	1	EA	$20,000.00	$20,000.00
				Total	$20,000.00

Subtotal	$822,978.00
10% Contingency	$82,297.80
Design Contingency	$123,446.70
Grand Total	**$1,028,722.50**

SECTION 8

SUMMARY

SUMMARY AND RECOMMENDATIONS

Based on the Hydrologic Tests performed for the Storm Water Drainage Plan, the ground water conditions encountered and estimates for the seasonal high Ground Water Tables (GWT), as shown in Appendix "E", it appears that the anticipated use of exfiltration systems for the discharge of stormwater will be available for practical application in the most easterly and some westerly portions of the City. The profiles of the GWT indicate a seasonal high ground water table 16" to 24" below existing grade in the area west of the projected north/south line of Tangelo Street to 42" to 60" below existing grade in the area east of a projected north/south line (parallel with S.R. A1A). The GWT encountered while performing hydraulic conductivity tests and the soil profiles was 3' to 4' below grade in a majority of the test holes indicating that more exfiltration is possible if the GWT did not rise during the rainy season.

The gradient of the Ground Water Table typically parallels the contour of the existing surface elevation which in this case is the General Street Profile from east to west. With this general gradient from east to west the elevation of the GWT is controlled by the free water surface level of the Grand Canal for the westerly portion of the City and the Atlantic Ocean for the most easterly portion of the City. The GWT elevations in the westerly portion (within 1500' to 3500' east of South Patrick Drive) are detrimental to many of the street pavement structures.

Most of the street flooding problems exist due to accumulated runoff from the areas in the eastern sections of the City and those streets which drain east from South Patrick Drive to the low existing points.

As an alternate approach, to exfiltration only, in areas where there is not adequate distance from the ground surface to the seasonal high ground water table of 3' to 4', a controlled GWT could be considered utilizing underdrains to keep the seasonal GWT at the predetermined elevation of the ordinary or dry season level in order to provide more utilization of soil storage and delay of peak flows with the use of exfiltration. This method is costly and maintenance intensive but will allow more extensive use of the exfiltration systems in areas where the seasonal GWT rises to within the 16" to 24" of the surface. Underdrains are complicated to construct and a high degree of quality control during construction is essential. This provides for removal of surface water from the roadways via storage in the pipelines and a longer duration to dissipate the peak rate of discharge. It also provides for the filtration of the collected stormwater runoff prior to discharge into the canals and ultimately the Indian River Lagoon System.

With development at 96% saturation within the City there is not an economical/practical way of providing a storm water conveyance and management system which can meet current quantitative regulatory requirements (25-year frequency 24 hour event) with limiting discharge values and providing retention/ detention facilities to meet water quality standards.

This drainage problem lends itself to utilizing an exfiltration concept in those areas adjacent to and within 1000' to 1500' west of A-1-A to limit the amount of runoff generated and draining west. For those areas in the westerly section there would be a concept of using a piped structural approach with sediment basin traps (baffle box, etc.) strategically placed along major outfalls. Though this concept is a maintenance intensive approach, the method can provide a magnitude of treatment for storm water generated by the developed areas in the City of Satellite Beach while providing for the conveyance of excess storm water runoff. The quantitative limits are based on the limiting capacity of the major outfalls which presently exist under South Patrick Drive.

A recommended approach to the implementation of this proposed concept would be:

1. Design, permit and construct the proposed exfiltration system in the eastern areas adjacent to A-1-A. This in turn will reduce the pollutant loading as well as tributary runoff from the eastern portions of the drainage basins which generate and direct stormwater runoff to the outfall systems draining to the west which are overloaded and contribute to the flooding during ordinary rainfall events.

2. Prepare the designs and working drawings for the Jamaica Boulevard diversion system. Upon completion of the designs, obtain the SJRWMD Permit.

3. The westerly portions of the drainage basins have been designed and sized for conveyance based on the appropriate outfall capacities for each drainage basin. As the conveyance systems are designed, locate the baffle box/sediment basins at the most critical places to provide for water quality treatment of the storm water prior to discharge into the major east/west outfalls.

4. Construction sequencing of the piped structural systems should begin in the down stream systems and work up stream in each basin with priorities set for the implementation to provide the most relief of flooding and water quality improvement.

5. Another option the City may wish to consider would be the control of the seasonal high GWT which can and does create the deterioration of roadways and "over the curb" flow of ground water which can be a hazard to the pedestrian public due to algae and slime growth on the curbs and sidewalks.

HYDROGRAPHIC INVESTIGATION

Ground water conditions in the City vary from a depth of 2' to 5' for most of the year with seasonal depth of 16" to 24" for the wet season with a general ground water flow pattern from east to west similar to the existing topography. Elevation profiles of the street grades and the ground water table (normal and seasonal high) are presented in Appendix "D" and "E" to assist in a better understanding of the circumstances within the City regarding the groundwater table and its influence on stormwater runoff.

These high ground water conditions in the City are dictated by the location of the Dunes and Savannahs created during the geologic formation of the Barrier Island. The dune was formed as the island grew to the east with savannah formation being the result of each dune being deposited. As the dune grows towards the ocean the savannah becomes a low area where vegetation can grow. When the vegetation dies it is mixed with the fine sands which are wind blown from the dunes and results in an organic/fine sand mixture and a "hard pan" deposit is created by the natural process. These dune/savannah formations are illustrated on the existing drainage system maps in Appendix "B" and basically show the locations of low ground water movement capacity as well as the reasons for high ground water conditions in the wet seasons. The ground water movement from east to west is restricted by the periodic locations of these savannahs in a north-south direction. These savannahs in effect act somewhat like a dam and block this movement due to the low hydraulic conductivities of the hard pan formation. Thus, ground water flows have to go under or over these hard-pan formations in order to flow east to west

The soils within the limits of the Project are identified in the following TABLE.

SOIL CLASSIFICATION TABLE

Label	Name	USDA Classification	%
We	Welaka Sand	A	5.9
Pb	Palm Beach Sand	A	10.4
Ga	Galveston - Urban Land Complex	A	34.6
Ps	Pomello Sand	C	6.9
Pu	Pomello - Urban Land Complex	C	40.9
Pw	Pompano Sand	A/D	1.1
Mk	Myakka Sand	D	0.2

The USDA - Soil Conservation Service Soil Classifications are per the "Soil Survey of Brevard County, Florida" issued November 1974. Since the basins contain approximately 51 percent type "A" soils, all curve numbers will be based upon type "A" soils.

The hydraulic conductivities and soil profiles in Appendix "E" are presented as a part of this report. Also shown in Appendix "D" are color plots of the profiles for the normal water table, estimated wet season water table and roadway centerline for each street where the tests were performed. The data clearly depicts the existing condition of low elevations between higher elevations and a water table profile from east to west which is nearer the surface of the road at the low elevations. The hydraulic gradient for the water table reduces at the point where the lower elevations are and shows a dramatic reduction/impact in the hydraulic conductivity rates for the insitu soils. Graphically, the rates show a significant reduction in the areas where the water table is closer to the surface elevation. In areas where a greater distance exists between the surface elevation and the water table, a higher hydraulic conductivity rate exists.

TABLE OF EXISTING DRAINAGE OUTFALLS

UNDER SOUTH PATRICK DRIVE

Constructed by the FDOT or The City of Satellite Beach

LOCATION OF OUTFALL ALONG SOUTH PATRICK DRIVE	OUTFALL SIZE	AVAILABLE OUTFALL CULVERT CAPACITY IN CFS	DRAINAGE AREA ACRE	BASIN'S EXISTING DISCHARGE CAPABILITY CFS***
South Ditch	52 X 39 CMP	180	158	70
Desoto Parkway	4'X8' Box Culvert	128	296	26
Cassia Blvd.	4'X9' Box Culvert	144	156	10
Lori Laine Shopping Center(Incl. Park Ave.)	42" R.C.P.	35	184	10
Roosevelt Avenue (Incl Grant Avenue)	5'X10' Box Culvert	185	193	70

***WITH CURRENT STREET FLOODING AND EXISTING DRAINAGE SYSTEM CONFIGURATION

CORRECTIVE APPROACHES

Alternate approaches to the correction of the current drainage situation include an extensive maintenance/repair program and/or the development of an overall master plan to reconstruct the system using the existing outfalls as the limiting factor on the capacity of the drainage system.

Alternate No. 1

An attempt to improve maintenance and repairs to the existing system would not improve the overall capacity nor improve water quality of the system. The existing system is maintained by the City Public Works Department on a regular if not daily basis. But most of the piping that is CMP cannot be cleaned due to structural deterioration. The existing RCP is routinely examined and maintained as necessary but the size of these pipe are the limiting factor with respect to capacity.

Alternate No. 2

The second alternative which examines an overall master plan for the City is limited to the existing discharge capabilities of the outfalls under South Patrick Drive but does provide for extensive relief from the existing flood conditions. This combines a structural approach along with proposed structures to be strategically located in the system to improve water quality of the storm water discharge. The added exfiltration systems west of A1A will reduce discharge for a 5-year storm but will most likely overflow to the main drainage system upon a rainfall event beyond a 5-year recurrence.

Analysis of the existing system beyond a 5-year frequency only indicates an increase in the depth of the flooded conditions.

PRIORITIZATION OF PROPOSED IMPROVEMENTS

Based upon calibrated models and actual working systems, there is a marked improvement in the function of the systems. The peak discharge rate is reduced and delayed. Further, by percolating the runoff to the ground water table, the pollutant load is dramatically reduced (30 to 80 percent). Therefore, the exfiltration systems are all a priority #1. Since the focus of this study is to reduce pollutant loading, entering the Indian River Lagoon baffle boxes, etc. are priority #2. Finally, the structural (pipe, box, etc.) improvements are priority #3.

The following table provides an itemized list of projects and their priority.

P1 - Priority 1
P2 - Priority 2
P3 - Priority 3

No.	Description	Basin	Classification	Cost
1.	Jamaica Boulevard	Desoto Parkway	P1	$ 490,000.00
2.	Grant Avenue, Lincoln Street and Washington Street	Grant Avenue	P1	$ 148,000.00
3.	Sherwood Avenue and Park Avenue	Park Avenue	P1	$ 108,500.00
4.	Ellwood Ave., Glenwood Ave., Harwood Ave., Norwood Ave., Cinnamon Dr., Cassia Blvd., Ocean Spray Ave. & Skyline Blvd	Cassia Blvd.	P1	$ 696,750.00
5.	Royal Palm Blvd., Coconut St., & Verbenia Ct.	Desoto Parkway	P1	$ 372,000.00
6.	Hibiscus Dr., Palm Dr. & Atlantic Dr.	South Ditch	P1	$1,351,500.00
7.	South Patrick Drive	Park Avenue	P2	$ 287,200.00
8.	Park Avenue from South Patrick Drive to Pineapple Street	Park Avenue	P2	$ 351,808.00

9.	Interconnect at Avocado Street	Park Avenue	P2	$ 15,240.00
10.	Interconnect at Pineapple Street	Park Avenue	P2	$ 11,688.00
11.	Park Avenue from Pineapple Street to Magnolia Street	Park Avenue	P2	$ 135,032.00
12.	Baffle Box	Grant Street	P2	$ 20,000.00
13.	Baffle Box	Desoto Parkway	P2	$ 32,000.00
14.	Baffle Box and Weir	Cassia Boulevard	P2	$ 67,000.00
15.	Baffle Box	Lori Laine Shopping Center	P2	$ 20,000.00
16.	Desoto Parkway from West Basin Limit to Verbenia Court	Desoto Parkway	P2	$ 754,362.00
17.	Cassia Boulevard	Cassia Boulevard	P2	$ 467,020.00
18.	Thyme Street from Cassia Boulevard to Norwood Avenue	Cassia Boulevard	P2	$ 60,922.00
19.	Kale Street from Cassia Boulevard to Norwood Avenue	Cassia Boulevard	P2	$ 80,778.00
20.	Temple Street and Norwood Avenue from Cassia Boulevard to Norwood Avenue	Cassia Boulevard	P2	$ 242,286.00
21.	Temple Street from Cassia Boulevard to Greenway Avenue	Cassia Boulevard	P2	$ 72,052.00
22.	Ocean Spray Avenue from Temple Street to the east.	Cassia Boulevard	P2	$ 108,334.00
23.	Greenway Avenue from Royal Palm Court to Cocoplum Court	Cassia Boulevard	P2	$ 103,760.00

24.	Avocado Street from Jackson Avenue to Sheridan Avenue	Grant Avenue	P2	$ 69,632.00
25.	Pineapple Street from Jackson Avenue to Sheridan Avenue	Grant Avenue	P2	$ 100,534.00
26.	Orange Street from Jackson Avenue to Grant Avenue	Grant Avenue	P2	$ 34,640.00
27.	Grant Avenue from Orange Street to Magnolia Street	Grant Avenue	P2	$ 59,172.00
28.	Sherwood Avenue from Avocado Street to Thyme Street	Lori Laine	P3	$ 65,356.00
29.	Thyme Street from Harwood Avenue to Sherwood Avenue	Lori Laine	P3	$ 37,386.00
30.	Sherwood Avenue from Hamlin Avenue to Kale Street	Lori Laine	P3	$ 84,948.00
31.	Kale Street from Harwood Avenue to Sherwood Avenue	Lori Laine	P3	$ 113,806.00
32.	Hamlin Avenue from Kale Street to Temple Street	Lori Laine	P3	$ 88,176.00
33.	Temple Street from Harwood Avenue to Hamlin Avenue	Lori Laine	P3	$ 74,994.00
34.	Interconnect on Tangelo Street	Lori Laine	P3	$ 10,120.00
35.	Tangelo Street from Glenwood Avenue to Ellwood Avenue	Lori Laine	P3	$ 25,680.00
36.	Ditch Along Satellite Beach Library Property	South Ditch	P3	$ 33,000.00
37.	Wimico Drive	South Ditch	P3	$ 72,400.00

The above costs do not include a 10% contingency for construction, a design contingency, and general construction costs (i.e. pavement repair, conflict manholes, etc.). These are costs to install the piping and the inlets associated with the piping. It is suggested, that prior to final implementations of these projects, a detailed cost estimate be prepared.

STORMWATER STANDARDS AND CRITERIA

The City of Satellite Beach currently has in place stormwater standards and criteria within their Land Development Regulations; Section 30-574- Design Standards. In Paragraph 30-574 (1) it is clearly stated that detention and retention systems shall be designed in conformance with SJRWMD Applicant's Handbook on management and storage of surface waters. The SJRWMD standards clearly address the criteria and standards for peak flow, runoff volume release rate, treatment, methodologies and groundwater recharge. Further, the City of Satellite Beach has in place flood plain storage protection in accordance with FEMA criteria. However, most of the City of Satellite Beach is above the FIRM "A" or "AE" flood zone elevation. In conclusion, the City of Satellite Beach via SJRWMD standards and criteria, already in place, has the appropriate stormwater standards and criteria.

APPENDIX "A"

WATER QUALITY ANALYSIS

Satellite Beach Stormwater Masterplan
Water Quality Modeling

INTRODUCTION

The City of Satellite Beach, located on the central Florida east coast, discharges stormwater to the Indian River. As part of the development of a stormwater masterplan for the City of Satellite Beach, the quality of the stormwater was investigated. The investigations were based on best available information, limited stormwater monitoring, and the use of a simple stormwater model. The modeling was conducted using the Watershed Management Model Version 4.

The primary objectives of the investigations and modeling were to determine the base-line mass loading for selected pollutants, and to use the information and model to evaluate future actions and the implementation of BMPs to improve water quality.

The investigations and approach are outlined below.

- Characterize the basin.
- Evaluate literature-based water quality information for various land use types.
- Evaluate water quality monitoring data.
- Determine event mean concentrations (EMC) for use in the mass load analysis and modeling.
- Estimate base-line mass loads for total suspended solids, total nitrogen, and total phosphorus.
- Evaluate the impact of BMPs on water quality.

BASIS FOR ANALYSIS

This section provides an overview of the information and data used in the analysis, and provides a limited amount of basin characterization information. A simple watershed model was used to determine annual mass loading from the stormwater basins. The model is suitable for a "screening-level" analysis.

Data and Information Sources

The following information was used in the analysis and modeling activities:

- Watershed Management Model Version 4.0.
- Model Local Government Stormwater Management Program, FDEP, 1993.
- Stormwater Loading Rate Parameters for the Central and South Florida, Harper, 1994.
- Water quality monitoring at the Grant Street Basin from July 1999 to February 2000.
- Land Use and basin data from Outlaw, Rice & Jones, Inc.

Study Area Characterization

The Satellite Beach area is divided into seven stormwater basins. The basins vary in size from 30.5 to 296 acres, with a total area of about 990 acres. Drainage is accomplished using both swale, and curb and gutter systems. An inlet/culvert system is used to convey the stormwater to five outfalls that discharge to the Indian River. Table 1 provides information regarding basin/outfall characteristics.

Table 1. Drainage Outfall Characteristics

Outfall	Contributing Basin	Outfall Description	Peak Discharge, cfs
Roosevelt Avenue	Grant Avenue or Roosevelt Avenue	5'x 10' Box Culvert	70
Lori Laine Shopping Center	Park Avenue and Lori Laine Shopping Center	42" RCP	10
Cassia Blvd.	Cassia Blvd	4' x 9' Box Culvert	10
Desoto Parkway	Desoto Parkway	4' x 8' Box Culvert	26
South Ditch	South Ditch	3-5'x6' Box Culverts	10

The watershed can be characterized as primarily residential, with a limited amount of light commercial (shopping and restaurants), institutional (schools and government) and light industrial land use. As shown in Table 2, which summarizes land use for each basin, residential (both single and mulit family) comprises approximately 90 % of the basin area.

Table 2. Land Use Data for Drainage Basins in Satellite Beach

Land Use	Basin Area, acres						
	Grant Avenue	Roosevelt	Park Avenue	Lori Laine	Cassia	Desoto	South Ditch
Single Family	111.6	43.8	30.5	153.4	85.8	272.3	122.4
Multi-Family	0.5	4.7	0.0	0.4	19.7	8.2	0.0
Commercial/Institutional	26.7	1.6	0.0	0.0	43.2	15.5	35.0
Light Industrial	0.0	4.0	0.0	0.0	7.6	0.0	0.0
Total	**138.8**	**54.1**	**30.5**	**153.8**	**156.3**	**296.0**	**157.4**

Water Quality Data

Water quality data is available for various land use types. The USEPA has accumulated pollutant concentration data for the United States under the National Urban Runoff Program (NURP). More recently, studies were conducted in 1994 for communities in the Central and

South Florida Area. Table 3 summarizes the data from the NURP study, as well as the 1994 study.

Table 3. Comparison of Concentrations from NURP and 1994 Study

Parameter	Single-Family		Multi-Family		Commercial/ Institutional		Light Industrial	
	NURP	1994 Study	NURP	1994 Study	NURP	1994 Study	NURP	1994 Study
Study Parameters								
TSS	140	27	102	71	91	81	108	102
Total Kjeldahl Nitrogen	2.35	-	1.44	-	1.28	-	-	-
Nitrate/Nitrite	0.96	-	0.67	-	0.63	-	-	-
Total Nitrogen	-	2.29	-	2.42	0	1.18	2.53	1.42
Total Phosphorus	0.47	0.30	0.33	0.49	0.24	0.15	0.42	0.31
Additional Parameters								
BOD	10.8	7.4	8.8	11.0	9.7	8.2	10	9.1
Lead	0.18	0.048	0.19	0.087	0.13	0.136	0.115	-

To supplement available data and to refine the input data for the modeling effort, water quality monitoring was conducted. The monitoring location was at the outfall located on Jackson Avenue. This outfall discharges stormwater from the Grant Street Basin. Base-line data was compile from the period of July 1999 through February 2000 and is presented in Table 4.

Table 4 Baseline Water Quality Data for Grant Avenue Basin (7/99 to 2/00), mg/l

Parameter	7/26/99	8/16/99	10/14/99	2/25/00	Average
Total Suspended Solids	1.0	1.3	2.6	1.6	1.6
Total Phosphorus	0.2	0.23	0.22	0.18	0.2
Nitrate/Nitrite	0.26	0.25	0.27	0.35	0.3
TKN	0.51	0.89	1.38	0.79	0.9
Total Nitrogen	0.77	1.14	1.65	1.15	1.2
Antimony	-	-	-	BDL	-
Arsenic	-	-	-	0.00638	-
Beryllium	-	-	-	BDL	-
Cadmium	-	-	-	BDL	-
Copper	-	-	-	0.00132	-
Chromium	-	-	-	0.00723	-
Lead	-	-	-	BDL	-
Mercury	-	-	-	BDL	-
Nickel	-	-	-	0.00269	-
Selenium	-	-	-	0.01507	-
Silver	-	-	-	BDL	-
Thallium	-	-	-	BDL	-

Data was also compiled during two storm events. Monitoring during these events was based on the following:

- Minimum period: 3 days with no more that 0.5" of rainfall.
- Minimum storm event: 0.5 inch.
- Sampler: ISCO 3700 with 4150 logger.
- Sample parameters: Total Phosphorus, Total Kjeldahl Nitrogen, Nitrate/Nitrite, Total Nitrogen, Total Suspended Solids, and Flow.
- Flow/Sample Increments: 10 to 30 minutes.

Tables 5 and 6 summarize the data from the two storm events.

Table 5 Monitoring Data from Storm Event 1 (11/21/99)

Item	1	2	3	4	5	Total	Average, mg/L
Duration, Minutes	10.0	10.0	20.0	10.0	40.0	90	-
Average Flow, gpm	1006	1425	939	467	179.0	-	-
Volume, gallons	10060	14250	18780	4670	7160	54,920	-
Concentration, mg/L							
TSS	169	125	52.8	29.3	14.7	-	85.85
Total Phosphorus	0.53	0.489	0.336	0.296	0.2	-	0.39
NO3/NO2	0.136	0.13	0.162	0.177	0.1	-	0.15
TKN	1.94	1.54	1	0.823	0.684	-	1.26
Total Nitrogen	2.076	1.67	1.162	1	0.825	-	1.40

Table 6 Monitoring Data from Storm Event 2 (1/6/00)

Item	1	2	3	4	5	Total	Average, mg/L
Duration, Minutes	10.0	10.0	30.0	30.0	30.0	110	-
Average Flow, gpm	2,840	4,446	4,547	3,751	2,023.0	-	-
Volume, gallons	28,400	44,460	13,6410	11,2530	60,690	382,490	-
Concentration, mg/L							
TSS	176	91	58.2	55.2	50.7	-	68.69
Total Phosphorus	0.491	0.388	0.327	0.275	0.2	-	0.32
NO3/NO2	0.104	0.087	0.084	0.071	0.1	-	0.08
TKN	1.94	1.43	0.83	0.749	0.577	-	0.92
Total Nitrogen	2.044	1.517	0.914	0.82	0.64	-	1.00

DATA ANALYSIS AND MODELING

The monitoring conducted for the Grant Street Basin consisted of a composite of flows from the land uses in the basin. Since the basin, (like the entire Satellite Beach area) is primarily residential, analysis focused on calibration of the residential pollutant concentrations. Data from

the 1994 study will be used in the model, unless monitoring indicates significant deviation from the literature values.

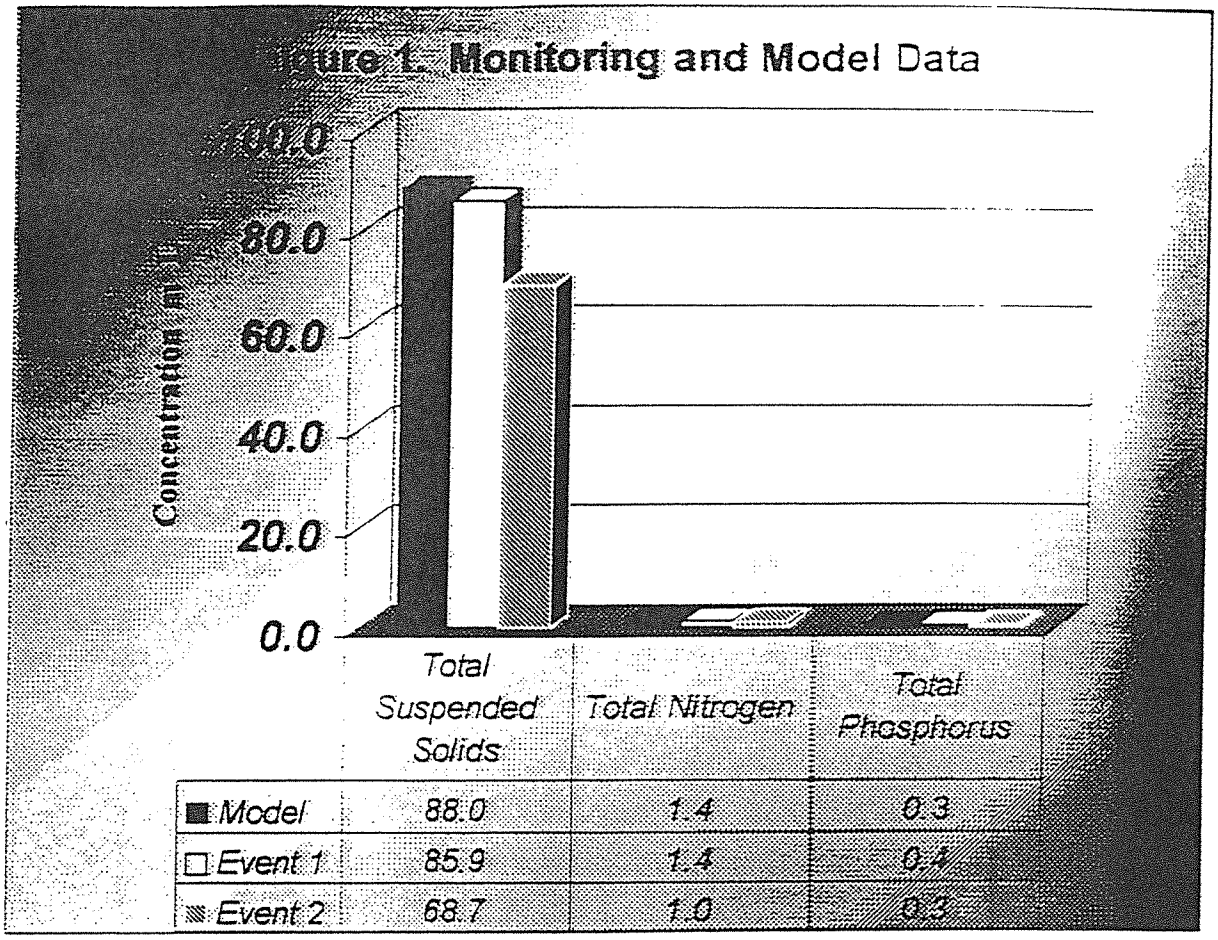
To validate, and if necessary, adjust the model input values; the monitoring data was compared to the literature values. For single-family residential, the literature values for the primary parameters were:

- Total Suspended Solids: 140 mg/L
- Total Phosphorus: 0.3 mg/L.
- Total Nitrogen: 2.3 mg/L.

Following a review and analysis of the data, the TSS concentration of 140 mg/l was very high compared to the flow-weighted average concentration from the monitoring data. TN was also found to be significantly higher that the flow-weighted average concentration. As a result, the model input parameters for TSS and TN were reduced to 90 and 1.5 mg/L, respectively. Table 8 and Figure 1 show the comparison of the revised model concentrations to the flow weighted monitoring data.

Table 8. Comparison of Model Input Data and Field Monitoring Data

Item	Model Concentrations, mg/L				Weighted Concentrations, mg/L		
	Total Suspended Solids	Total Nitrogen	Total Phosphorus	Land Use Percent	Total Suspended Solids	Total Nitrogen	Total Phosphorus
Single Family	90	1.5	0.30	80.4%	72.360	1.206	0.241
Multi-Family	70	2.4	0.49	0.4%	0.252	0.009	0.002
Commercial/Institutional	80	1.2	0.15	19.2%	15.360	0.230	0.029
Light Industrial	100	1.4	0.31	0.0%	0.000	0.000	0.000
Total	-	-	-	-	88.0	1.4	0.3
Storm Event 1							
Maximum	-	-	-	-	169.0	2.1	0.5
Average	-	-	-	-	85.9	1.4	0.4
Storm Event 2							
Maximum	-	-	-	-	176.0	0.5	2.0
Average	-	-	-	-	68.7	1.0	0.3



The model uses annual precipitation data, event mean concentrations for land use types, and limited watershed information to compute average annual mass loading. The impact of BMPs can also be assessed using the model. Input data for the model is presented in Table 9.

Table 9 Model Input Data

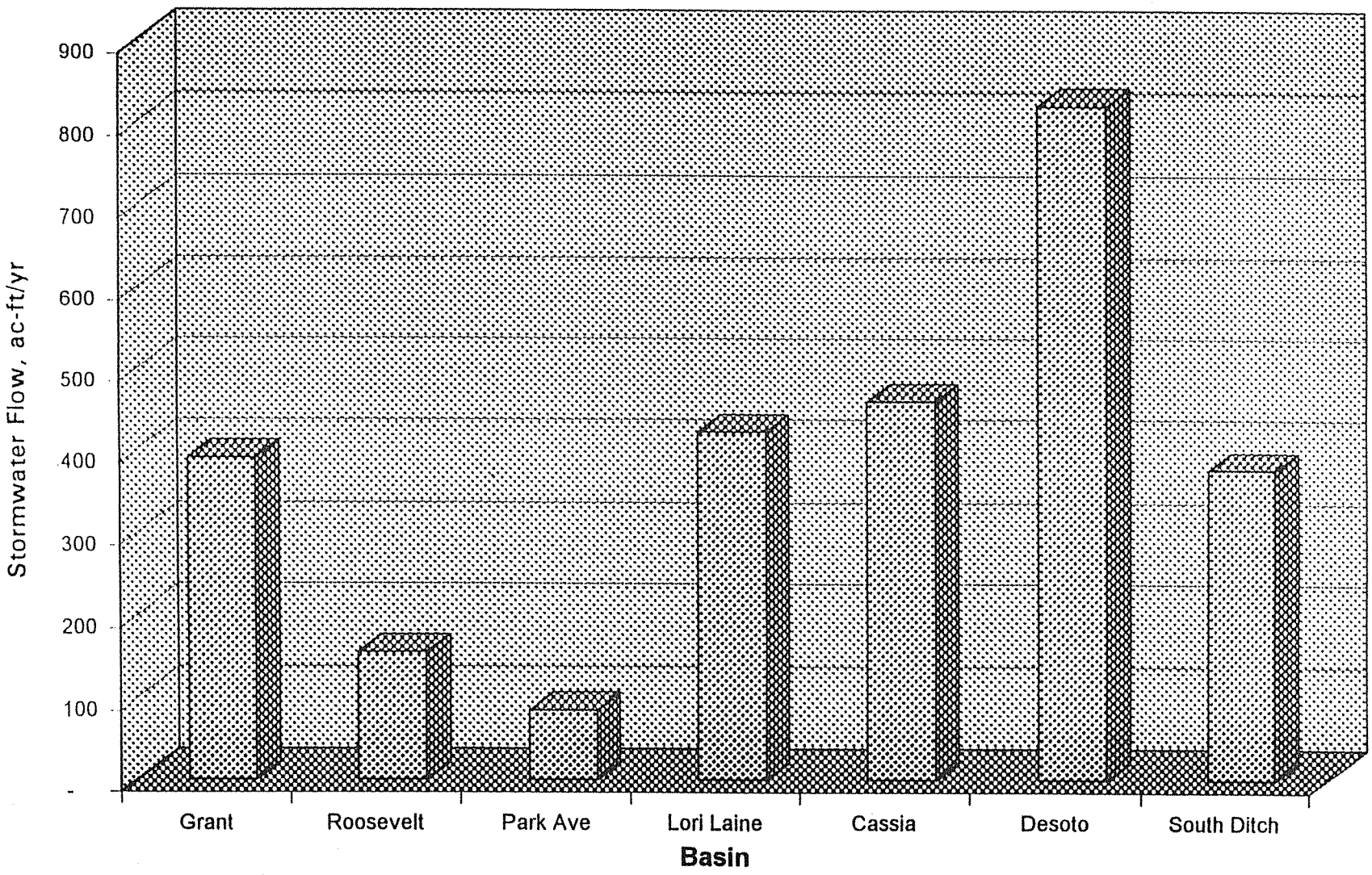
Model Parameter, mg/L unless noted	Single-Family Residential	Multi-Family Residential	Commercial/ Institutional	Light Industrial	General
TSS	90	70	80	100	-
Total Nitrogen	1.5	2.4	1.2	1.4	-
Total Phosphorus	0.30	0.49	0.15	0.31	-
Additional					
BOD	7.40	11.0	8.2	9.1	-
Lead	0.05	0.09	0.14	0.12	-
Impervious, %	50	60	60	80	-
Runoff					
Pervious, %	-	-	-	-	0.9
Impervious, %	-	-	-	-	0.2
Annual Rainfall, in	-	-	-	-	51

Based on the model input information model scenarios were conducted for average annual conditions. The modeling results are shown on Table 10. Flow and mass loading for TSS, TN and TP are shown in Figures 2, 3 and 4.

Table 10 Modeled Mass Loading By Basin

Parameter	Grant	Roosevelt	Park Ave	Lori Laine	Cassia	Desoto	South Ditch	Total
Basin Area, ac	139	54	31	154	156	296	157	987
Flow, ac-ft/yr	391	155	84	423	460	822	377	2,712
Annual Loading, lb/yr								
TSS	79,398	31,844	17,448	87,955	90,402	170,000	90,079	567,126
TN	1,302	561	291	1,469	1,622	2,870	1,471	9,586
TP	243	133	58	294	300	565	274	1,847

Figure 2. Annual Average Stomwater Flow By Basin



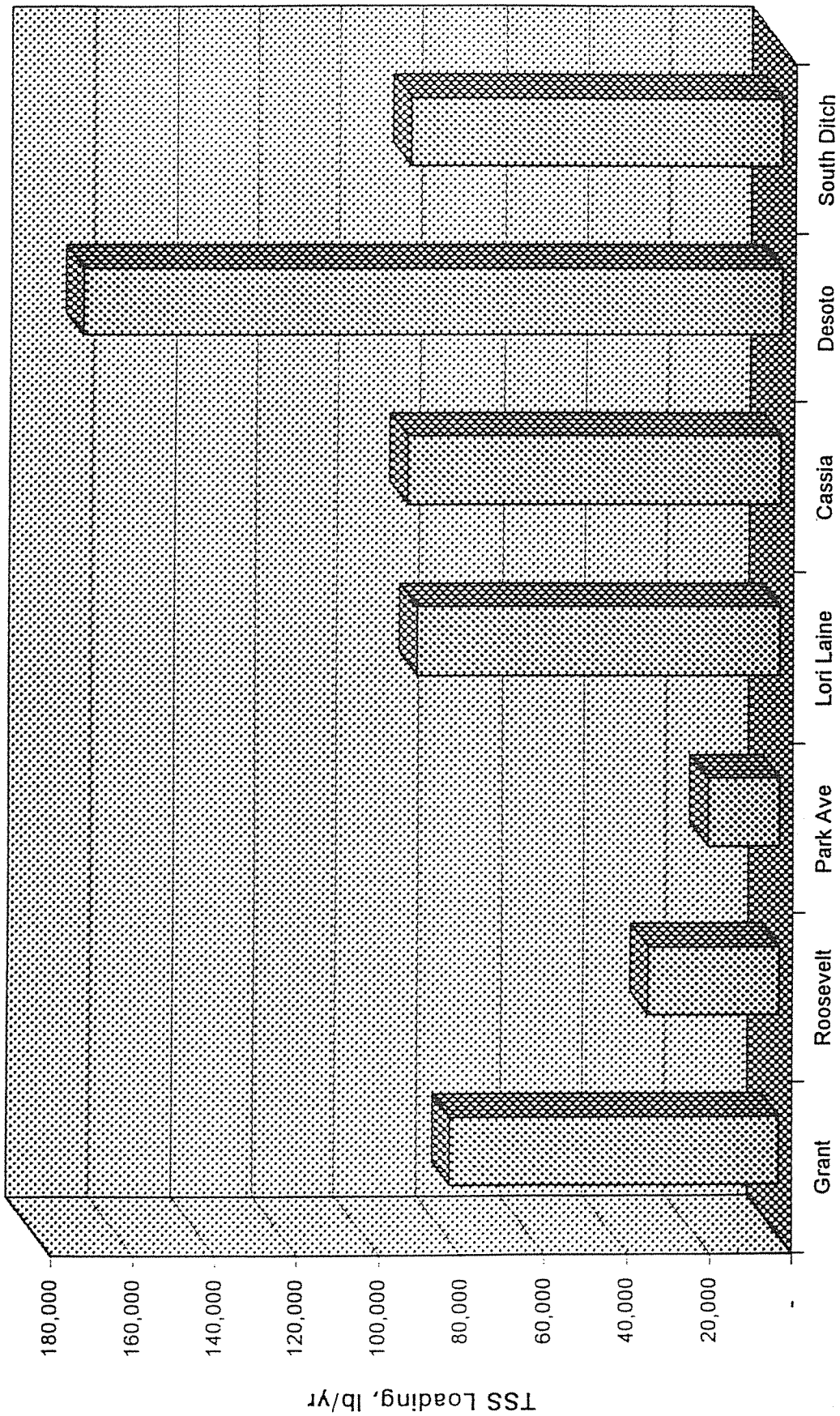


Figure 3. Annual Average TSS Loading By Basin
TSS Loading, lb/yr
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
-
Grant
Roosevelt
Park Ave
Lori Laine
Cassia
Desoto
South Ditch
Basin

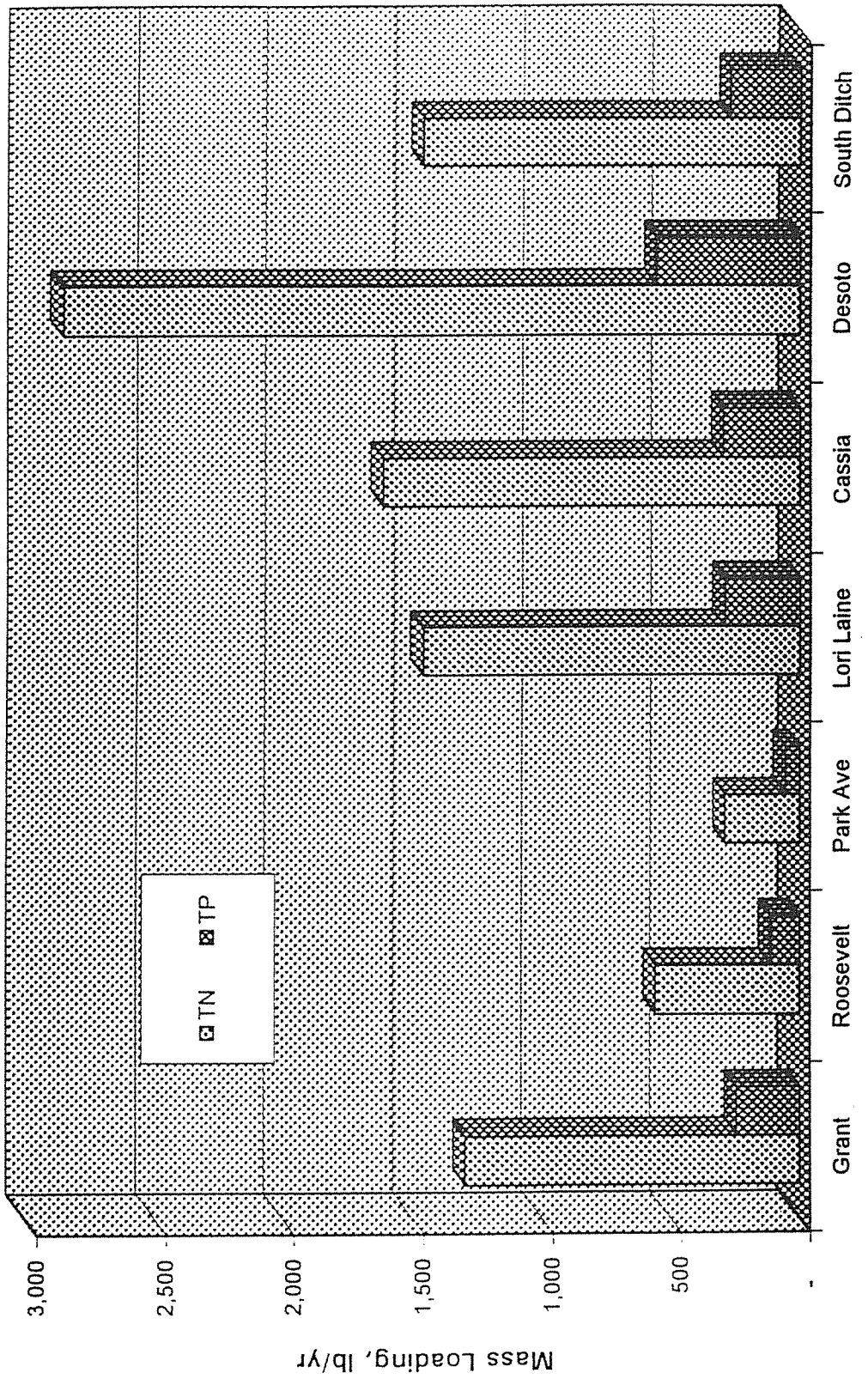


Figure 4. Annual Average TN and TP Mass Loadings

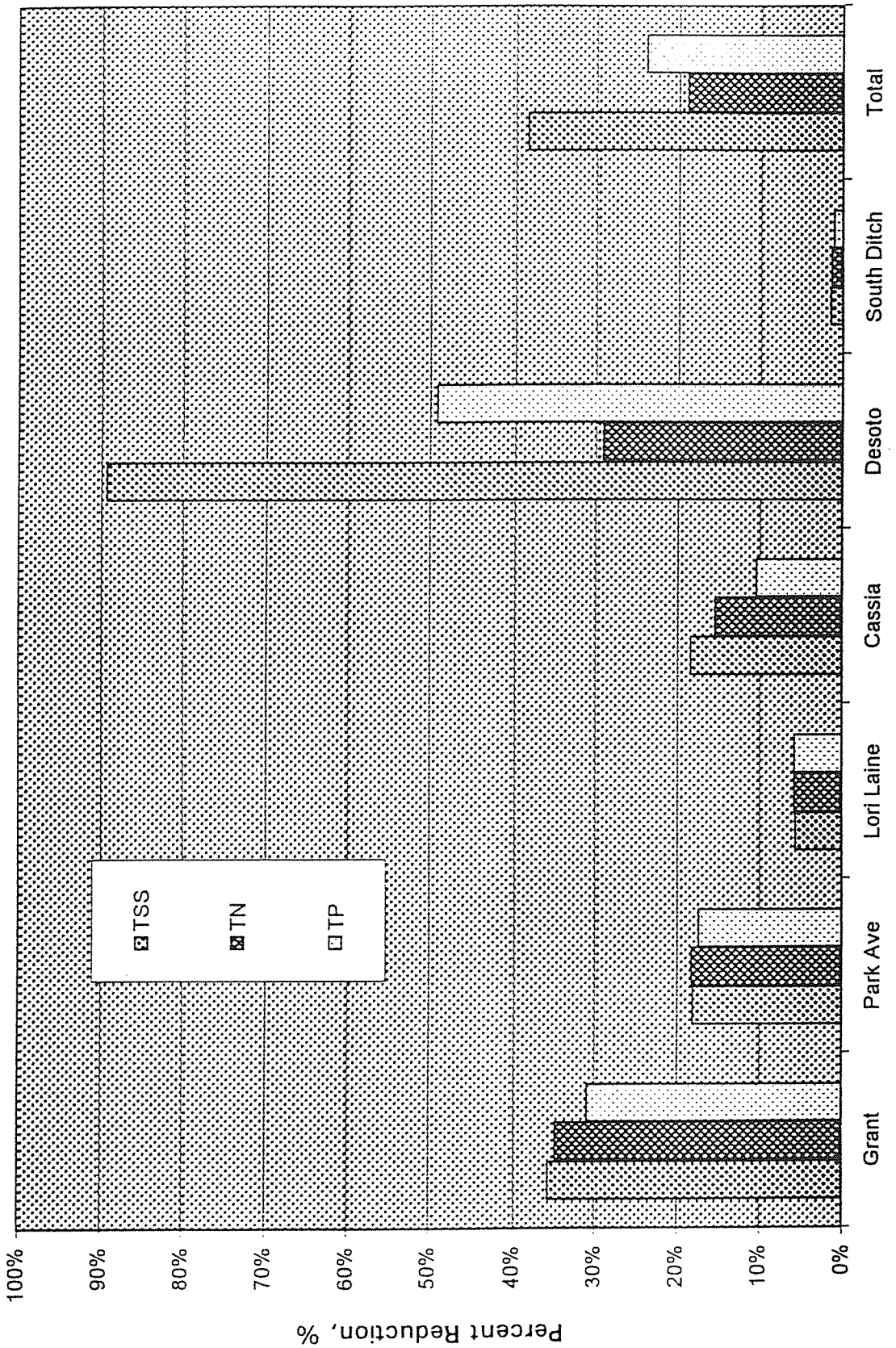


Figure 5. Estimated Mass Reduction From BMPs
Percent Reduction, %
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
TSS
TN
TP
Grant
Park Ave
Lori Laine
Cassia
Desoto
South Ditch
Total

IMPACT OF BEST MANAGEMENT PRACTICES

A number of stormwater treatment projects have been proposed to improve water quality. The "calibrated" model was used to assess the impact of these improvements on water quality. It is important to note that the model is only suitable for planning level evaluations. The results indicated general levels of improvement, as opposed to quantitatively predicting water quality concentrations.

Table 11 summarizes the best management practices (BMPs) proposed for each basin, as well as the water quality impact of these improvements. Figure 5 also shows the mass reductions by basin. The model results can be summarized as follows:

- TSS reduction ranged from 6 to 89%, with the largest reduction occurring in the Desoto Basin (exfiltration and wet detention)
- Total nitrogen was reduced by an average of 22%.
- Total phosphorus was reduced by an average of 28%.

Table 11 Estimated Mass Loading Reduction Due to BMPs

Parameter	Grant	Park Ave	Lori Laine	Cassia	Desoto	South Ditch	Total
Basin Area, ac	139	31	154	156	296	157	933
Flow, ac-ft/yr	391	84	423	460	822	377	2,557
Type of BMP	Exfiltration	Exfiltration	Exfiltration	Exfiltration	Exfiltration and Wet Detention	Exfiltration	
Impact Area of BMP, ac.	55	6	10	32	21 and 179	3	
Loading w/o BMP, lb/yr							
TSS	79,398	17,448	87,955	90,402	170,000	90,079	535,282
TN	1,302	291	1,469	1,622	2,870	1,471	9,025
TP	243	58	294	300	565	274	1,734
Loading w/ BMP, lb/yr							
TSS	51,033	14,307	83,035	73,910	18,172	88,792	329,249
TN	848	238	1,384	1,374	2,034	1,451	7,329
TP	168	48	277	269	287	271	1,320
Percent Reduction, %							
TSS	36%	18%	6%	18%	89%	1%	38%
TN	35%	18%	6%	15%	29%	1%	19%
TP	31%	17%	6%	10%	49%	1%	24%

APPENDIX "B"

24" X 36" PLANS OF EXISTING SYSTEM

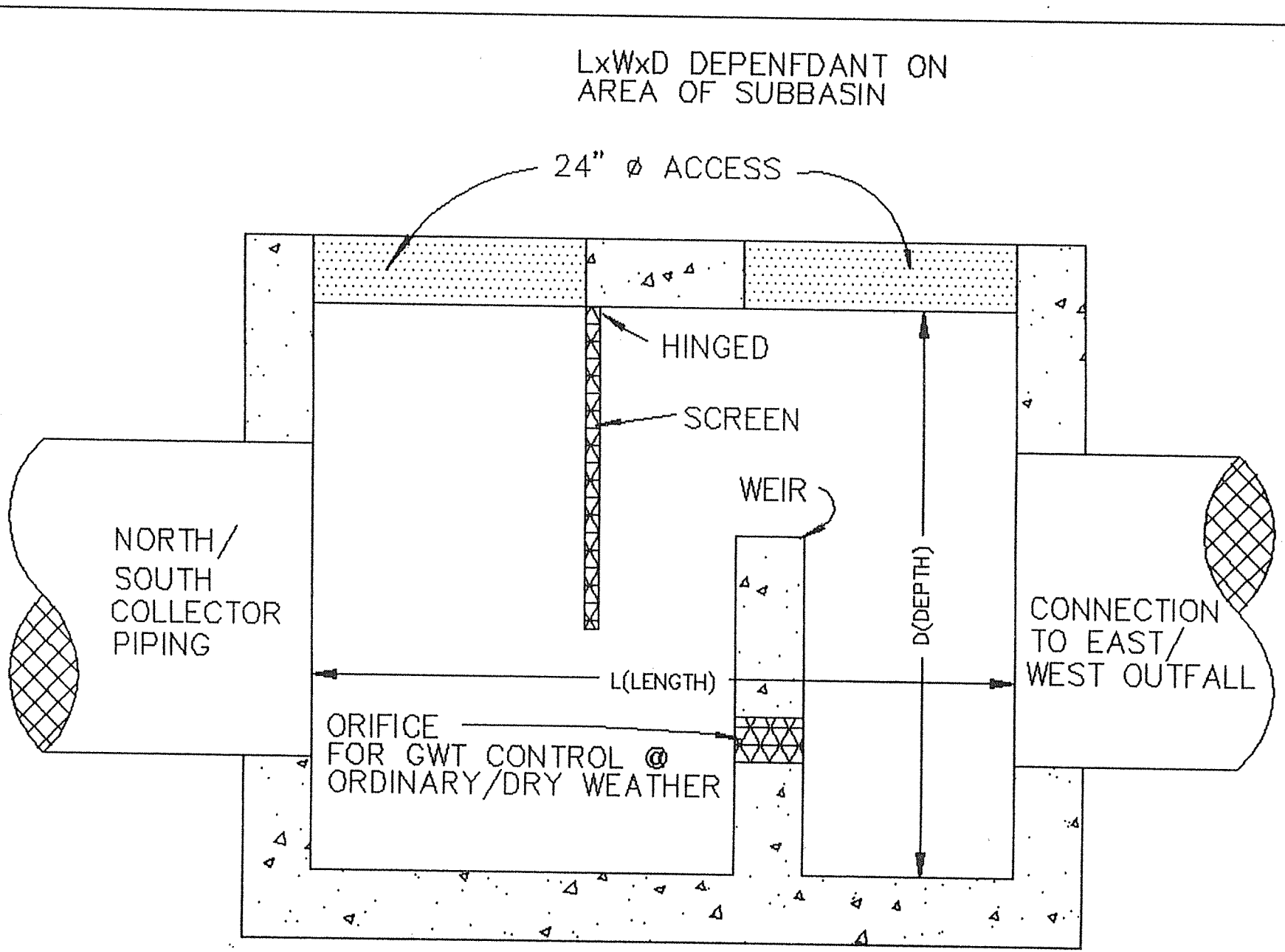
The large-scale maps are not included in this copy of the plan.

APPENDIX "C"

24" X 36" PLANS OF

PROPOSED MASTER PLAN IMPROVEMENTS

The large-scale maps are not included in this copy of the plan.

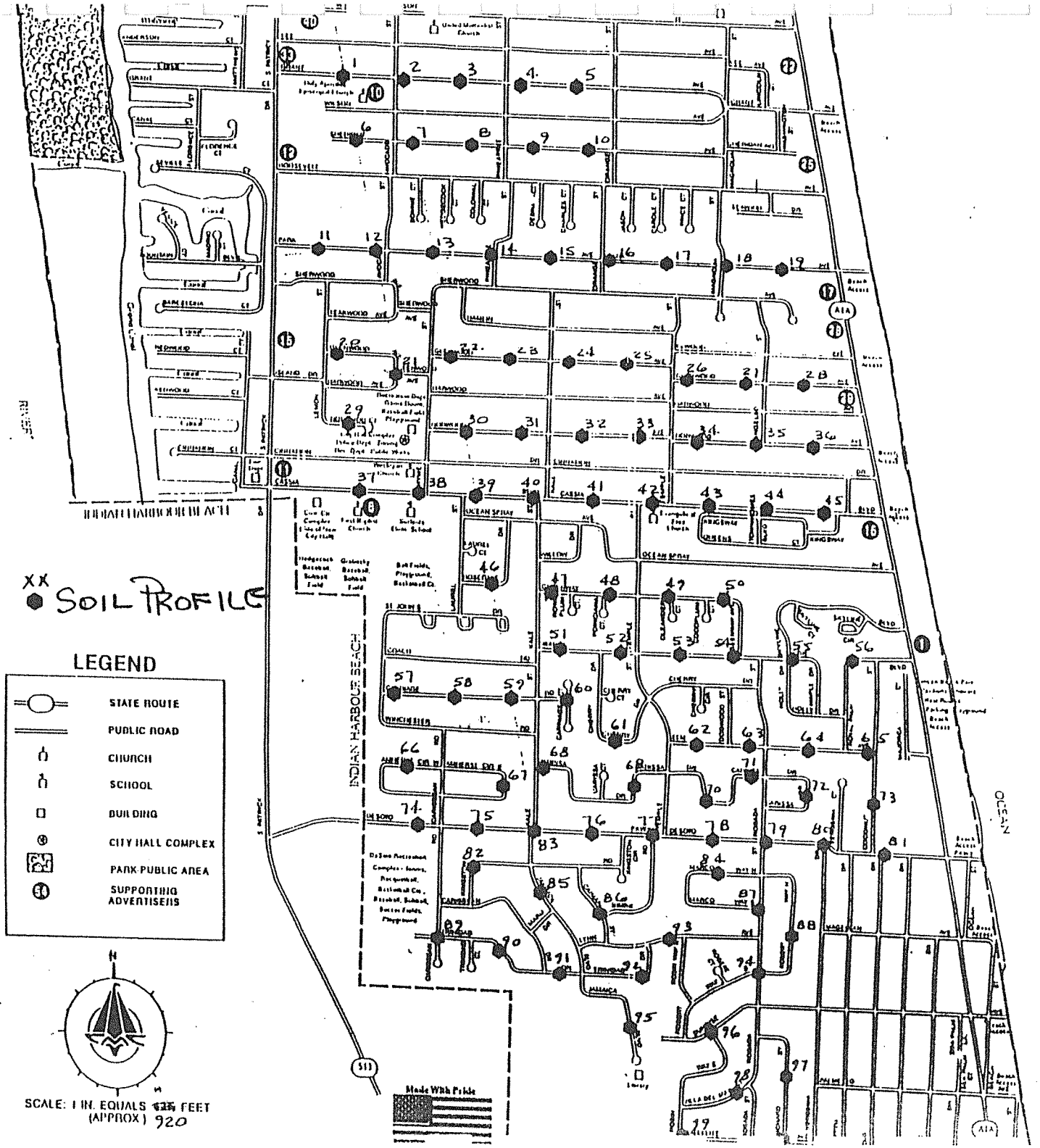


BAFFLE BOX TYPICAL SECTION

N.T.S.

APPENDIX "D"

HYDROGRAPHIC DATA


XX SOIL PROFILE
LEGEND
STATE ROUTE
PUBLIC ROAD
CHURCH
SCHOOL
BUILDING
CITY HALL COMPLEX
PARK-PUBLIC AREA
SUPPORTING ADVERTISERS
SCALE: 1 IN. EQUALS 625 FEET
(APPROX) 920
INTRACOASTAL WATERWAY
INDIAN HARBOUR BEACH
OCEAN
A1A
513
Made With Pride

SATELLITE BEACH MASTER DRAINAGE PLAN IN COOPERATION WITH SJRWMD - REGS & REQUIREMENTS

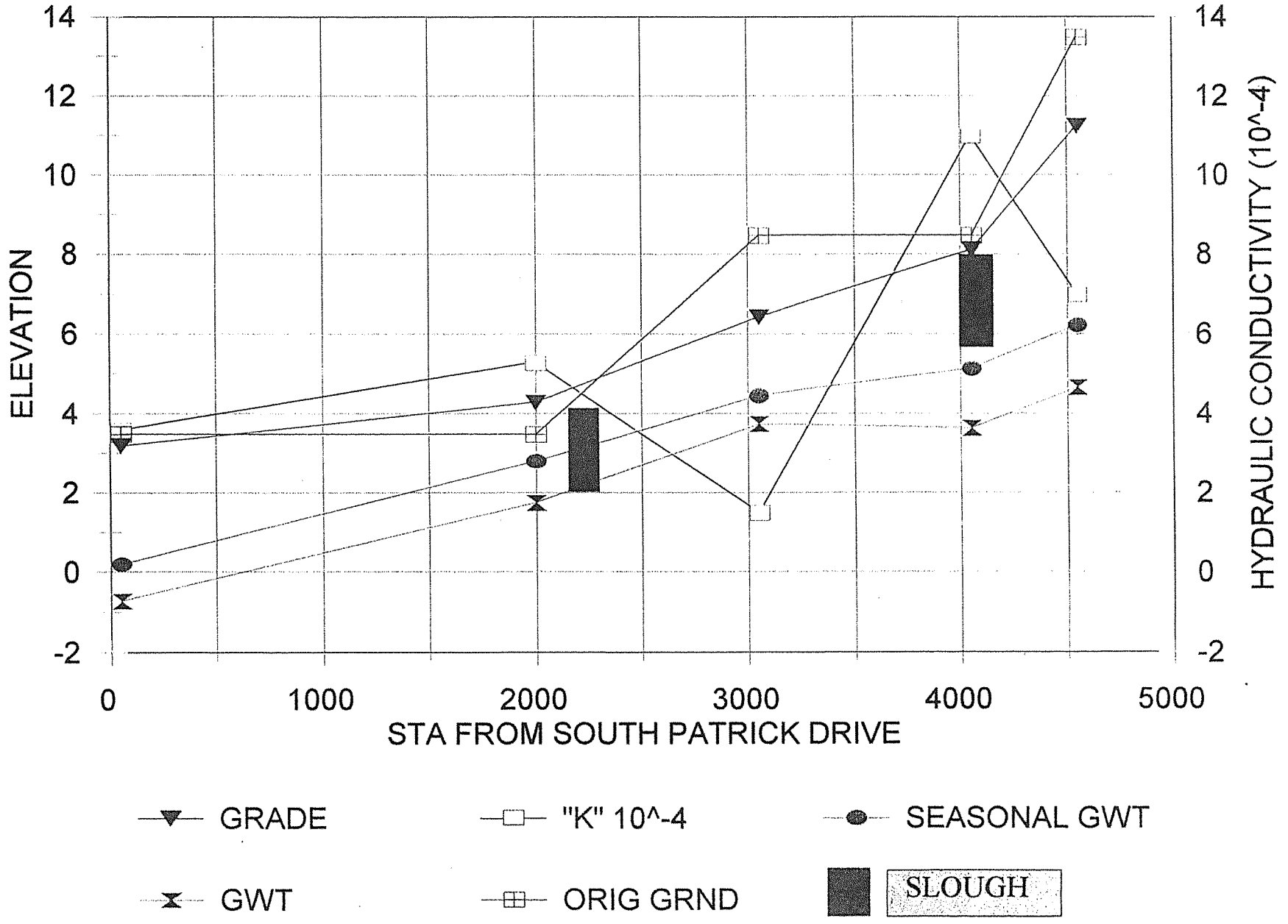
SOUTH PATRICK DR. IS STATION 0+00 +/-

TEST NO	EXIST GRADE ELEV	HYD COND "K" X10-^4	DEPTH TO GWT @ BORING	GWT ELEV	ANTICIPATED WET SEASON DEPTH	ANTICIPATED WET SEASON ELEVATION	STREET NAME LOCATION	STATION LOCATION WEST TO EAST
1-J	3.2	3.6	3.92	-0.72	3	0.2	JACKSON AVENUE	50
2-J	4.3	5.3	2.54	1.76	1.5	2.8	JACKSON AVENUE	2000
3-J	6.46	1.5	2.71	3.75	2	4.46	JACKSON AVENUE	3050
4-J	8.15	11	4.50	3.65	3	5.15	JACKSON AVENUE	4050
5-J	11.25	7	6.58	4.67	5	6.25	JACKSON AVENUE	4550
AVG "K"		5.68					Hyd. Grad GWT =	0.13%
1	3	2	3.67	-0.67	2.5	0.5	GRANT	550
2	3.8	1.3	3.00	0.80	2	1.8	GRANT	1100
3	4.8	6.3	3.25	1.55	2.5	2.3	GRANT	1600
4	4.6	4	2.25	2.35	1.5	3.1	GRANT	2200
5	7.8	3.5	2.67	5.13	1.5	6.3	GRANT	2700
AVG "K"		3.42					Hyd. Grad GWT =	0.27%
6	2.8	7.8	2.96	-0.16	1.8	1	SHERIDAN	570
7	3.9	10	3.00	0.90	2	1.9	SHERIDAN	1100
8	4.9	14	2.83	2.07	1.5	3.4	SHERIDAN	1600
9	5.7	21	2.00	3.70	1	4.7	SHERIDAN	2200
10	6.7	11	2.63	4.08	1.5	5.2	SHERIDAN	2700
AVG "K"		12.76					Hyd. Grad GWT =	0.20%
11	2.8	4.7	2.88	-0.08	1.5	1.3	PARK	325
12	3.1	9.3	2.50	0.60	1.5	1.6	PARK	900
13	2.7	3.4	1.67	1.03	0.8	1.9	PARK	1350
14	3.6	8.7	1.79	1.81	0.8	2.8	PARK	1900
15	5.2	17	1.50	3.70	0.5	4.7	PARK	2400
16	7.8	23	3.17	4.63	2.5	5.3	PARK	2850
17	7.4	14	2.25	5.15	1.5	5.9	PARK	3350
18	8.3	14	3.17	5.13	2.5	5.8	PARK	3900
19	10.8	28	5.38	5.43	4	6.8	PARK	4350
AVG "K"		13.57					Hyd. Grad GWT =	0.11%
20	2.9	10	2.67	0.23	1.7	1.2	GLENWOOD	550
21	2.9	14	2.50	0.40	1.5	1.4	GLENWOOD	1100
22	3.4	15	2.25	1.15	1.5	1.9	GLENWOOD	1450
23	4.6	21	2.29	2.31	1.5	3.1	GLENWOOD	2100
24	5.4	11	2.04	3.36	1	4.4	GLENWOOD	2550
25	6.3	11	2.04	4.26	1	5.3	GLENWOOD	3200
26	7	20	2.04	4.96	1	6	GLENWOOD	3600
27	8.9	12	2.83	6.07	2	6.9	GLENWOOD	4100
28	11.9	24	6.92	4.98	4.5	7.4	GLENWOOD	4650
AVG "K"		15.33					Hyd. Grad GWT =	0.14%
29	2.9	4.6	2.58	0.32	1.5	1.4	NORWOOD	700
30	4.2	23	2.38	1.83	1.5	2.7	NORWOOD	1700
31	4.7	12	2.25	2.45	1.5	3.2	NORWOOD	2200
32	5.9	13	2.67	3.23	1.8	4.1	NORWOOD	2700
33	7.3	13	2.00	5.30	1	6.3	NORWOOD	3250
34	8	23	3.83	4.17	3	5	NORWOOD	3750
35	9.5	12	3.29	6.21	2.5	7	NORWOOD	4250
36	11.3	23	5.17	6.13	4	7.3	NORWOOD	4700
AVG "K"		15.45					Hyd. Grad GWT =	0.16%
37	2.9	4.6	3.17	-0.27	2.5	0.4	CASSIA	600
38	3.3	6.2	2.67	0.63	2	1.3	CASSIA	1300
39	4.7	19	3.50	1.20	2.5	2.2	CASSIA	1800
40	5.2	23	3.75	1.45	3	2.2	CASSIA	2300
41	6.2	35	4.25	1.95	3	3.2	CASSIA	2850
42	7.6	32	4.13	3.48	3	4.6	CASSIA	3350
43	8.9	9.6			2	6.9	CASSIA	3850
44	10.1	12			2	8.1	CASSIA	4300
45	11.8	20	5.42	6.38	4	7.8	CASSIA	5000
AVG "K"		17.93					Hyd. Grad GWT =	0.21%
46	5.2	19	2.75	2.45	2	3.2	ROSEDALE/GREENWAY	1950
47	6	19	2.96	3.04	2	4	ROSEDALE/GREENWAY	2500
48	4.8	2.3	5.17	-0.37	4	0.8	ROSEDALE/GREENWAY	3000
49	4.9	23	2.63	2.28	1.5	3.4	ROSEDALE/GREENWAY	3450
50	6.3	11	2.83	3.47	1.8	4.5	ROSEDALE/GREENWAY	4000
AVG "K"		14.86					Hyd. Grad GWT =***	0.06%

51	5.4	8.3	2.63	2.78	1.3	4.1	MAPLE	2500
52	6	6.9	2.33	3.67	1.3	4.7	MAPLE	3000
53	6	8.6	1.54	4.46	0.5	5.5	MAPLE	3500
54	7	19	1.42	5.58	0.5	6.5	MAPLE	4000
55	9.3	22	2.92	6.38	1.8	7.5	MAPLE	4550
56	9.1	17	3.83	5.27	3	6.1	MAPLE	5100
AVG "K"		13.63					Hyd. Grad GWT =	0.07%

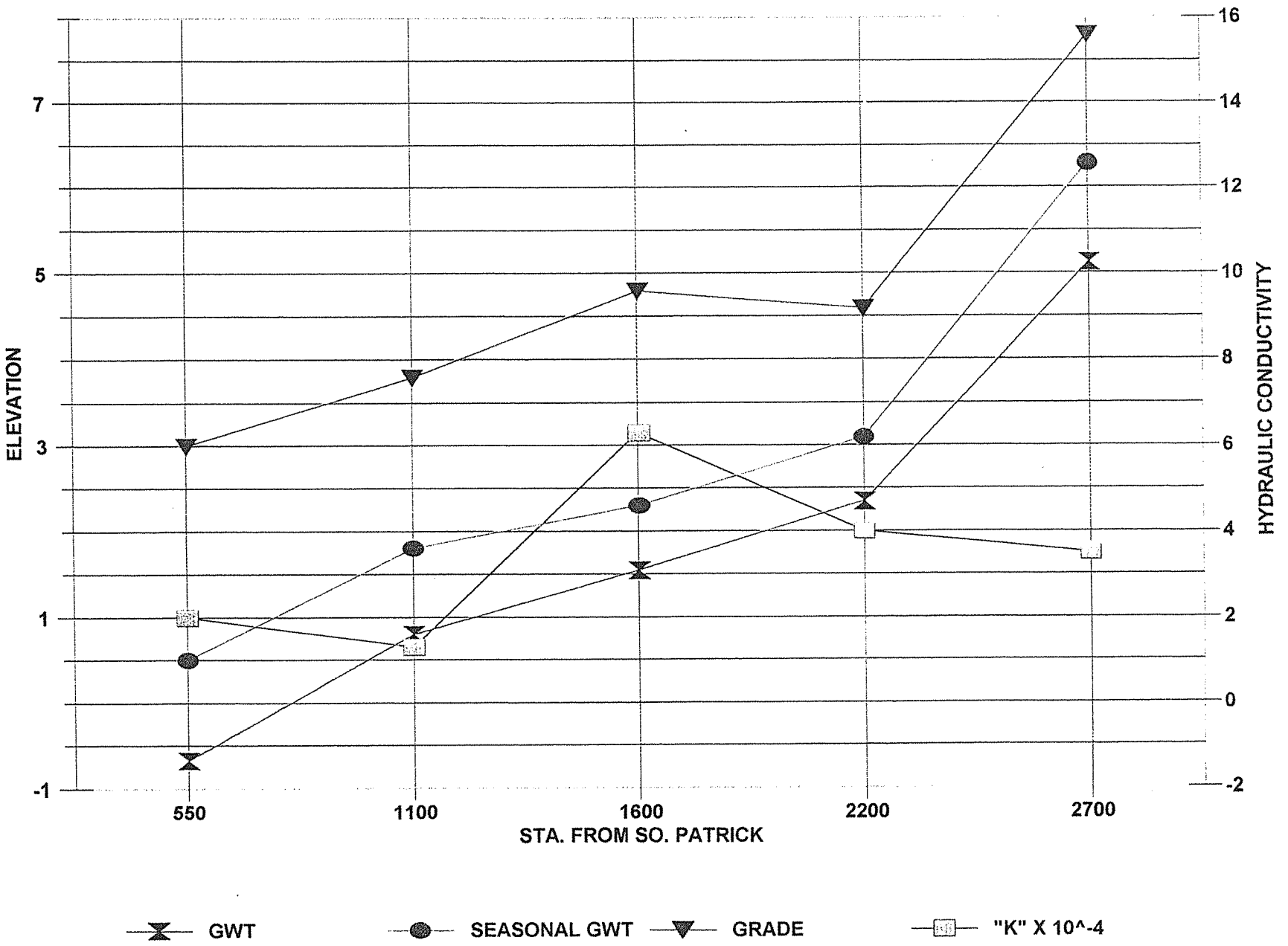
TEST NO	EXIST GRADE ELEV	HYD COND "K" X10-^4	DEPTH TO GWT @ BORING	GWT ELEV	ANTICIPATED WET SEASON DEPTH	ANTICIPATED WET SEASON ELEVATION	STREET NAME LOCATION	STATION LOCATION WEST TO EAST
57	4.3	3	3.17	1.13	2	2.3	CARRIAGE	1100
58	4.3	4	2.63	1.68	1.5	2.8	CARRIAGE	1700
59	4.3	9	2.46	1.84	1.5	2.8	CARRIAGE	2100
60	5.2	9.7	1.67	3.53	1	4.2	CARRIAGE	2600
AVG "K"		6.43					Hyd. Grad GWT =	0.16%
61	6.2	7.8	2.46	3.74	1.4	4.8	CHERRY/ELM	3000
62	5.3	9.9	1.17	4.13	0.3	5	CHERRY/ELM	3700
63	6.5	7.3	1.67	4.83	0.5	6	CHERRY/ELM	4150
64	8.5	21	2.67	5.83	1.5	7	CHERRY/ELM	4600
65	8.2	18	3.33	4.87	2	6.2	CHERRY/ELM	5200
AVG "K"		12.8					Hyd. Grad GWT =***	0.06%
66	4.1	0.44	3.08	1.02	2	2.1	AMHERST/CARISSA	1200
67	4.3	5.3	2.25	2.05	1.3	3	AMHERST/CARISSA	2050
68	5.4	17	2.67	2.73	1.5	3.9	AMHERST/CARISSA	2350
69	5.3	1.3	2.17	3.13	1	4.3	AMHERST/CARISSA	3150
70	5.9	9	2.17	3.73	1	4.9	AMHERST/CARISSA	3750
71	6.8	3.7	2.08	4.72	1	5.8	AMHERST/CARISSA	4200
72	6	16	0.96	5.04	0	6	AMHERST/CARISSA	4700
73	9.7	8.8	4.00	5.70	2.5	7.2	AMHERST/CARISSA	5250
AVG "K"		7.69					Hyd. Grad GWT =	0.14%
74	3.5	7.6	2.96	0.54	1.8	1.7	DESOTA PKWY	1200
75	3.5	8.3	2.75	0.75	1.5	2	DESOTA PKWY	1800
83	4.3	13	2.83	1.47	1	3.3	DESOTA PKWY	2350
76	4.3	6.3	2.54	1.76	1.5	2.8	DESOTA PKWY	2850
77	4.7	14	2.71	1.99	1.5	3.2	DESOTA PKWY	3400
78	4	22	3.50	0.50	2	2	DESOTA PKWY	3750
79	5.9	15	3.67	2.23	2	3.9	DESOTA PKWY	4300
80	7.4	17	3.63	3.78	2	5.4	DESOTA PKWY	4850
81	9.6	13	3.92	5.68	2.5	7.1	DESOTA PKWY	5300
AVG "K"		12.91					Hyd. Grad GWT =	0.21%
82	5.4	15	3.00	2.40	1.5	3.9	SO. OF DESOTA	1800
83	4.3	13	2.83	1.47	1	3.3	SO. OF DESOTA	2350
84	7.4	18	3.67	3.73	2	5.4	SO. OF DESOTA	4000
AVG "K"		15.33					Hyd. Grad GWT =***	0.13%
85	4.7	2.1	2.50	2.20	1	3.7	SO. OF DESOTA	2400
86	4.8	7.3	1.75	3.05	0.8	4	SO. OF DESOTA	2900
87	7.3	15	2.50	4.80	1	6.3	SO. OF DESOTA	4250
88	7.7	11	2.75	4.95	1.5	6.2	SO. OF DESOTA	4550
AVG "K"		8.85					Hyd. Grad GWT =	0.14%
89	4.9	12	2.17	2.73	0.6	4.3	SO. OF DESOTA	1550
90	5.8	7.7	2.33	3.47	1.2	4.6	SO. OF DESOTA	2150
91	4.8	13	2.17	2.63	1.1	3.7	SO. OF DESOTA	2700
92	5.2	4.5	1.92	3.28	1	4.2	SO. OF DESOTA	3350
93	7.3	23	3.33	3.97	2	5.3	SO. OF DESOTA	3550
94	7.5	15	2.75	4.75	1.5	6	SO. OF DESOTA	4300
							Hyd. Grad GWT =***	0.07%
95	7	11	3.92	3.08	2.5	4.5	SO. OF DESOTA	3200
96	7.1	21	2.75	4.35	1.5	5.6	SO. OF DESOTA	3950
97	7	18	2.42	4.58	1.3	5.7	SO. OF DESOTA	4600
							Hyd. Grad GWT =	-0.10%
98	6.5	12	2.92	3.58	1.5	5	SO. OF DESOTA	4200
99	4.4	16	3.00	1.40	1.5	2.9	SO. OF DESOTA	3700
100	5.4	17	2.92	2.48	1.5	3.9	SO. OF DESOTA	4600
AVG "K"		14.18					Hyd. Grad GWT =***	-0.27%

WEST TO EAST GWT PROFILE
JACKSON AVENUE



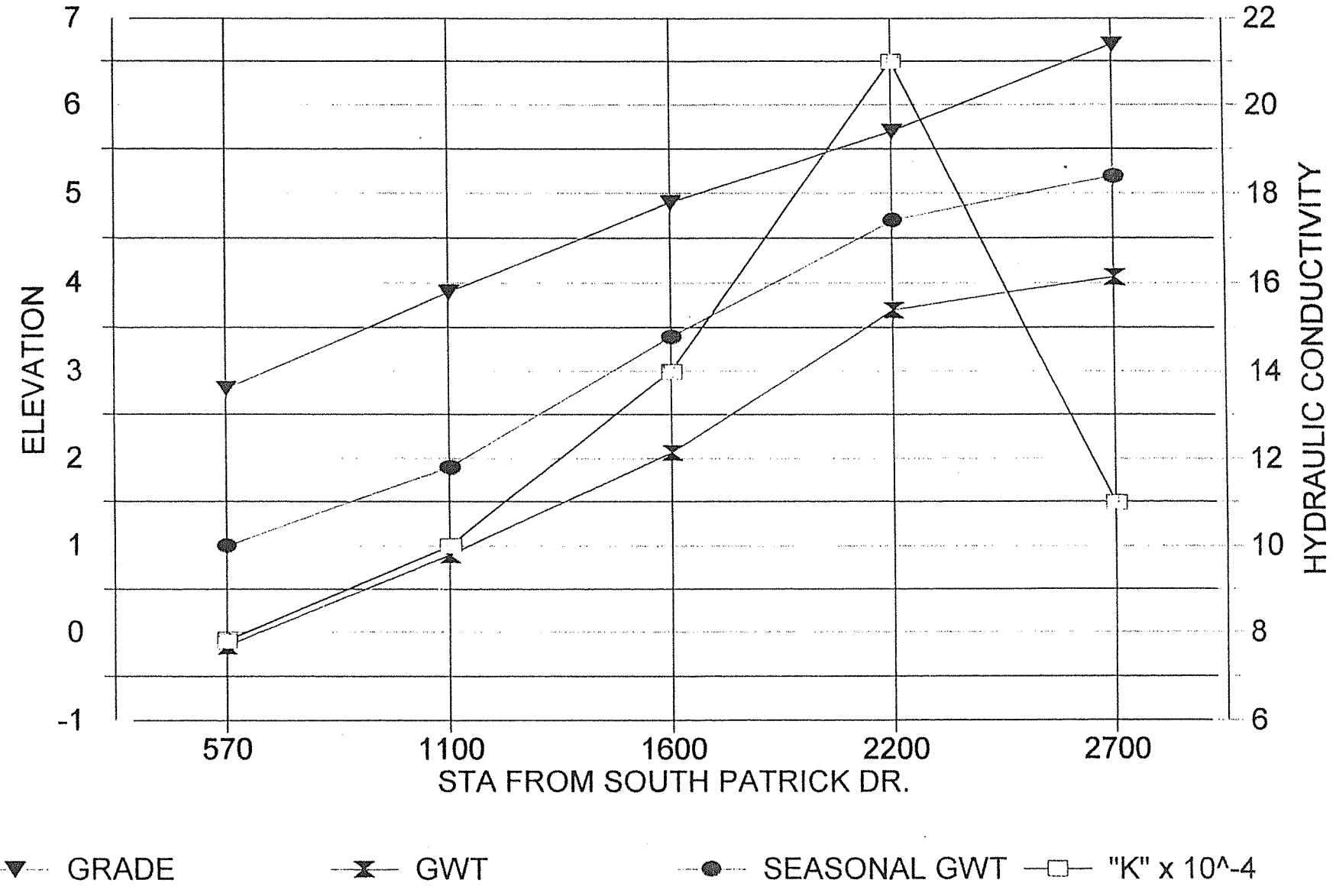
WEST TO EAST PROFILES

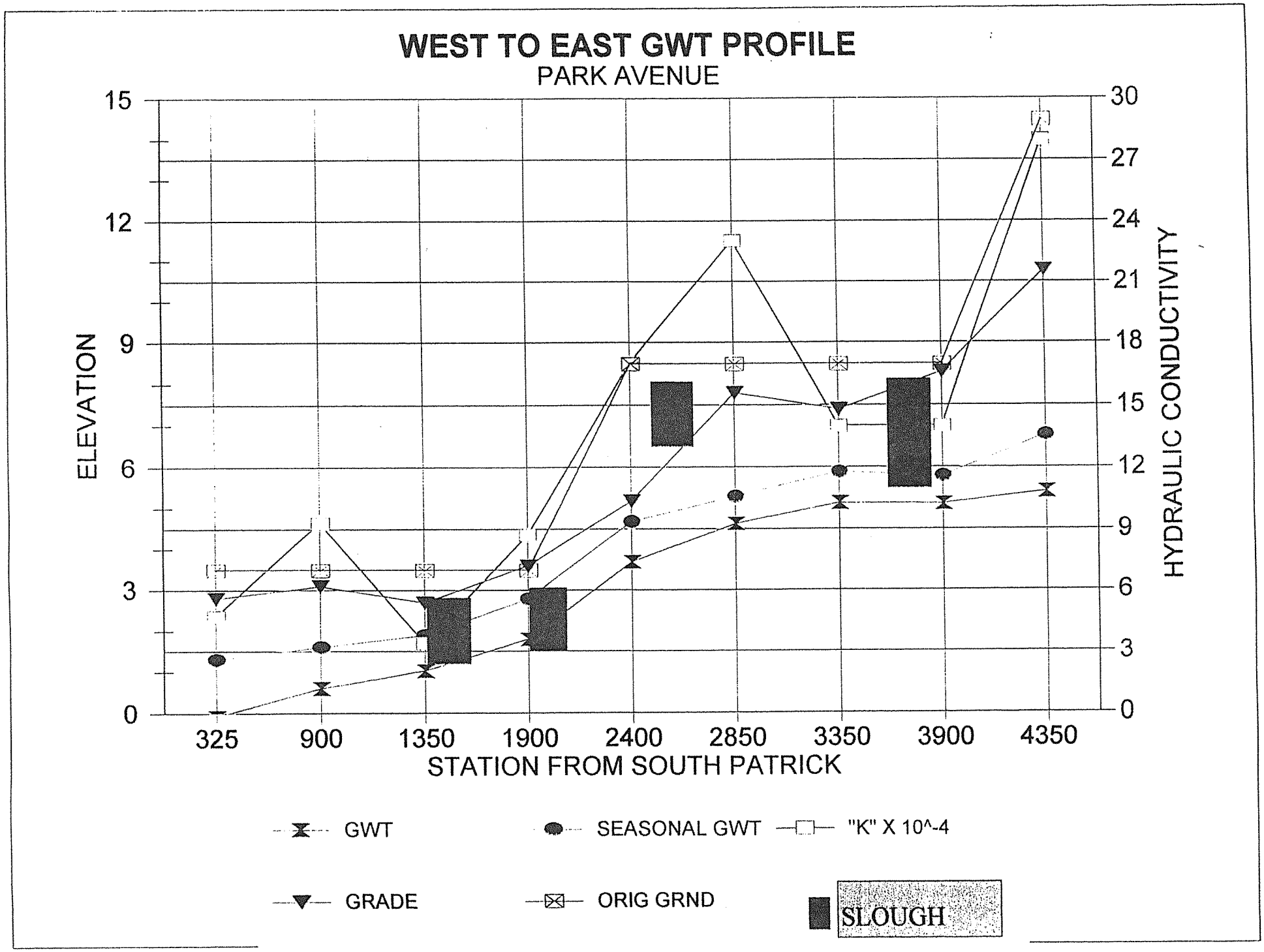
GRANT STREET



WEST TO EAST PROFILES SHERIDAN ST.

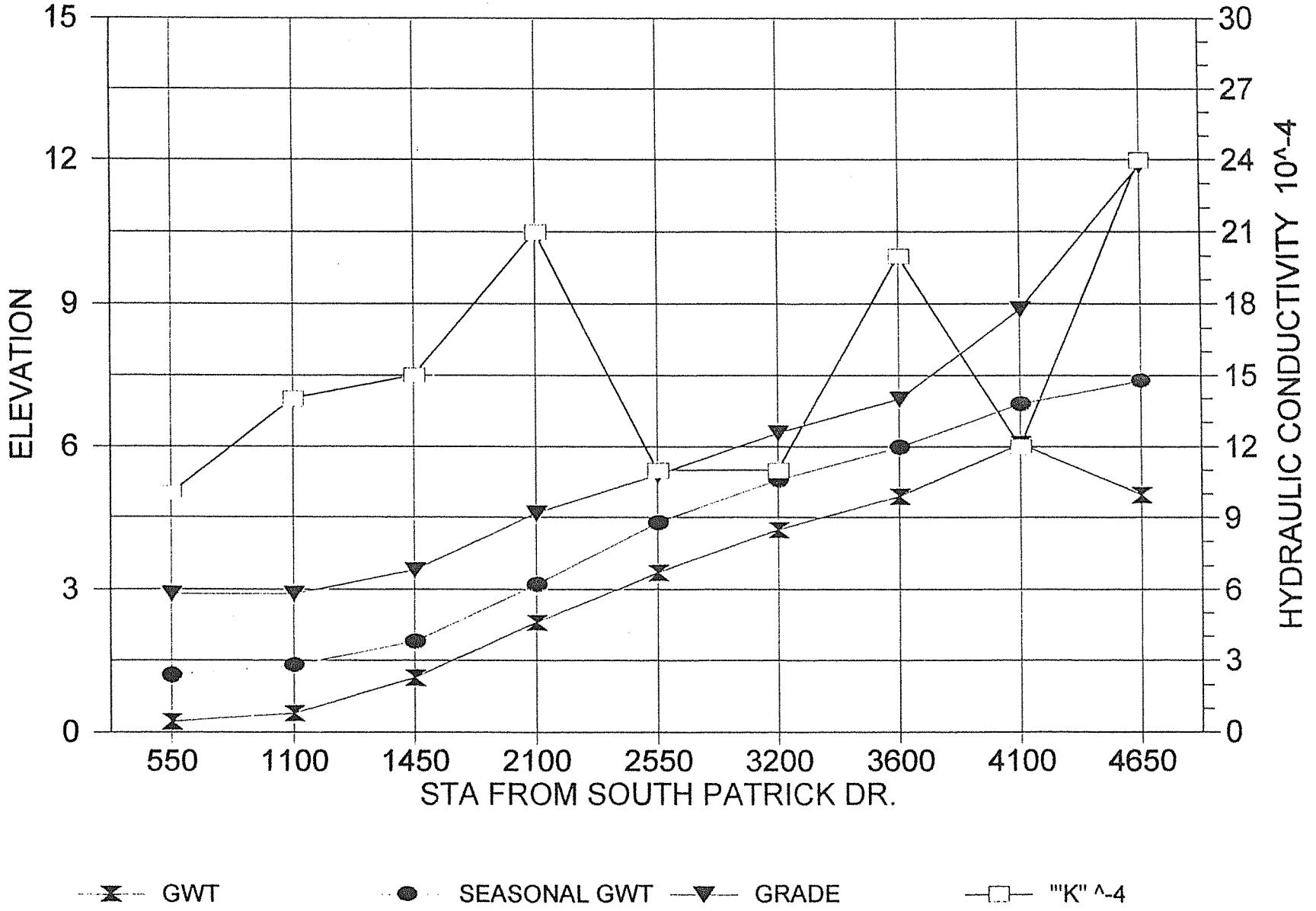
SATELLITE BEACH




WEST TO EAST GWT PROFILE
PARK AVENUE
ELEVATION
HYDRAULIC CONDUCTIVITY
15
12
9
6
3
0
30
27
24
21
18
15
12
9
6
3
0
325
900
1350
1900
2400
2850
3350
3900
4350
STATION FROM SOUTH PATRICK
GWT
SEASONAL GWT
"K" X 10^-4
GRADE
ORIG GRND
SLOUGH

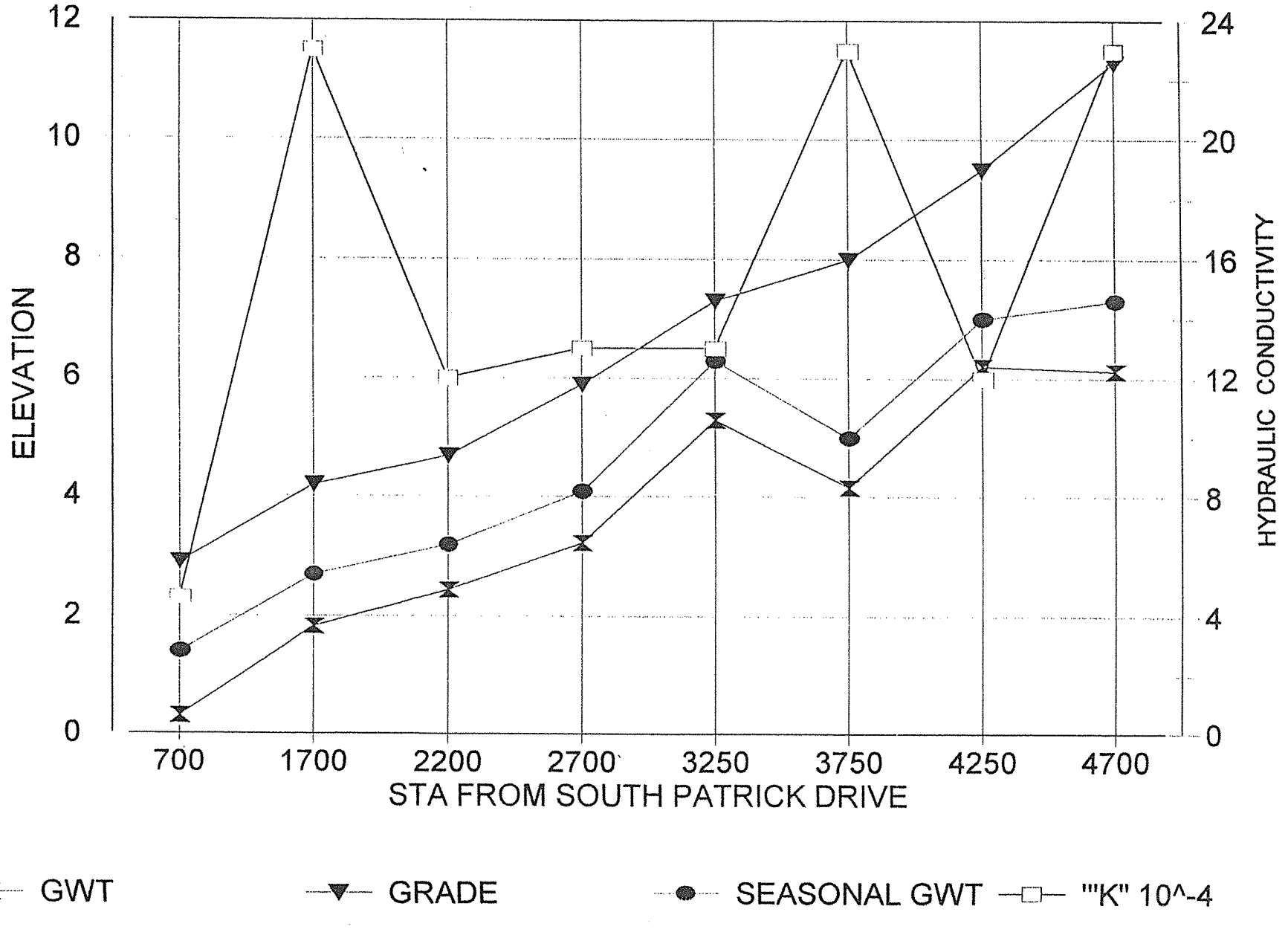
WEST TO EAST GWT PROFILE

GLENWOOD AVE



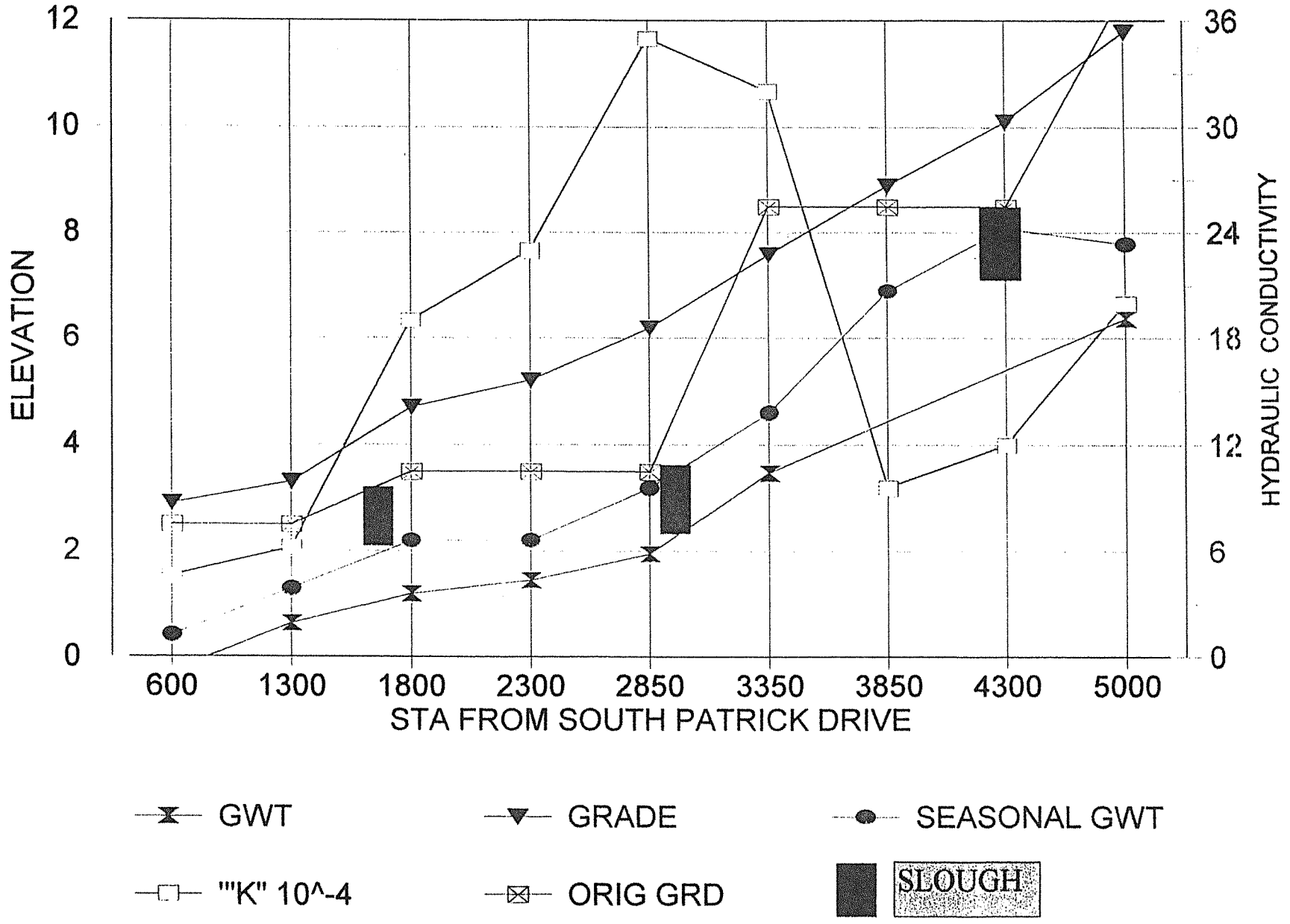
WEST TO EAST GWT PROFILE

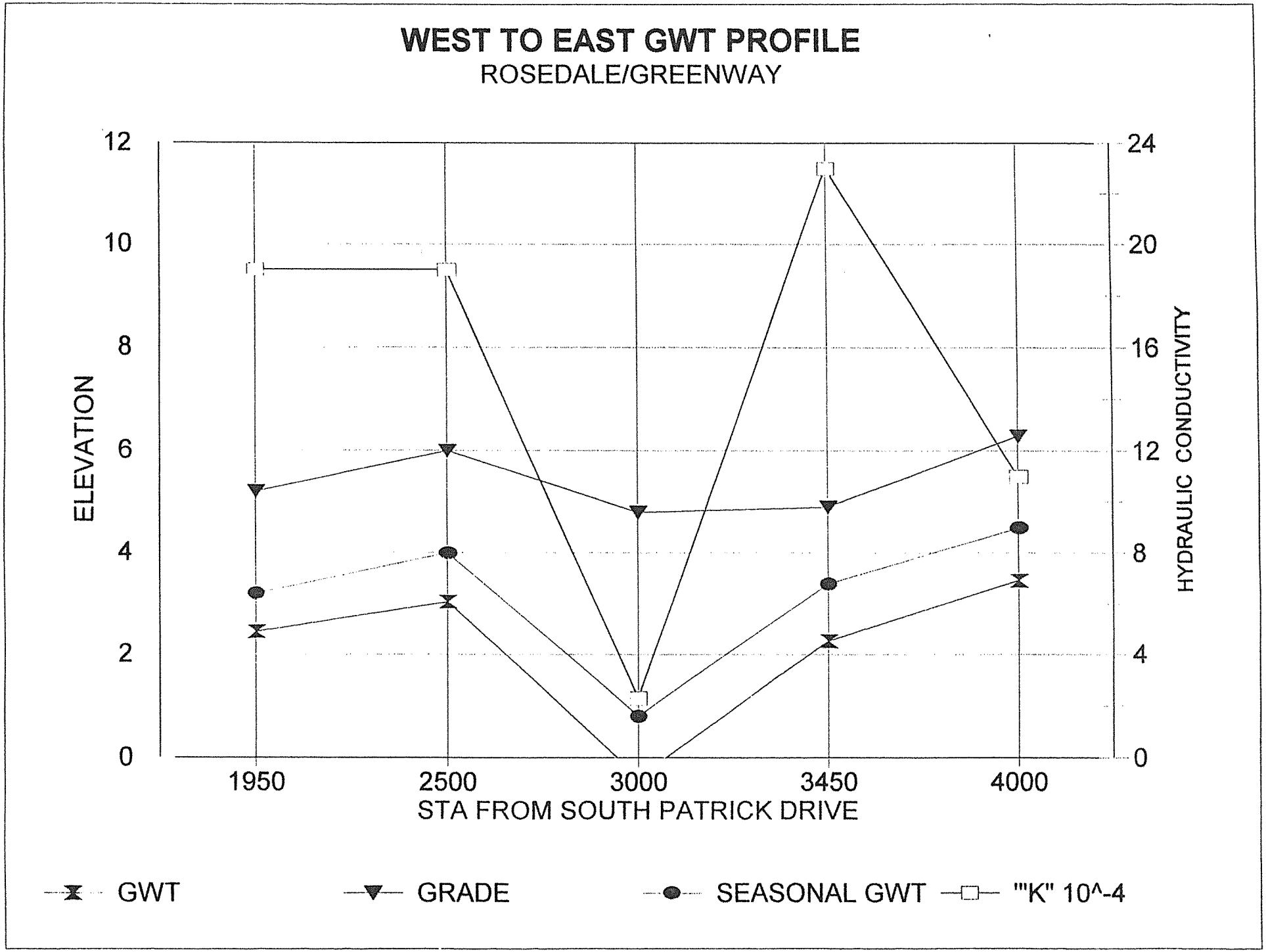
NORWOOD AVE

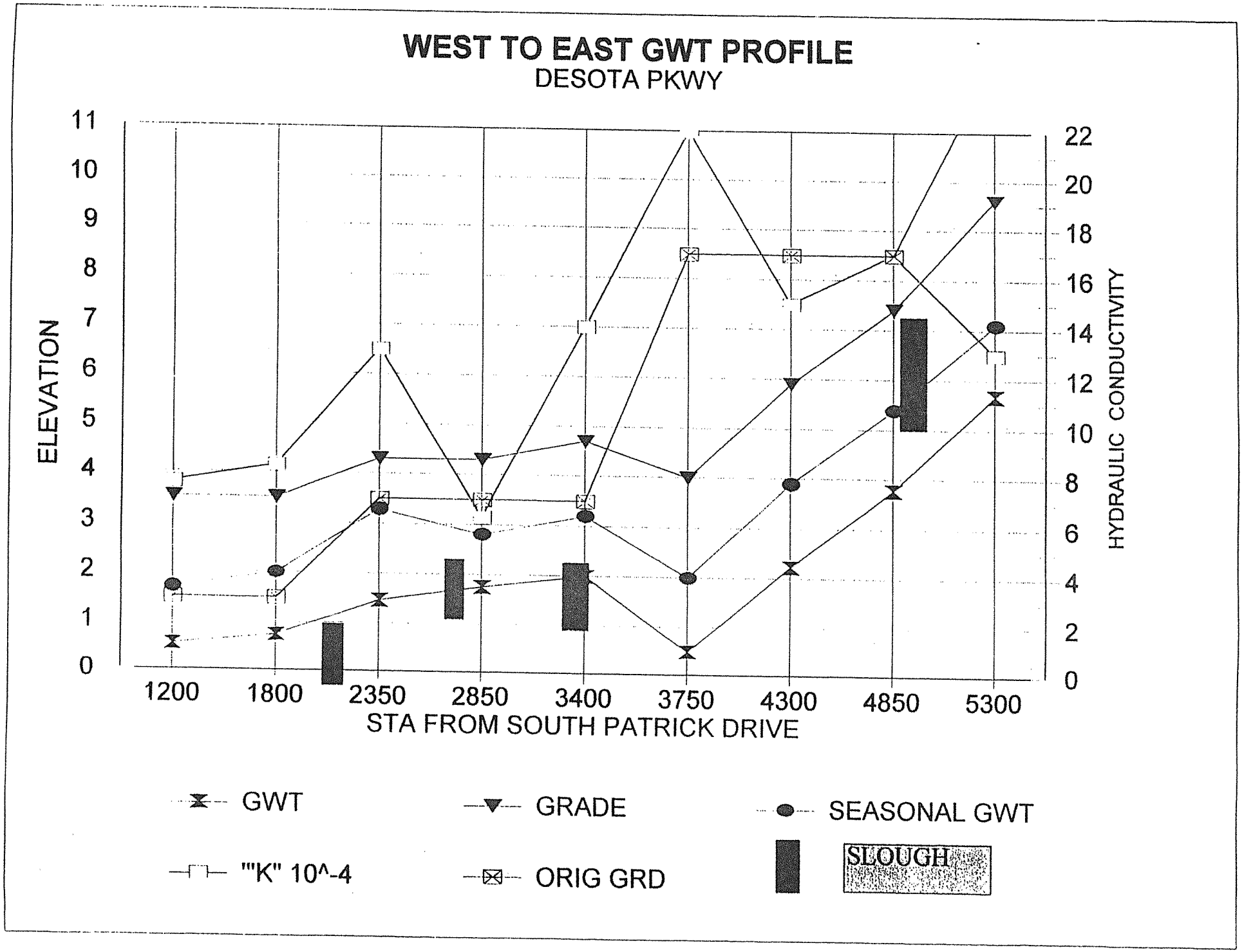


WEST TO EAST GWT PROFILE

CASSIA AVE

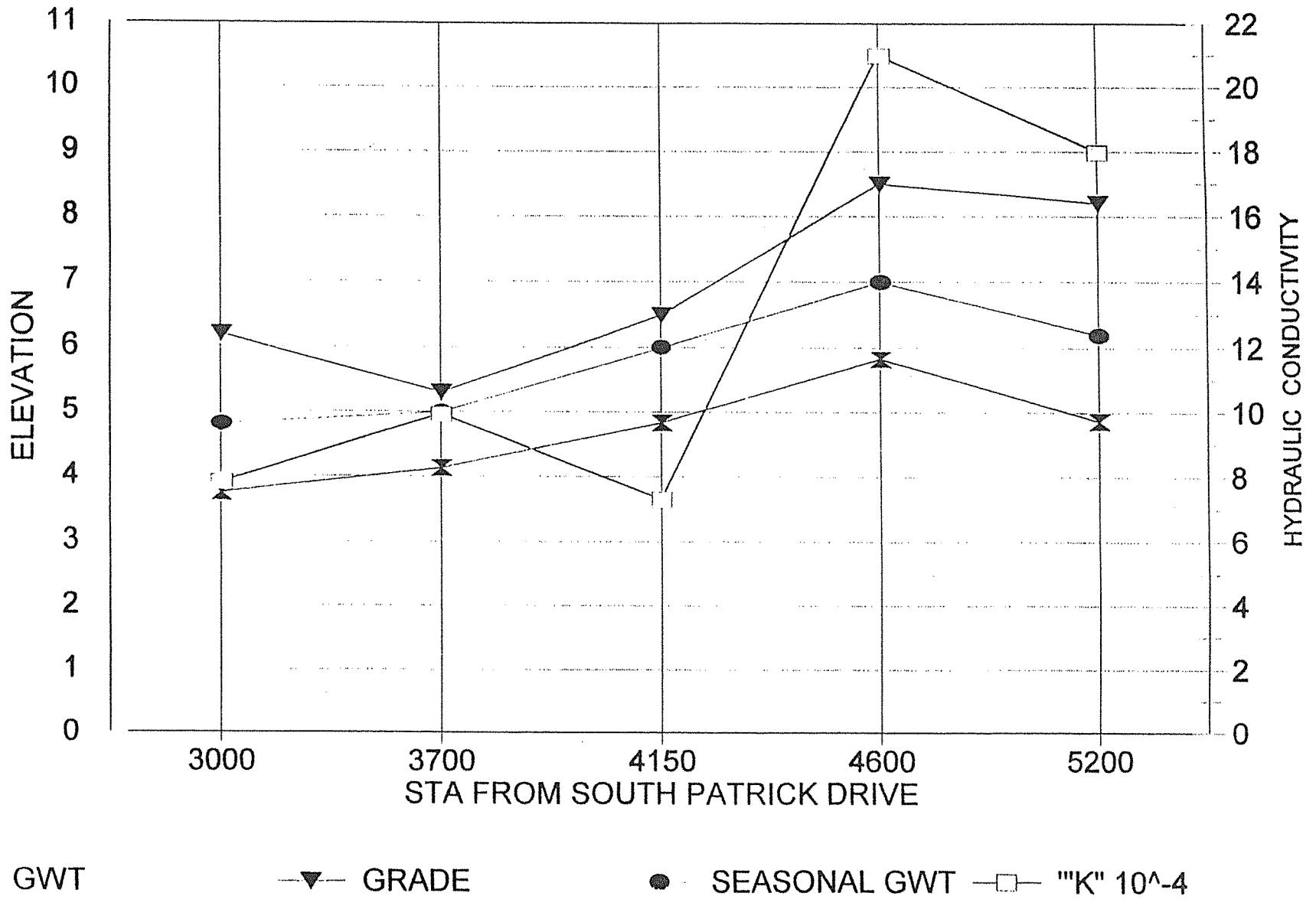



WEST TO EAST GWT PROFILE
ROSEDALE/GREENWAY
ELEVATION
HYDRAULIC CONDUCTIVITY
0
2
4
6
8
10
12
0
4
8
12
16
20
24
1950
2500
3000
3450
4000
STA FROM SOUTH PATRICK DRIVE
GWT
GRADE
SEASONAL GWT
"'K" 10^-4

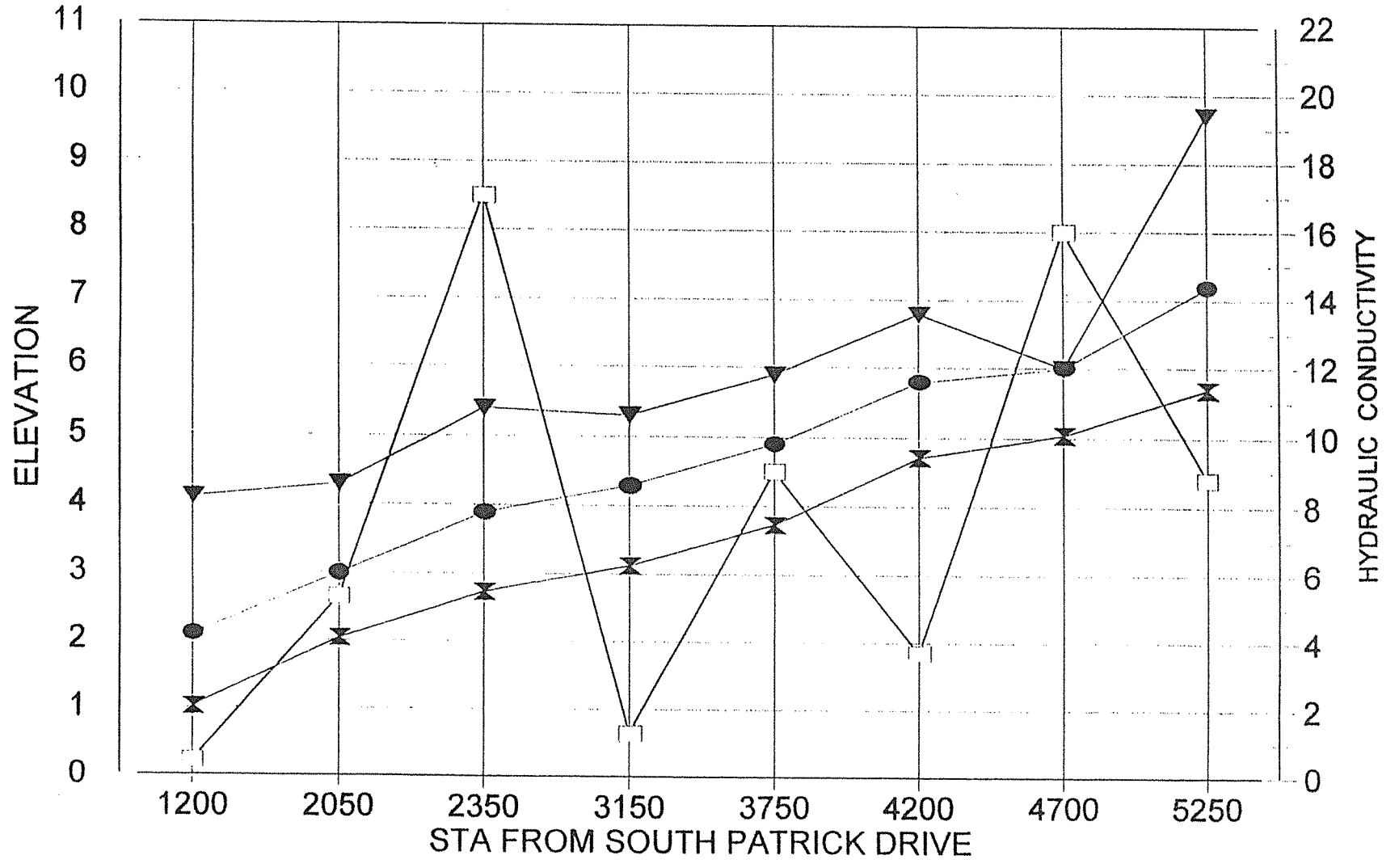

WEST TO EAST GWT PROFILE
DESOTA PKWY
ELEVATION
HYDRAULIC CONDUCTIVITY
0
1
2
3
4
5
6
7
8
9
10
11
0
2
4
6
8
10
12
14
16
18
20
22
1200
1800
2350
2850
3400
3750
4300
4850
5300
STA FROM SOUTH PATRICK DRIVE
GWT
GRADE
SEASONAL GWT
"'K" 10^-4
ORIG GRD
SLOUGH

WEST TO EAST GWT PROFILE

CHERRY / ELM

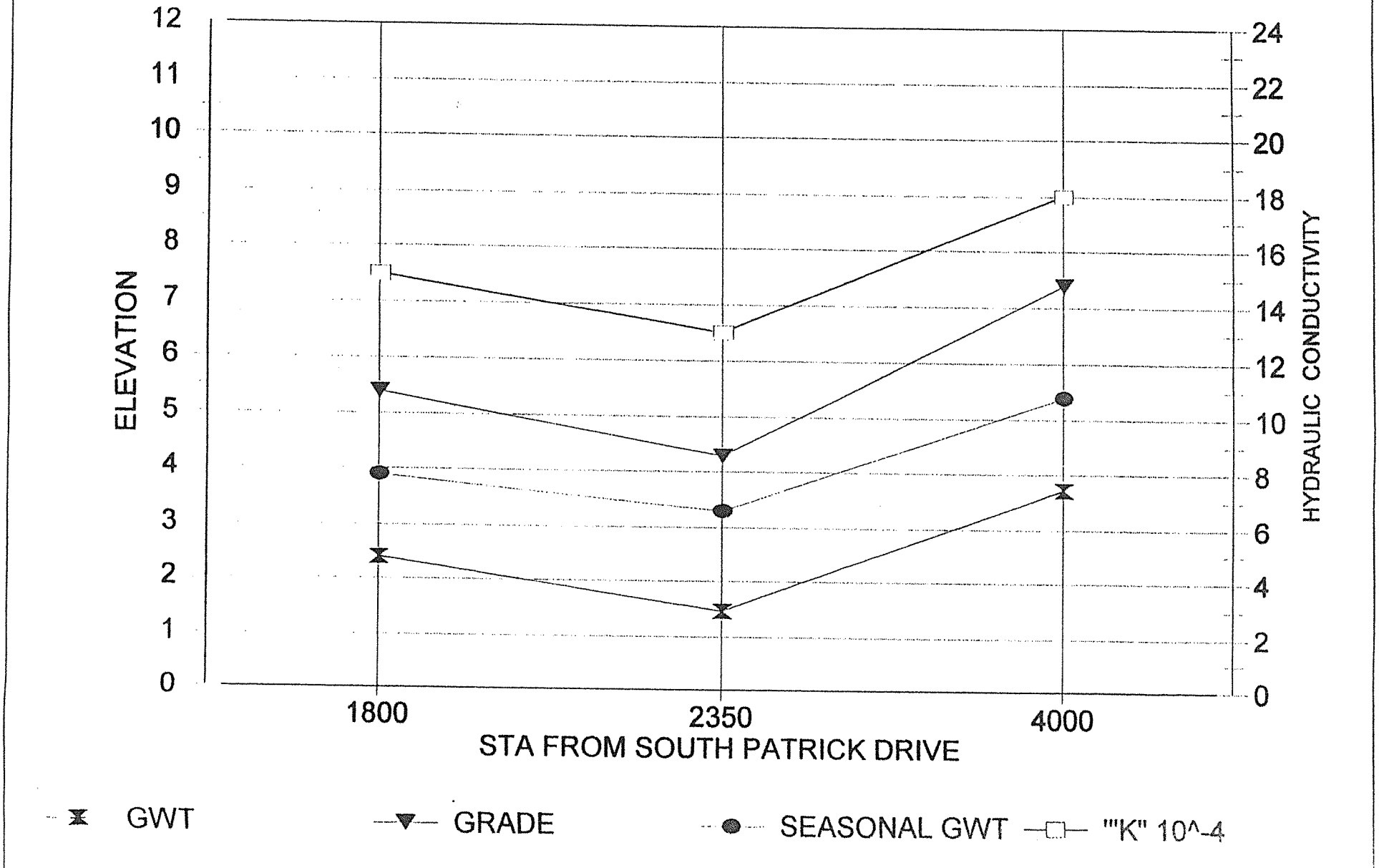


WEST TO EAST GWT PROFILE
AMHERST / CARISSA



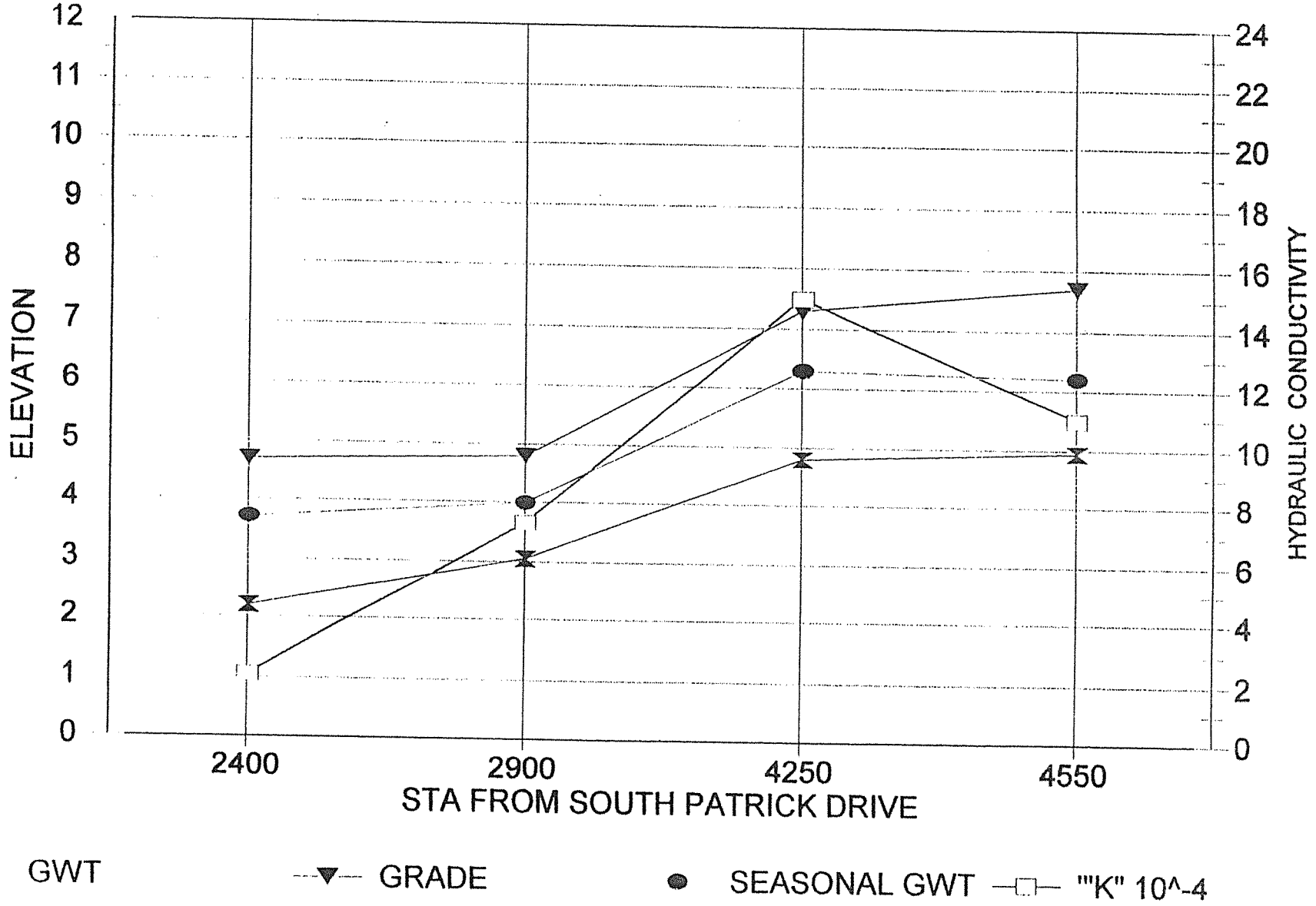
WEST TO EAST GWT PROFILE

SOUTH OF DESOTA #82 - #84



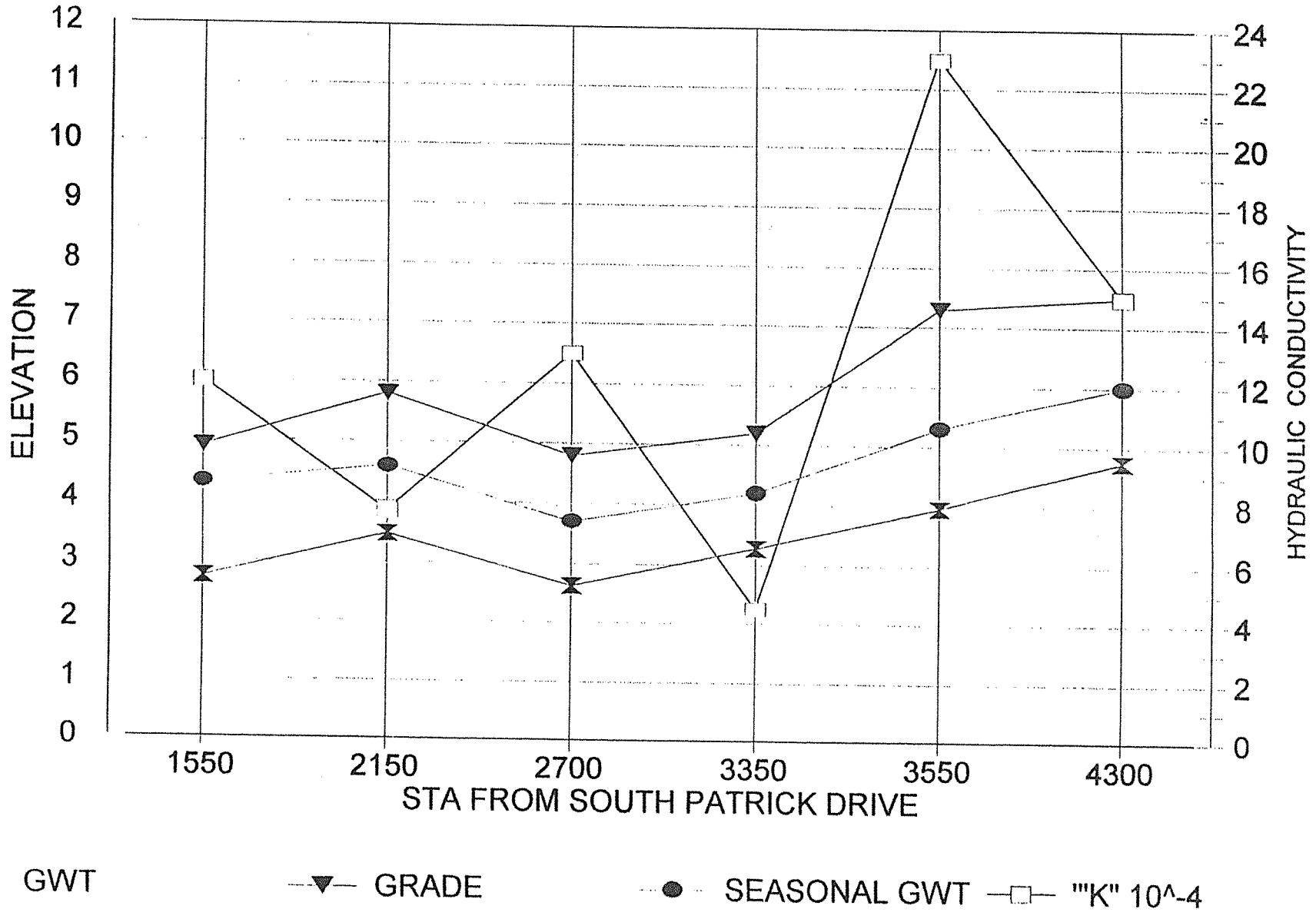
WEST TO EAST GWT PROFILE

SOUTH OF DESOTA #85 - #88



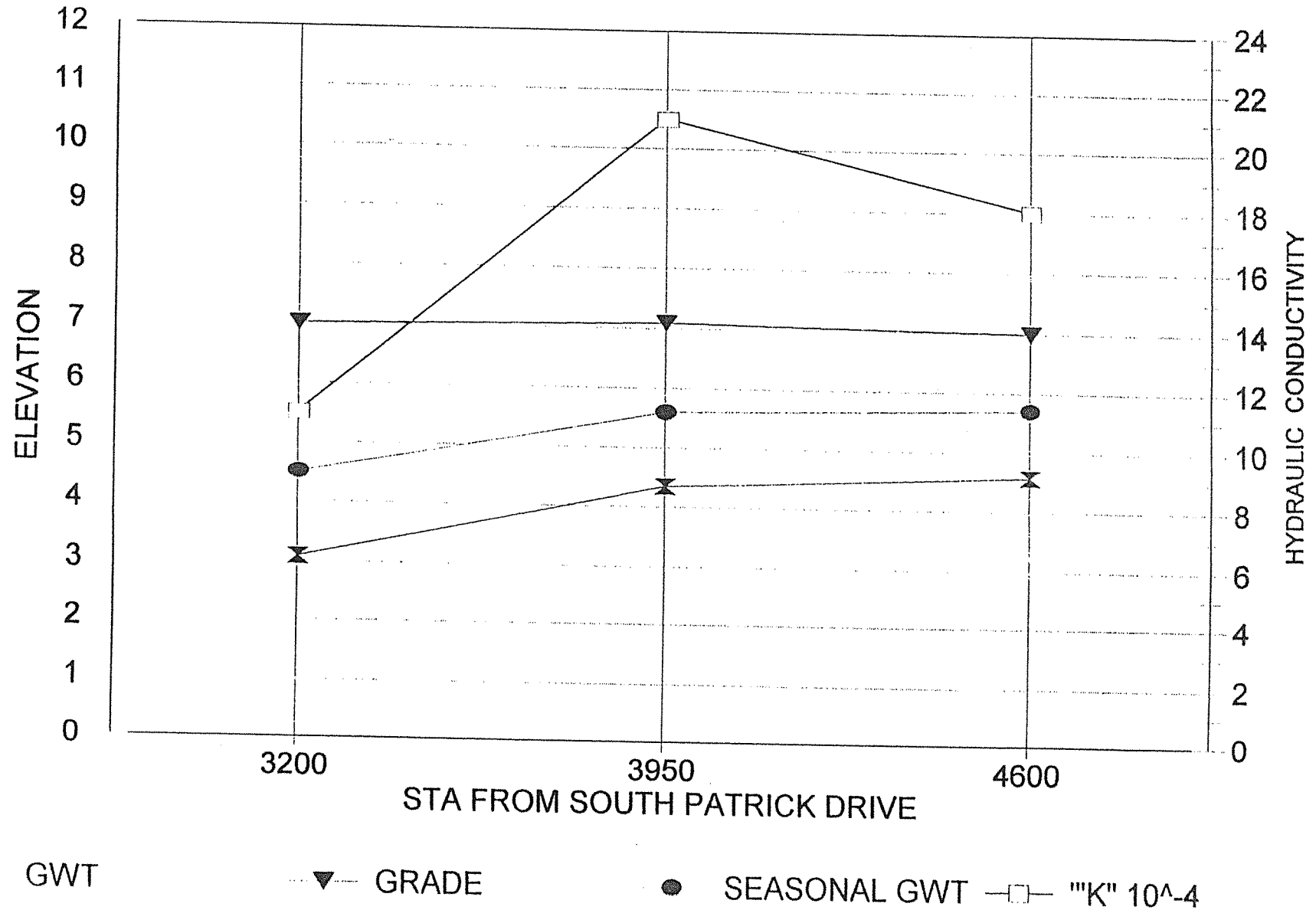
WEST TO EAST GWT PROFILE

SOUTH OF DESOTA #89 - #94



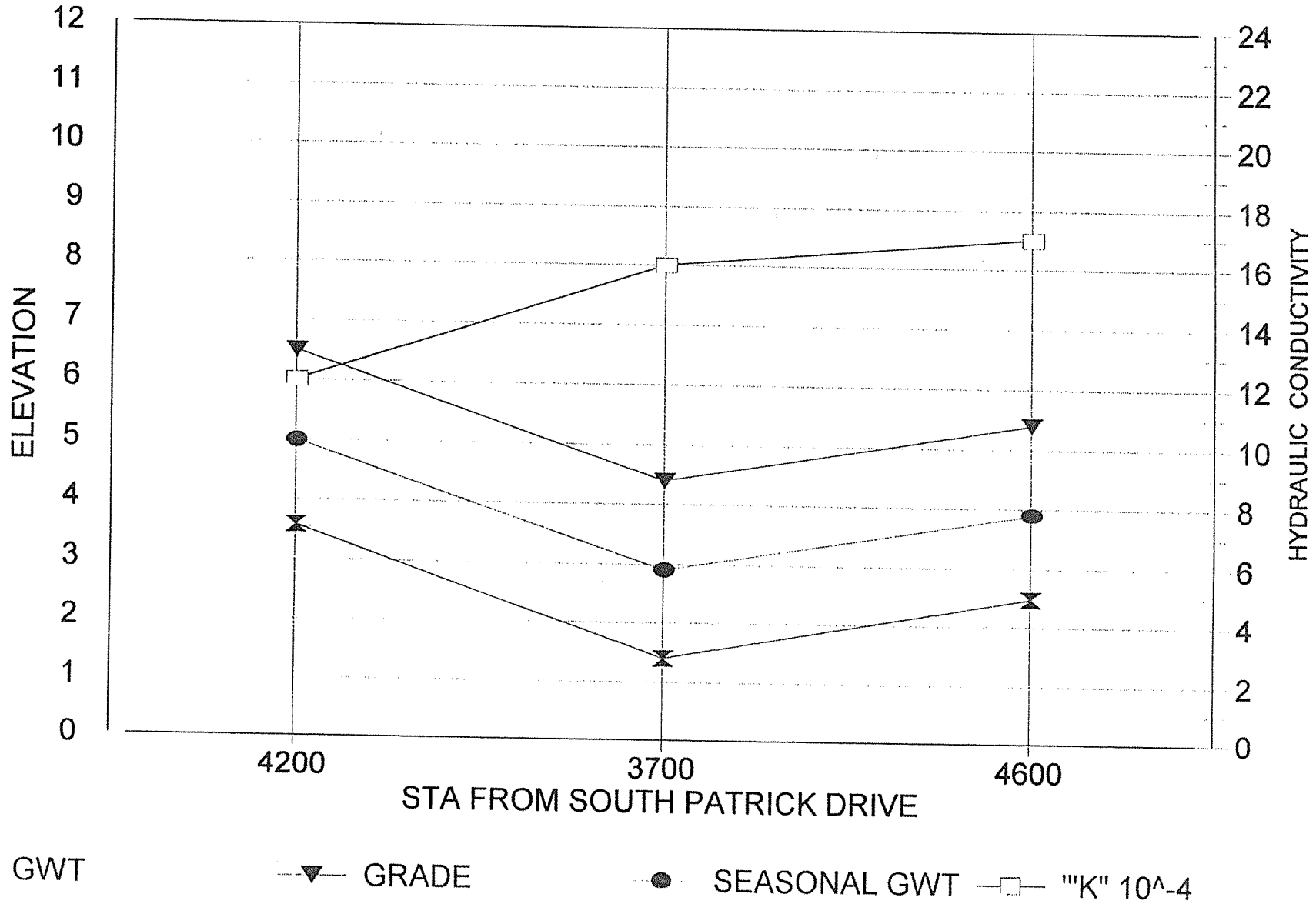
WEST TO EAST GWT PROFILE

SOUTH OF DESOTA #95 - #97



WEST TO EAST GWT PROFILE

SOUTH OF DESOTA #98 - #100



APPENDIX "E"

SOILS DATA

(PROFILES OF HYDRAULIC CONDUCTIVITIES)

ATLANTIC TESTING LABORATORIES, INC.
Testing, Soils and Foundation Engineers

POST OFFICE BOX 360816
MELBOURNE, FLORIDA 32936-0816
(407) 259-4141
FAX: 259-4838

December 2, 1998
98-3441-A-1
(WO #11-291)

Outlaw, Rice, & Sweeney
1222 North Harbor City Boulevard
Melbourne, Florida 32935

Attention: Gail Jones

Reference: Hydraulic Conductivity Study for the City of Satellite Beach
Satellite Beach, Florida

Pursuant to your request, ATLANTIC TESTING LABORATORIES, INC. is pleased to submit the following Subsurface Investigation on the above referenced project, for your use and information.

The data reflecting the hydraulic conductivity "k" values, the groundwater level at the time of boring, and the anticipated seasonal high groundwater level is indicated on the attached logs.

All information is relative to the particular location of the test boring, and Atlantic Testing Laboratories, Inc. does not warrant that other conditions do not exist in the area of the site outside of the test borings.

We are available at your convenience to answer any questions you may have concerning this report.

Sincerely,

ATLANTIC TESTING LABORATORIES, INC.

Peter C. Swarr, PE #44159
Vice President

ATLANTIC TESTING LABORATORIES, INC.
Testing, Soils and Foundation Engineers

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MELBOURNE, FLORIDA 32936-0816
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Sincerely,

ATLANTIC TESTING LABORATORIES, INC.

Peter C. Swarr, PE #44159
Vice President

REPORT OF

SUBSURFACE INVESTIGATION

FOR

HYDRAULIC CONDUCTIVITY STUDY FOR THE CITY OF SATELLITE BEACH

SATELLITE BEACH, FLORIDA

Boulevard

Submitted to: Outlaw, Rice, & Sweeney
1222 North Harbor City

Melbourne, Florida 32935

Submitted by: Atlantic Testing Laboratories, Inc..
1861 Avocado Avenue
Melbourne, FL 32935

Date: December 2, 1998

REPORT OF

SUBSURFACE INVESTIGATION

FOR

JACKSON AVENUE IMPROVEMENTS

SATELLITE BEACH, FLORIDA

Submitted to:	Outlaw, Rice, Soyka, & Sweeney 1222 North Harbor City Boulevard Melbourne, Florida 32935
Submitted by:	Atlantic Testing Laboratories, Inc.. 1861 Avocado Avenue Melbourne, FL 32935
Date:	July 26, 1999