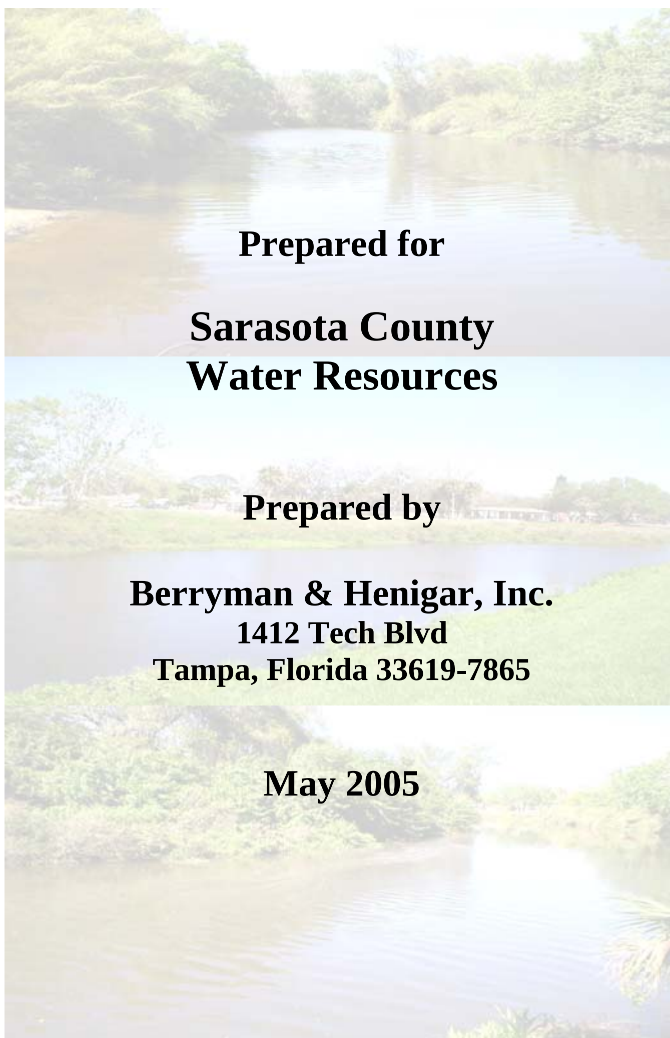
PINECRAFT
SEDIMENT ABATEMENT STUDY



Prepared for

Sarasota County
Water Resources

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TABLE OF CONTENTS

1.0 INTRODUCTION

Sarasota County's Navigable Waterways Program (NWP) routinely conducts feasibility studies for residential canal dredging throughout the unincorporated coastal regions of the County. To complement some of the feasibility projects, Sarasota County has engaged Berryman & Henigar, Inc. (BHI) to perform a series of sediment abatement analyses to determine if opportunities exist for reducing future land-based sediment accumulation in the canals. Sedimentation is a significant concern to the citizens residing along canals and channels. This study is not part of the NWP but it follows the format developed for the previous canal studies.

This report is the seventh of a series of sediment abatement studies being conducted by BHI for the County. The areas being examined include:

- Baywood Canal
- America Drive Canal
- Phillippi Cove
- Hidden Harbor
- South Creek
- Cedar Cove
- Phillippi/Pinecraft

The area being considered for this study is the Pinecraft area (channel) located south of Bahia Vista Street and north of Hawthorne Street. This project area covers a portion of Phillippi Creek, which discharges to Little Sarasota Bay. See Figure 1 for the project location map.

2.0 BACKGROUND

The portion of Phillippi Creek of the channel is aligned north to south between Bahia Vista Street and Hawthorne Street. The channel varies in width between 45 and 75 feet.

A historical report describes the Phillippi Creek primary conveyance system as open channels, originally dredged in the 1920's to improve drainage for agricultural uses (Smalley, et al, 1961). One of the concerns voiced by the citizens along several residential canals and channels is the possibility of future sedimentation from stormwater runoff causing a loss of water depth after the expense of the dredging operation. To address those concerns, the County has engaged BHI to analyze the stormwater systems entering the channels and estimate the effects these systems may have on future sediment accumulation.

3.0 SITE CONDITIONS

Channel sedimentation can be the result of many factors, including stormwater discharges, upland erosion, illegal discharges, excess vegetation growth from high nutrient levels in the channels, or wind blown currents. Most channels are influenced by a combination of these factors. A careful investigation is required to determine the causes of sedimentation prior to recommending courses of action to reduce sedimentation in channel systems.

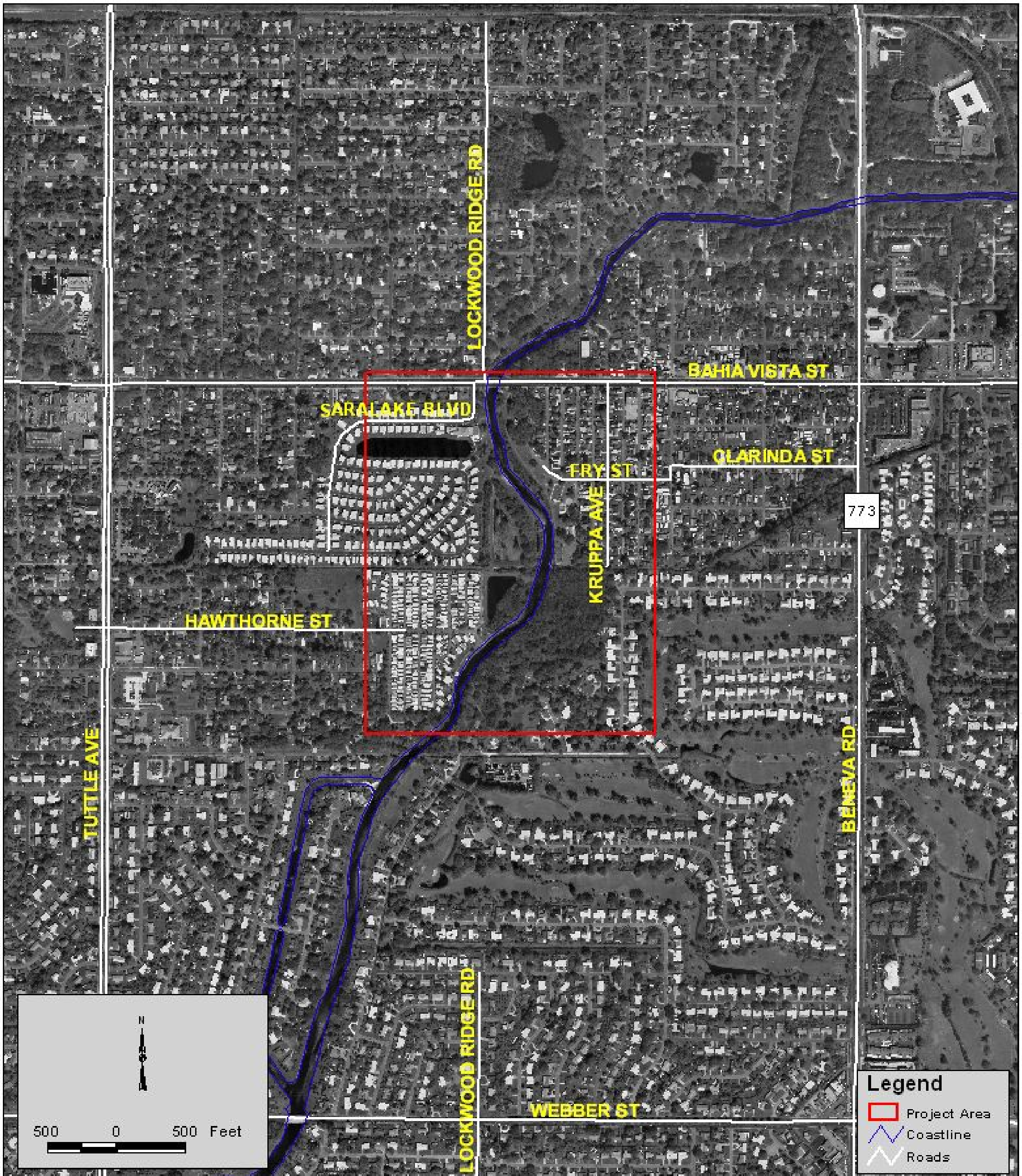

Figure 1	Project Location Map	Berryman & Henigar

Field investigations of the channel were made by BHI staff on December 21, 2004 and March 30, 2005. Steep slopes with apparent erosion were observed on a few ditches discharging to the channel.

The drainage basin for the channel is generally bordered by Tuttle Avenue on the west, Ingram Avenue on the east, Bahia Vista Street on the north, and Webber Street on the south. The overall drainage basin consists of 504 acres of mixed land uses. See Figure 2, which shows subbasins within the study area.

Soils in the area consist predominantly of Pople, Pineda, Felda, and Cassia fine sands. The soils are nearly level, somewhat and/or poorly-drained dark gray fine sand. Also, it is assumed that natural soils bordering the channel are covered with dredged material.

There are six stormwater outfalls that discharge to the channel. The outfalls are shown on the Existing Conditions Outfall Map, Figure 3. Each outfall is identified and discussed below.

3.1 Basin 1

This drainage basin area consists of 15.9 acres of mostly single family residential property, but it also includes roadway and commercial properties, and drains properties along Bahia Vista Street west of Phillippi Creek. There is an offsite stormwater treatment pond, located in basin 1B (Figure 4), that partially serves this basin but there is also a 36” Reinforced Concrete Pipe (RCP) pipe, outfall PI1, that directly discharges to the upper portion of the channel (Figure 5). There was no sediment build up observed along the shoreline at this basin.

3.2 Basin 2

This drainage basin area consists of 21.1 acres of single family and multi family residential properties. This basin drains properties along Sara Lake Boulevard, Viola Drive and Joline Drive. There is a stormwater treatment pond (Figure 6) that serves this basin and it discharges to the channel via a 53”x34” pipe, outfall PI2 (Figure 7). Erosion of the steep slopes of the channel was observed at this outfall.

3.3 Basin 3

This drainage basin area consists of 88.6 acres of mostly single family residential property, but it also includes multi family residential and commercial properties. This is the second largest basin and it drains properties from Tuttle Avenue to the west and properties south of Bahia Vista Street and north of Hawthorne Street. There is a stormwater treatment pond (Figure 8) that partially serves this basin but there is also a large ditch, outfall PI3, that directly discharges to the middle portion of the channel. Erosion of the steep slopes of the ditch and sediment discharges were observed at this outfall (Figures 9 & 10).

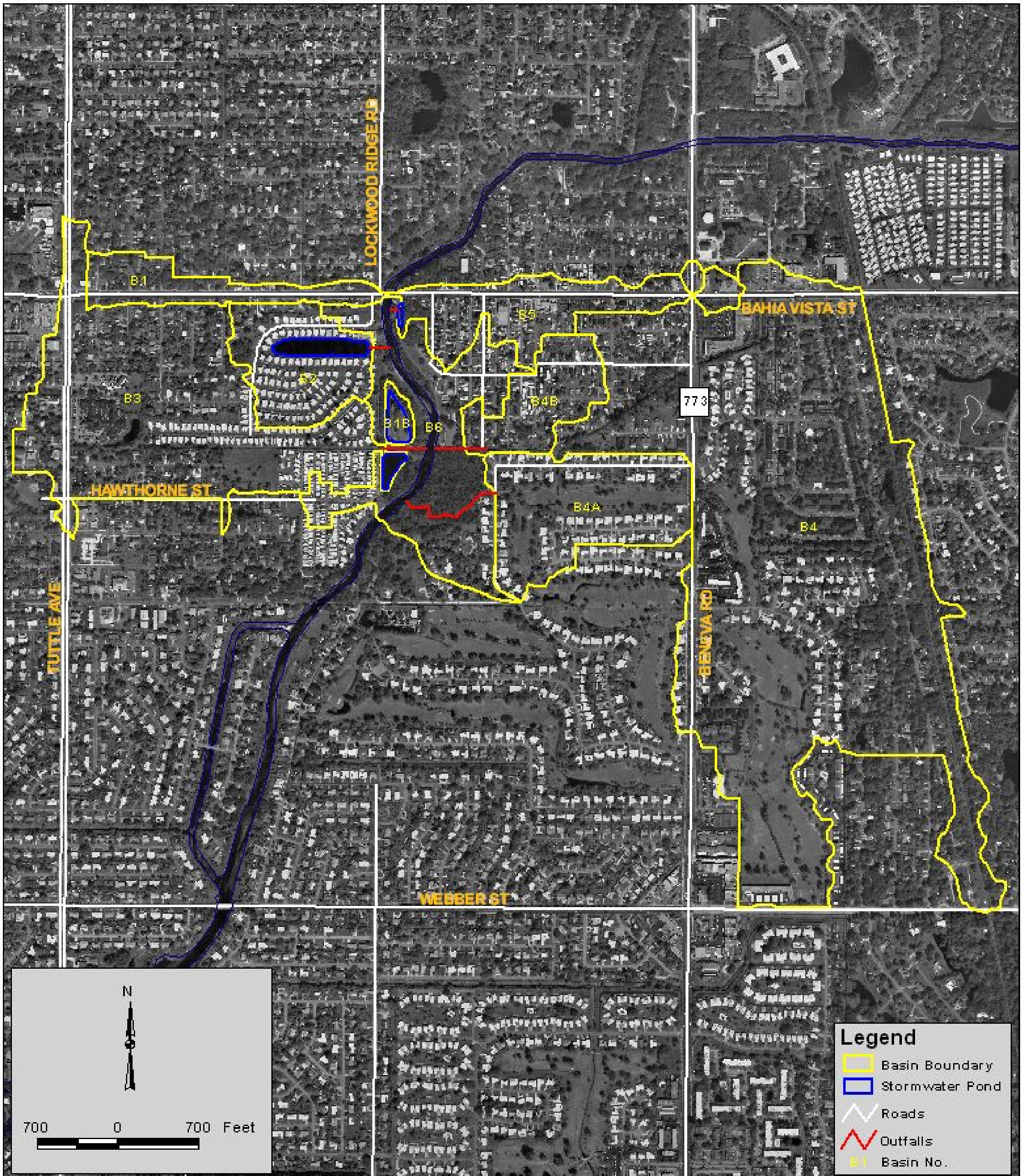

Figure 2	Existing Features Map	Berryman & Henigar

Figure 3	Existing Conditions Outfall Map	Berryman & Henigar

Figure 4.
Offsite stormwater pond in Basin 1B.

Figure 5.
Looking northeast at Bahia Vista St. Bridge. Uppermost portion of channel.

Figure 6.
Stormwater pond in Basin B2. Note rip-rap installed at toe of slope.

Figure 7.
Depression at Outfall PI2

Figure 8.
Stormwater pond in Basin B3

Figure 9.
Outlet ditch PI3. Note erosion of the steep slopes.

Figure 10.
Outlet PI3 ditch bed. Note sediments at bottom.

3.4 Basin 4

This drainage basin area consists of 296.3 acres of mostly single family residential property, but it also includes multi family residential and commercial properties, roadway and open space. This is the largest drainage basin discharging to the canal system and has no stormwater treatment systems. This basin drains properties from Bahia Vista Street to the north, Webber Street to the south, and Ingram Avenue to the east, and it splits into two systems just north of Sea View Street (Figures 11 & 12). The system to the south drains through a ditch, outfall PI4A (Figure 13), that runs through the preservation area south of Pinecraft Park , while the system to the north drains through a ditch, outfall PI4B (Figure 14), just south of Pinecraft Park. Erosion of the steep slopes of the ditch and sediment discharges were observed at both of these outfalls (Figures 15 & 16).

3.5 Basin 5

This drainage basin area consists of 26.8 acres of mostly single family residential property, but it also includes roadway and commercial properties, and drains properties along Bahia Vista Street east of Phillippi Creek. There is a stormwater treatment pond that serves this basin (Figure 17) and discharges to the upper portion via a 54” RCP pipe, outfall PI5. There was no sediment build up observed along the shoreline at this basin.

Figure 11.
Pipe at Basin 4 towards outfall PI4B. Note sediment island at turn.

Figure 12.
Pipe under Sea View St. towards outfall PI4A in Basin B4.

Figure 13.
Ditch of outfall PI4A in the preservation area

Figure 14.
Ditch of outfall PI4B. Note steep slopes

Figure 15.
Upstream of outfall PI4A at golf Course. Note eroded steep slopes.

Figure 16.
Outfall PI4B eroded ditch bed.

Figure 17.
Stormwater pond in Basin B5

4.0 POLLUTANT LOADING ASSESSMENT

A pollutant loading analysis was performed to quantify potential land-based sediment and nutrient loadings entering the channel. The analysis used a spreadsheet-based model, with loading estimates based on land uses from the Southwest Florida Water Management District (SWFWMD) FLUCCS land use GIS coverage, drainage basin boundaries obtained from Sarasota County, stormwater treatment efficiency rates for Best Management Practices (BMPs) (ASCE, 2001), and annual pollutant loading unit rates (ERD, 1994). Loading rates used are summarized in Table 1. BMP treatment efficiencies are shown in Table 2. Land uses were field verified. This type of planning-level analysis does not take into account short-term erosion from sources such as construction sites or leaking pipe joints.

Pollutant loadings were estimated by multiplying the total acreage in each drainage basin by a composite annual loading rate that was developed by weighting the land use specific loading rates by the relative proportion of basin area in that land use. Where appropriate, the gross loadings were adjusted to account for BMP reduction factors to estimate the net pollutant loadings by parameter.

The largest drainage discharging to the project area, Basin 4, splits into two systems just north of Sea View Street. The loading from this large basin was proportionally distributed based on flows taken from the Phillippi Creek AdICPR models with 75% of the loadings being attributed to outfall PI4A and 25% of the loadings to outfall PI4B.

The existing conditions pollutant loadings are presented in Table 3. Loadings were calculated for total suspended solids (TSS), total phosphorus (TP), and total nitrogen (TN). While TSS can account for sediment build up in a channel, nutrients from TP and TN can lead to algae blooms and vegetation growth, with subsequent muck accumulation in water bodies. The assessment estimates current TSS loading at 40,386 kg/year, TP loading at 295 kg/year, and TN loading at 2,268 kg/year.

Using a typical unit weight for sandy silt of 90 lb/cubic foot (Dunn et. al., 1980), the 89,036 lb annual sediment load could contain a volume of approximately 989 cubic feet (36.6 cubic yards), or about 0.08 inches annually over the area of the channel bottom. However, under field conditions, the sediment would tend to accumulate near the outfalls, although tidal and stream flows would disperse the sediment throughout the channel and into Phillippi Creek.

Table 1.
Summary of unit pollutant loading rates for central and south Florida (ERD, 1994).

LAND USE CATEGORY	UNIT LOADING RATE (kg/ac-yr)						
	TOTAL N	ORTHO-P	TOTAL P	BOD	TSS	TOTAL Zn	TOTAL Pb
Low Density Residential	2.88	0.169	0.320	7.63	31.9	0.06	0.052
Single-Family	4.68	0.335	0.594	14.3	56.1	0.122	0.083
Multi Family	8.51	0.924	1.72	38.4	256	0.188	0.299
Low-Intensity Commercial	5.18	0.157	0.650	36.1	343	0.511	0.635
High Intensity Commercial	13.0	1.52	1.96	79.3	435	0.782	0.985
Industrial	7.30	0.519	1.24	39.5	383	0.543	0.872
Highway	6.69	0.361	1.32	21.9	182	0.508	0.727
Agricultural							
a. Pasture	4.54	0.732	0.876	7.99	126	---	---
b. Citrus	2.91	0.123	0.197	3.60	21.9	---	---
c. Row Crops	2.84	0.421	0.595	---	---	---	---
d. General Agriculture	3.62	0.380	0.551	5.80	74.0	---	---
Recreational/Open Space	1.07	0.003	0.046	0.956	7.60	0.005	0.021
Mining	2.21	0.131	0.281	18.0	176	0.229	0.378
Wetland	1.81	0.204	0.222	4.96	11.2	0.009	0.039
Open Water	3.23	0.130	0.273	4.02	8.05	0.073	0.065

Table 2.
BMP selection guide (ASCE, 2001).

BMP	Design Factor				Type of Pollutant					
	Land Area Needed	Distance Above Groundwater	Soil Type Needed	Cost	Mainten-ance	Total Nitrogen % Removal	Total Phosphorus% Removal	Suspended Solids % Removal	Heavy Metals % Removal	Floating Trash Removal
Ponds										
Dry Retention Online	High	Low	A or B	High	Medium	60-98	60-98	60-98	60-98	High
Dry Offline Retention or Detention	High	Low	A or B	High	Medium	60	85	90	65-85	High
Wet Detention	High	High	Any	High	Low	26	65	75	25-70	High
Wet Detention With Filtration	High	Low	Any	High	High	25	65	85	60-85	High
Dry Detention	High	Low	A or B	High	Medium	15	25	70	35-70	High
Alum System		NA	NA	High	Medium	50	90	90	80-90	0
Constructed Wetlands	High	0 ft.	C or D	High	High	****	****	High	High	High
Sand Filters										
Austin Sand Filter	Medium	2 ft.			High	31-47	50-65	70-87	20-84	N/A
D.C. Underground Sand Filter	Medium				High					N/A
Delaware Sand Filter	Medium	2 ft.			High	47	41	57	45.2	N/A
Alexandria Stone Reservoir Trench	High				High	47.2	63-72	79-84	***	N/A
Texas Vertical Sand Filter	Medium	7 feet	N/A		High					N/A
Peat Sand Filter	Medium				High					N/A
Washington Compost Filter System	200 S.F/cfs	4 feet	N/A		High	N/A	41	95	75.8	N/A
Other										
Baffle Boxes	Low	NA	NA	Medium	Medium	0	30-40	20-90	Unknown	Low
Vegetated Swales	Medium	Low	A,B, C	Medium	Low	0-25	29-45	60-83	35	Low
Buffer Strips	Low	1 ft-2 ft	A,B,C	Medium	Low	20-60	20-60	20-80	20-80	Low
Infiltration Trenches	Low	2-4 ft	A or B	Medium	High	45-70	50-75	75-99	75-99	High
Inlet Devices	None	NA	NA	Low	High	**	**	Low-Medium	Low	High

** Traps particulate phosphorus and nitrogen in the form of leaves and grass - not effective for dissolved nutrients

*** No Data Available

**** Varies widely

Table 3. Pinecraft Pollutant Estimates Existing Conditions												
Basin No.	**Area (ac)**	**Land Use**	**Type of Treatment System**	**% TSS Reduction**	**% TP Reduction**	**% TN Reduction**	**TSS Loading Rate (kg/ac-yr)**	**TP Loading Rate (kg/ac-yr)**	**TN Loading Rate (kg/ac-yr)**	**TSS Loading (kg/yr)**	**TP Loading (kg/yr)**	**TN Loading (kg/yr)**
1	14.54	Single Family Residential	None				56.1	0.59	4.68	815.8	8.6	68.1
1	0.32	Commercial	None				343.0	0.65	5.18	108.0	0.2	1.6
1	4.66	Roadway	None				182.0	1.32	6.69	847.2	6.1	31.1
1B	1.03	Open Space	None				7.6	0.05	1.07	7.8	0.0	1.1
1	15.89	Total Basin Land Use	Wet Pond	75	65	26				379.4	4.3	59.3
2	3.66	Single Family Residential	None				56.1	0.59	4.68	205.5	2.2	17.1
2	17.42	Multi Family Residential	None				256.0	1.72	8.51	4,458.5	30.0	148.2
2	21.08	Total Basin Land Use	Wet Pond	75	65	26				1,166.0	11.2	122.4
3	47.15	Single Family Residential	None				56.1	0.59	4.68	2,645.1	28.0	220.7
3	19.79	Multi Family Residential	None				256.0	1.72	8.51	5,067.3	34.0	168.4
3	21.37	Commercial	None				343.0	0.65	5.18	7,328.9	13.9	110.7
3	0.34	Open Space	None				7.6	0.05	1.07	2.6	0.0	0.4
3	88.65	Total Basin Land Use	Wet Pond	75	65	26				3,761.0	26.6	370.1
4	113.31	Single Family Residential	None				56.1	0.59	4.68	6,356.9	66.9	530.3

Basin No.	Area (ac)	Land Use	Type of Treatment System	% TSS Reduction	% TP Reduction	% TN Reduction	TSS Loading Rate (kg/ac-yr)	TP Loading Rate (kg/ac-yr)	TN Loading Rate (kg/ac-yr)	TSS Loading (kg/yr)	TP Loading (kg/yr)	TN Loading (kg/yr)
4	59.25	Multi Family Residential	None				256.0	1.72	8.51	15,168.0	101.9	504.2
4	13.50	Commercial	None				343.0	0.65	5.18	4,630.8	8.8	69.9
4	46.03	Open Space	None				7.6	0.05	1.07	349.8	2.1	49.2
4	10.71	Roadway	None				182.0	1.32	6.69	1,949.6	14.1	71.7
4	242.80	Sub-total Basin Land Use	None							28,455.1	193.8	1,225.4
4A	25.38	Single Family Residential	None				56.1	0.59	4.68	1,424.0	15.0	118.8
4A	10.27	Open Space	None				7.6	0.05	1.07	78.1	0.5	11.0
4A	0.48	Roadway	None				182.0	1.32	6.69	86.6	0.6	3.2
4A	36.13	Sub-total Basin Land Use	None							1,588.7	16.1	133.0
(1)4A	218.23	Total Basin Land Use	None							22,930.1	161.4	1,052.0
4B	17.37	Single Family Residential	None				56.1	0.59	4.68	974.5	10.2	81.3
(2)4B	78.07	Total Basin Land Use	None							8,088.2	58.7	387.6
5	15.95	Single Family Residential	None				56.1	0.59	4.68	895.0	9.4	74.7
5	4.61	Commercial	None				343.0	0.65	5.18	1,580.2	3.0	23.9
5	6.27	Roadway	None				182.0	1.32	6.69	1,141.7	8.3	42.0

Basin No.	Area (ac)	Land Use	Type of Treatment System	% TSS Reduction	% TP Reduction	% TN Reduction	TSS Loading Rate (kg/ac-yr)	TP Loading Rate (kg/ac-yr)	TN Loading Rate (kg/ac-yr)	TSS Loading (kg/yr)	TP Loading (kg/yr)	TN Loading (kg/yr)
5	26.83	Total Basin Land Use	Wet Pond	75	65	26				904.2	7.2	104.0
6	18.46	Single Family Residential	None				56.1	0.59	4.68	1,035.6	10.9	86.4
6	7.73	Multi Family Residential	None				256.0	1.72	8.51	1,978.1	13.3	65.8
6	18.90	Open Space	None				7.6	0.05	1.07	143.7	0.9	20.2
6	45.09	Total Basin Land Use	None							3,157.4	25.1	172.4
	TOTAL									40,386.3	294.5	2,267.8

Notes: (1) Basin 4A includes 75% of basin 4 area and loads
(2) Basin 4B includes 25% of basin 4 area and loads

5.0 DISCUSSION AND RECOMMENDATIONS

Existing conditions land-based pollutant loadings to the channel were calculated for total suspended solids (TSS), total phosphorus (TP), and total nitrogen (TN). The estimate loadings are 40,386 kg/year for TSS, 295 kg/year for TP, and a TN loading of 2,268 kg/year.

The 997 lb annual sediment load could contain a volume of approximately 11 cubic feet, or about 0.0004 inches annually over the area of the channel bottom. As stated above however, under field conditions, the sediment would tend to accumulate near the outfalls, although stream flows would disperse the sediment throughout the channel and into the rest of Phillippi Creek.

This section describes recommendations on how to reduce runoff-borne sediment from entering the channel. Nutrients can become adsorbed onto sediment particles, so trapping sediment also can reduce nutrient loading to the estuarine system.

In the Pinecraft watershed, all but one of the five drainage basins currently provide some level of stormwater treatment, accounting for 152 acres out of 504 acres with BMP treatment for the stormwater. Most of the 351 acres not being treated are part of the largest basin, basin 4 which accounts for 296 acres, the rest directly discharge to the channel or are in the properties bordering the channel, where it is not generally feasible to install BMPs other than rear lot swales.

Some silt accumulation was noted on the bottom of the channel and can be indicative of a combination of sediment from soil erosion and from upstream sources of high nutrient levels in the channel. Potential nutrient sources include fertilizers, leaves, grass, organic yard debris, and pet wastes from local runoff, or stream-borne nutrients from Phillippi Creek. Inlet devices and other land-limited BMPs can be effective in capturing TSS from runoff, but not nutrients. Reduction of nutrients in urban settings can be more effectively accomplished with source controls. Educating the homeowners in the area to reduce fertilizer use, prevent grass clippings from entering the channels, and mowing less frequently would benefit the nutrient levels in the channels. Also, small back yard swales to hold runoff instead of letting it run directly into the channel can be effective.

There were some areas of grass clippings and leaves in the street which could enter the channel. In addition, lawn mowers should blow leaves and grass back into the yards instead of into the street or the channel. It is therefore recommended that the County continue to provide public education regarding methods of source control and single lot design that could reduce sediment and nutrient loadings to the channel.

Specific recommendations for each subbasin outfall are also included in this section. Each outfall to the channel is discussed below.

5.1 Basin 1

This drainage basin drains properties along Bahia Vista Street west of Phillippi Creek, it is partially treated by an offsite stormwater treatment pond but it also has a pipe that drains to the upper portion of the channel through Outfall PI1. No new BMPs are recommended for this outfall because of the basin size and because the existing offsite stormwater pond is working properly.

5.2 Basin 2

This drainage basin drains properties along Sara Lake Boulevard, Viola Drive and Joline Drive. There is a stormwater treatment pond that serves this basin and it discharges to the channel via outfall PI2. Due to the unstable condition of the channel side slopes near the outfall BHI recommends stabilization with riprap and/or other channel stabilization system to avoid further erosion.

5.3 Basin 3

This drainage basin area, the second largest basin, drains properties from Tuttle Avenue to the west and properties south of Bahia Vista Street and north of Hawthorne Street. There is a stormwater treatment pond that partially serves this basin but there is also a large ditch, outfall PI3, that directly discharges to the middle portion of the channel. Due to the unstable condition of the ditch side slopes near the outfall BHI recommends stabilization with riprap and/or other channel stabilization system to avoid further erosion.

5.4 Basin 4

This is the largest drainage basin discharging to the channel and has no stormwater treatment systems. This basin drains properties from Bahia Vista Street to the north, Webber Street to the south, and Ingram Avenue to the east, and it splits into two systems just north Sea View Street. The system to the south drains through a ditch, outfall PI4A, that runs through the preservation area south of Pinecraft Park, while the system to the north drains through a ditch, outfall PI4B, just south of Pinecraft Park. BHI recommends a series of BMPs and sediment and erosion measures to treat this basin. A dry offline detention pond is being proposed to treat the large untreated drainage area of Basin 4. A baffle box is being recommended for outfall PI4A to be installed under Brookhaven Drive just upstream of the preservation area. An enhanced nutrient separating baffle box, which has an added benefit of reducing nutrient loads by trapping grass, leaves, and organic debris and keeping this material dry so that the nutrients do not leach out into the stormwater would also be appropriate for this site (BHI, 2004). An added feature of using this BMP is that it would help the County achieve nutrient reductions recommended for Sarasota Bay. Finally due to the unstable condition of the ditch side slopes near the PI4B outfall BHI recommends stabilization with riprap and/or other channel stabilization system to avoid further erosion.

5.5 Basin 5

This drainage basin drains properties along Bahia Vista Street east of Phillippi Creek. It is treated by a stormwater treatment pond that discharges to the upper portion of the channel via a 54" RCP pipe, outfall PI5. No new BMPs are recommended for this outfall because of the basin size and because the existing offsite stormwater pond is working properly.

6.0 CONCLUSIONS

The Pinecraft area has some sedimentation problems typical of many residential channels near the coastline. Accumulations of sediment occur from natural erosion and anthropogenic activities such as construction and land clearing. Some silt accumulation was noted on the bottom of the channel and can be indicative of a combination of sediment from soil erosion and from upstream sources of high nutrient levels in the channel. Potential nutrient sources include fertilizers, leaves, grass, organic yard debris, and pet wastes from local runoff, septic tanks, or stream-borne nutrients from Phillippi Creek. It has to be noted that the County is currently converting large areas, e.g. Area C, and connecting them to the county sewer system. With the dredging project being investigated by the County, it is natural that the affected property owners would inquire as to possible methods to reduce future sedimentation and dredging expenses.

An analysis of the land uses and drainage basins of the channel was undertaken to determine possible causes of sediment build up. Outfall pipes to the channel were inspected for obvious joint leakage or erosion problems. There were no obvious signs of sediment in the pipes themselves, indicating that there were no significant structural problems to the system, but steep slopes with apparent erosion were observed on a few ditches discharging to the channel.

To further examine potential pollution sources to the channel, a pollutant loading analysis of the stormwater runoff from the watershed was undertaken. TSS, TN, and TP loadings were estimated using a spreadsheet calculation accounting for the land areas, land uses, pollutant loadings, and existing stormwater treatment systems. This analysis suggests that the highest pollutant loadings originate in basin B4, the largest basin. Most of the residential basins were smaller and had treatment systems in place. Recommendations are summarized in Figure 18.

There are six stormwater outfalls to the channel. Based on the field investigations and analysis in this report, it is recommended that a dry offline detention pond will be constructed to treat the large untreated drainage area of Basin 4 (Figure 19), a baffle box be constructed, upstream of outfall pipe PI4A, and rear lot swales be constructed next to the paved trail in Pinecraft Park. These proposed added structures would provide a higher level of treatment to runoff by detaining a volume of runoff and by preventing much debris and sediment from entering the channel. Finally due to the unstable condition of the ditches side slopes near PI3 and PI4B outfalls, and on the channel steep side slopes near outfall PI2 and west of Pinecraft Park, BHI recommends stabilization with riprap and/or other channel stabilization system to avoid further erosion.

One of the most important aspects of pollutant reduction is source control. At some locations it was observed that residents were allowing grass clippings to wash or blow into the inlets. A strong public education effort will inform residents that changing their day to day activities can be one of the best methods of pollution control. By reducing fertilizer application amounts and frequencies, reducing lawn sprinkling to twice a week, reducing mowing, controlling disposal of grass and yard debris, and cleaning pet refuse, the homeowners can take a large part in reducing nutrient loading to the channel and thereby reducing muck accumulations in the channel.

Figure 18	Recommended Sediment Abatement Facilities	Berryman & Henigar

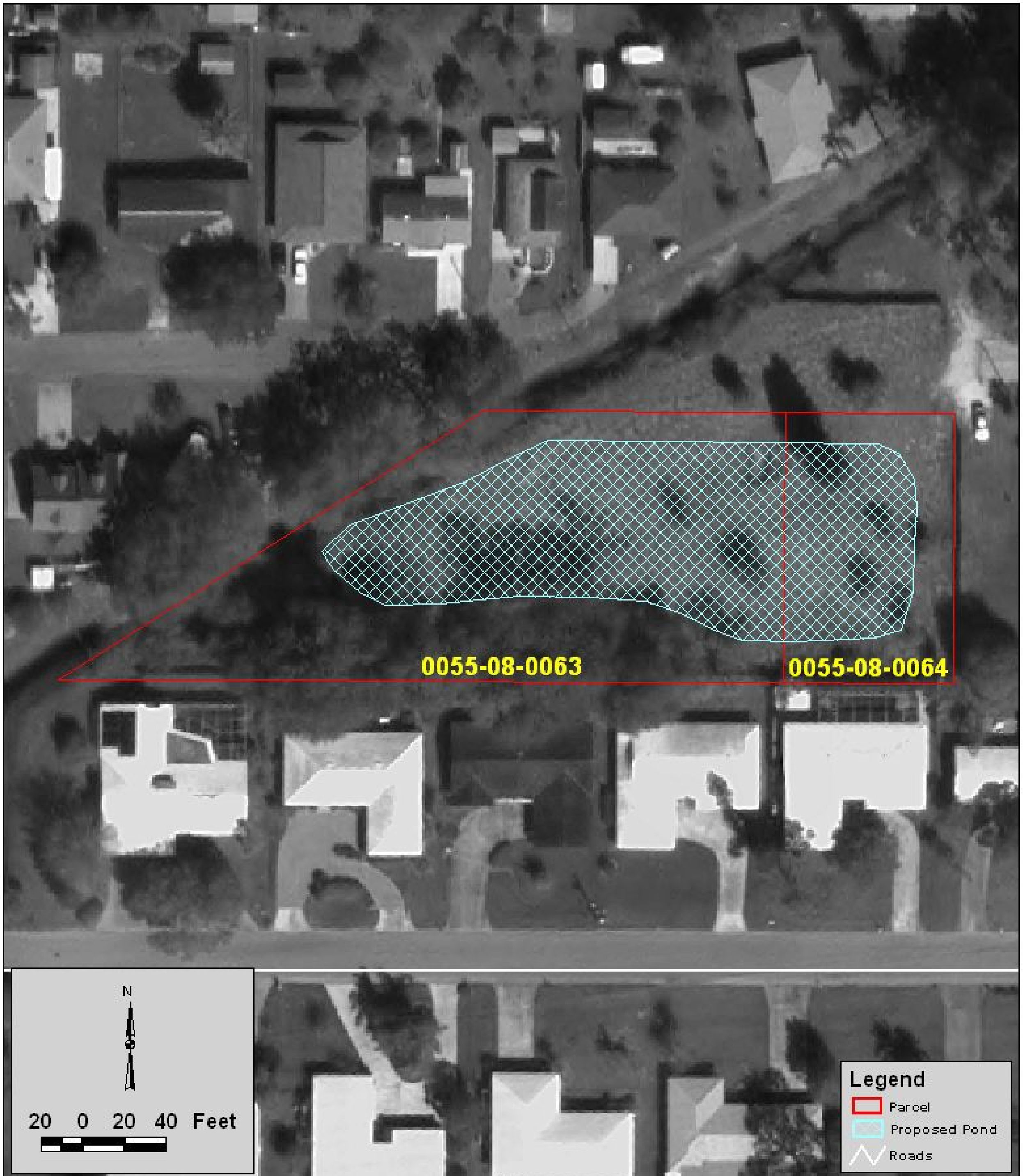

Figure 19	Proposed Pond Parcels Map	Berryman & Henigar

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8.0 APPENDICES