

WATER QUALITY WITHIN A FOUR YEAR OLD PHOSPHATE SURFACE MINED  
RECLAIMED WETLAND IN CENTRAL FLORIDA

by

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Abstract. The project (Agrico Swamp) site consists of 148 hectares of phosphate mined land of which 61 hectares of wetlands and 87 hectares of contiguous uplands were reclaimed in 1981/82. The wetlands were designed to create freshwater marsh, hardwood swamp, and open water habitats. After three complete growing seasons (3 years) the comprehensive monitoring of ground and surface waters within and adjacent to the project, including the receiving waters of Payne Creek shows that Agrico Swamp is stabilizing. Surface water within the project is comparable to open water areas within natural wetlands of the region. The vegetation growth should buffer the high alkalinity and moderate other peak values recorded in Agrico Swamp. The most unexpected finding was that total N and total P were relatively low. The low P values may be partially due to the insolubility of calcium fluorapatite in the alkaline water within the project. The perturbation resulting from surface mining is probably responsible for peak values of pH, dissolved solids, specific conductance, alkalinity, and gross alpha in the project. Groundwater quality in Agrico Swamp is good considering the recent surface mining of the area. Payne Creek continues to meet Class III water quality standards with Agrico Swamp having no apparent adverse impacts to date.

Introduction

Agrico Mining Company proposed to reclaim 148 hectares of phosphate mined land in 1980 to comply with Florida's mine reclamation rules. The Company proposed to reclaim 61 hectares of wetland (Agrico Swamp) and 87 hectares contiguous uplands. The reclamation site was originally pine flatwoods and rangeland with some mixed forest before it was mined in 1978 and 1979. This plan was approved in 1980. Construction was completed on all but 8 hectares by December, 1981. The remaining acreage was completed in May, 1982.

The reclamation project was designed and

constructed to create open water, fresh water marsh, hardwood swamp, and upland habitats. The project is intensively monitored for evaluating the various tree planting and marsh establishment methods, biological integrity, and the quality and quantity of ground and surface waters within the project. Data from this reclaimed area over the next several years should aid in evaluating the rate and type of habitat development in the reclaimed surface mined lands in Florida.

In order to provide a complete evaluation of the Agrico Swamp reclamation project's changing conditions, a comprehensive water quality monitoring program was designed and implemented in June 1982. Water quality parameters are monitored quarterly at two sites within the Agrico Swamp open water association (AOWA), four Agrico Swamp groundwells, two background wells in natural areas in the vicinity of Agrico Swamp, four wells in Hardee County south of the project, a natural marsh open water association (NOWA) near Agrico Swamp, and four locations within Payne Creek - both upstream

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and downstream of the point of discharge of Agrico Swamp. Discharges from the project occur only during the rainy season or during extremely wet weather.

The water quality monitoring of Agrico Swamp is designed to assess the surface and groundwater quality onsite as well as the receiving waters of Payne Creek. This report covers the period from August 1984 to July 1985.

The most significant event during this reporting period was a prolonged drought in the area. The annual average rainfall is 51.77 inches, but during the 12 months of this report there were only 29.69 inches recorded at the on-site rain gauge. The total rainfall for the 8 month dry season (October to May) was only 8.3 inches. As a result, the streamflow in Payne Creek was severely reduced. By the end of May, the inlet flow (PC-1) was 0. However, flow of up to 0.05 MGD was recorded on several days in May. In contrast the inlet flow in mid-August was 4.0 MGD. The outlet flow (PC-4) in May was generally less than 1 MGD and as low as 0.2 MGD compared to the 75 MGD recorded in August.

#### Methods

The water quality monitoring program is flexible and provides for changes in sampling stations as well as water quality test parameters. These changes are made to respond to changing conditions and to take advantage of information acquired. During the period of this report water samples were taken from two open water areas and four wells within Agrico Swamp and offsite from a natural open water area, two wells adjacent to the project, and four stations along Payne Creek. Four existing wells in Hardee County were also sampled during this reporting period to better assess background conditions. The location of these sampling stations are shown in Figure 1. Water samples were analyzed for as many as 24 different physical and chemical parameters.

#### General Description of Sampling Stations

Open Water Areas. The open water sampling sites within Agrico Swamp are located in a large marsh that extends along the eastern side of Agrico Swamp. These sites are in deep water specifically constructed to ensure the availability of open water habitat during the dry season. One station is located at the southern end of the marsh (AOWAS) and a new station was added during this reporting period in the northern end of the marsh (AOWAN). At these locations, samples were taken from the surface and bottom (-3.0 meters) of the water column. An ambient station in a natural open water area (NOWA) located approximately 9 kilometers south of Agrico Swamp in Hardee County was sampled at the water's surface.

Payne Creek. Payne Creek is located north and east of Agrico Swamp and flows in a southerly direction to the Peace River. Water sampling stations are located in the vicinity of State Road 37, where the creek enters Agrico property northwest of Agrico Swamp (PC-1), just downstream of the Agrico Swamp overflow discharges (PC-3), in Hardee County where the creek leaves Agrico property (PC-4), and an additional station has been added just upstream of overflow discharges (PC-2). The

addition of sampling station PC-2 permits a clearer assessment of the impact of Agrico Swamp on the creek without the perturbations caused by landowners upstream of the project.

Wells. Within Agrico Swamp, two wells (W-2 and W-4) are located in uplands on the western side of the project and two wells (W-3 and W-5) are centrally located in transitional wetland areas. The off-site wells are located just outside the boundary of the project to the north (W-1) and south (W-7). During this reporting period, four additional wells (W-17, W-18, W-19, and W-20) located from 4 to 10 kilometers south of the project in Hardee County were also monitored.

#### Water Sampling Procedures

Groundwater. The construction details of the wells used for groundwater monitoring are shown below.

<u>WELL #</u>	<u>DIAMETER</u>	<u>CASING DEPTH</u>	<u>WELL DEPTH</u>
1	6" PVC	0-30'	37'
2	6" PVC	0-30' screen 30-40'	40'
3	6" PVC	0-25' screen 25-35'	35'
4	6" PVC	0-30'	37'
5	6" PVC	0-30'	37'
7	6" PVC	0-20'	27'
17	6" PVC	0-70'	125'
18	4" Black Steel	0-63'	125'
19	4" Black Steel	0-75'	125'
20	4" Black Steel	0-59'	125'

Schedule 40 PVC used

An ISCO Model 2600 portable, compressed air operated, submersible well pump was used to evacuate the wells in a minimum of one well volume before sampling. These wells were evacuated one day and sampled the next. The wells were pumped ten minutes before samples were collected in the ISCO sampler.

Surface Water. Surface water samples were collected directly in sample containers by dipping, except for those taken at the bottom of the water column, which required the use of a Kemmerer sampler.

Water samples were collected in new plastic bottles (nonreusable), except for dissolved oxygen which was collected in glass, and preserved as follows:

1. Metals were preserved with nitric acid to a pH less than 2.0 and refrigerated.
2. Nitrogen samples were preserved with sulfuric acid to pH less than 2.0 and refrigerated.
3. Dissolved oxygen samples were preserved with a manganous sulfate solution and an alkaline iodide-

azide solution (Winkler method).

4. The temperature was measured in the field at the time of sampling.
5. All samples were refrigerated.

The water samples were then hand carried, on the day of collection, to a laboratory for measurement of selected chemical constituents and physical parameters according to Standard Methods (1980).

### Results and Discussion

Water quality analysis in Erwin 1983 and 1984 concentrated on the comparison of water quality in Agrico Swamp with State Water Quality Standards (Chapter 17-3, Florida Administrative Code, 1983; and Chapter 17-22, Florida Administrative Code, 1982). This comparison required that surface and groundwater be examined separately. Erwin, 1985 focuses on the comparison of water quality test parameters at the different sampling stations. However, deviations from State Standards are noted.

Temperature. Variations in temperatures recorded were primarily reflections of seasonal changes, however there were some differences noted between sampling stations. The samples taken from the surface of the Agrico open water areas ranged from 54 to 93 degrees F., while samples taken from the bottom of the water column and surface samples from the ambient openwater area were about 3 degrees cooler. The temperatures of the water from the wells was, as expected, less variable, ranging from 70 to 80 degrees. There was little or no difference between temperatures recorded from the 125' deep wells in Hardee County and the 30' wells of Agrico Swamp. Payne Creek was intermediate in variability with a range of 58-82 degrees. No differences were noted between Payne Creek sampling stations.

pH. As reported in Erwin and Bartleson, 1985, the pH of open water samples within Agrico Swamp was again quite high. The mean values were 8.80 for surface samples and 8.61 for bottom samples. The highest mean values for the quarterly samples were found in May (9.90-surface and 9.35-bottom) at the end of the severe dry season. During the other three sampling periods the mean values were 8.43 for surface and 8.37 for bottom samples. The pH of the ambient NOWA station in the same three periods averaged 6.47. This is higher than the 5.93 average value found for the same three reporting periods in the previous year. The NOWA dried up in May and no sample was available. The pH averaged 6.59 for all Agrico Swamp wells and 7.89 for the Hardee County wells. Little variation was noted between wells within these two locations. The sampling stations in Payne Creek also displayed little variation in pH, with a mean of 7.08, but there was still a tendency, as previously noted, for an increase in alkalinity of the downstream stations.

Although measurements have not been made to determine the pH of rainfall in the area, it appears that rainfall lowers the pH of surface water and conversely the lack of rainfall allows the pH to rise. On the other hand rainfall had the opposite effect on wells. Water filtering through the upper layers of soil obviously

increased in pH. Wells had the lowest pH in the dry periods.

The State water quality standard for pH is 6-8.5. The maximum value is frequently exceeded in the open water of Agrico Swamp, but no ill effects to receiving waters have been noted. No perceptible decrease in pH of the open water has been noted during the three years of sampling. However, since other similar wetlands in the area have a pH of approximately 6.0 according to Best (1984) and Cowell (1984), a gradual decrease in pH is anticipated as the area stabilizes.

Dissolved Oxygen. The dissolved oxygen recorded from the Agrico Swamp open water surface samples was quite high, ranging from a mean of 10.1 mg/l in February to a mean of 15.5 mg/l during the dry season in May. The samples from the bottom of the water column at these two locations displayed an inverse relationship with mean values ranging from 1.45 mg/l in May to a high of 10.05 mg/l in February. The three sampling periods available for the surface water of the NOWA provided values of 2.0, 7.0, and 1.0 mg/l in August, November, and February, respectively. As previously reported, the low values for D.O. in the NOWA were undoubtedly the result of respiration of dense aquatic growth of vegetation.

The dissolved oxygen in Payne Creek increased from a mean of 2.13 at PC-1 to 7.13 at PC-4. The mean dissolved oxygen levels at PC-2 (2.65) and PC-3 (2.68) were significantly depressed during the period of low water level and flow during the drought. Both of these stations had less than 0.5 mg/l D.O. in the May sampling period. The depression of the dissolved oxygen content was due to stagnation of the water and dense aquatic vegetation.

Turbidity. The effects of the drought are most apparent in the measurement of turbidity (NTU). The turbidity in the Agrico Swamp open water ranged from 6.65 NTU in the August rainy season, to 7.75 in November, to 14.5 in February, to 22.5 in May. The ambient open water area was less turbid with values of 1.0 (Aug.), 4.6 (Nov.) and 10.0 (Feb.) before drying up.

The turbidity in Payne Creek jumped from 1.0 at PC-2 and PC-3 in February to 15.0 (PC-2) and 18.0 (PC-3) in May. At PC-4, despite low water levels, there was adequate stream flow to maintain turbidity levels at less than 2.0 NTU throughout the year.

As reported in Erwin, 1984 the maximum values found for turbidity were 18 NTU in open water and 4 NTU in Payne Creek. The periodic surges in turbidity can be attributed at least in part to algal blooms as reported by Reusch (1983).

Specific Conductance. In Payne Creek, the highest specific conductance (in UMHS) was found at PC-1 which had a mean value of 356. The other three stations all averaged between 210 to 220. There did appear to be seasonal variation in that all four stations had their lowest values in the rainy season (August) and remained relatively constant during the other three reporting periods. This seasonal variation was not noted in the specific conductance measurements of the open water stations during this reporting period, but it was noted in the results of the Second Annual Report. There was

no difference between the surface and bottom samples of the Agrico Swamp open water, which averaged 282.4 and 290.5, respectively, but the ambient station was considerably lower with a mean of 167.4.

The four Hardee County wells had a mean specific conductance of 422.8 UMHOS. Wells 1 and 7, outside of the project, had an average of only 167.4. Within Agrico Swamp, Wells 4 and 5 averaged 358.9 while Wells 2 and 3, which have screens at the bottom of the casing and are known to be contaminated, had an average of 719.6. Reports on the water quality of the contaminated wells will be discontinued because Wells 4 and 5 permit assessment of the same groundwater sources and their similar construction provides a better means of comparison with the other test wells.

Bicarbonate. In Payne Creek, bicarbonate levels were lowest in August, ranging from 29.9 mg/l (PC-4) to 71.0 (PC-1). During the other reporting periods the values for bicarbonate generally ranged from 60-100 mg/l, except that PC-1 had values of 283 in November and 160 in May. In the Agrico Swamp open water areas, bicarbonate ranged from 103 to 180. The lowest values were found in August in both surface and bottom samples, and the bottom samples consistently had about 40 mg/l more bicarbonate than the surface samples. The ambient open water station had a range of 19 (August) to 45 (November) mg/l bicarbonate.

The Hardee County wells had a range of 183.9-250.6 mg/l bicarbonate and there was no indication of seasonal variation. Agrico Swamp Wells 2 and 3 again had high values for bicarbonate, ranging from 661-759 mg/l, while Wells 4 and 5 ranged from 340-419 and Wells 1 and 7 ranged from 37-138 mg/l.

There does not appear to be any relationship between bicarbonate and pH at any of the sampling stations.

Carbonate. No carbonate was detected in any of the water samples taken during this reporting period.

Fluoride. Levels of fluoride detected in all water quality samples were quite low. In Payne Creek the mean value for all samples taken was 0.84 mg/l. PC-1 had the highest value of 1.31, in February, and PC-2 had the lowest, 0.53 in August. Seasonal variation was apparent in the open water sampling for fluoride. The mean values for all open water samples was 0.91 (August), 0.12 (November), 0.13 (February), and 0.15 (May). There was no difference in concentrations of fluoride between the top and bottom of the water column and no appreciable difference between the Agrico Swamp open water and the ambient station.

In Payne Creek the average fluoride content was 0.84 mg/l. The highest value was found at PC-1 in February (1.31), and the lowest was found at PC-2 in August (0.53). Seasonal variation was not apparent in Payne Creek or any of the wells. In Hardee County the wells averaged 1.42 mg/l fluoride. Within Agrico Swamp, Wells 2 and 3 averaged 0.50 and 0.76, respectively, while Wells 4 and 5 had only 0.09 and 0.06 mg/l fluoride. Wells 1 and 7 just outside the project had values of 0.96 and 0.62.

Phosphorus. Levels of phosphorus in the Agrico Swamp open water areas remained quite low with a mean value of 0.36 mg/l. However, the phosphorus levels in August were consistently higher than the other periods. This same trend was reported in Erwin, 1984.

This again appears to reflect the findings of Upchurch (1979) that phosphorus is relatively insoluble in alkaline water. The ambient open water area averaged 0.82 for the three reporting periods at that station. This included the finding of 1.54 mg/l in February, which accounts for most of the difference between the two areas. The increase in February was probably due to the release of phosphorus from winter killed decaying vegetation.

Phosphorus levels in Payne Creek were highest at PC-1 (0.88 mg/l) and decreased downstream to 0.42 mg/l at PC-4. The phosphorus level generally declined from August through the November periods and then increased again in May. This increase was most notable at PC-2, which increased from 0.29 (February) to 1.80 in May.

In the Hardee County wells all phosphorus levels were less than 0.1 mg/l, with the exception of one well (in February) which had 0.64 mg/l. The Agrico Swamp wells ranges were: 0.45-0.54 (Well 2), 0.74-0.80 (Well 3) and 0.02-0.12 (Wells 4 and 5). The wells on the perimeter of the project had phosphorus levels of 0.80-1.19 (Well 1) and 0.55 to 1.25 (Well 7). There was no apparent seasonal variation in the amount of phosphorus in any of the wells.

Sulphate. The open water areas had low levels of sulphate with ranges of less than 1.0 to 4.0 mg/l in Agrico Swamp and less than 1.0 to 3.0 mg/l in the ambient open water area. On the other hand, Payne Creek was considerably higher in sulphate, with a mean value of 31.4 mg/l. The average concentration for the four stations was lowest in August (15.5) and increased each reporting period to May (42.8). PC-1 had the lowest concentration of sulphate (less than 1.0 recorded in May) and also the highest (68.0 recorded in February). The other three stations had approximately equal concentrations of sulphate.

Concentrations of sulphate in the Agrico Swamp wells were generally less than 1.0 mg/l, but detectable levels were recorded in some of the wells in all reporting periods except August. The higher concentrations were generally found in Well 4, but Well 3 had the highest single concentration found (21.0 in February). The wells adjacent to Agrico Swamp had levels less than 1.0 except for 8.0 mg/l found in the February sampling of Well 7. The deeper wells in Hardee County had higher concentrations of sulphate ranging from 0.2 to 12.3 with a mean of 6.12 mg/l and there were no apparent seasonal trends.

Dissolved Solids. In the Agrico Swamp open water areas the levels of dissolved solids ranged from 177 to 303 mg/l with no seasonal differences. There were noticeable differences between the two open water sampling stations, both at the surface and at the bottom of the water column. The surface samples at the south station were consistently lower than those at the north station and averaged 200 mg/l, while the northern station averaged 276 mg/l. The bottom samples had an inverse relationship with the north station averaging 209 mg/l and

the south station averaging 268 mg/l. At the ambient station the levels were slightly less than the other surface samples and ranged from 139 to 275 mg/l. In Payne Creek, the mean concentration of dissolved solids was 272 at PC-1 and approximately 170 for the other three stations.

Wells 2 and 3 were again quite high in dissolved solids, ranging from 363 to 500 mg/l while Wells 4 and 5 ranged from 231 to 324 and Wells 1 and 7 from 94 to 167. The Hardee County wells ranged from 225 to 424 mg/l dissolved solids.

Suspended Solids. The distribution of suspended solids in the Agrico Swamp open water areas is similar to that of the dissolved solids. The average surface water values were 10 mg/l at the south station and 50 mg/l at the north station. The bottom samples averaged 48.9 (south) and 15.8 (north). The suspended solids at the ambient station had a mean of 27.7 mg/l.

In Payne Creek, the suspended solids were quite low averaging only 4.0 mg/l, except for the readings of 26.3 and 28.3 at PC-2 and PC-3, in May. At the same time PC-1 and PC-4 had readings of 4.6 and less than 1.0 mg/l suspended solids. The higher values observed for PC-2 and PC-3 during this time were undoubtedly due to the effects of the drought when the water at these two locations was stagnant and choked with vegetation.

Suspended solids measurements were not taken in the wells.

NO<sub>2</sub>. All values for the surface samples of open water areas were less than 0.05 mg/l NO<sub>2</sub>, except for the findings of 0.75 and 0.68 at the two Agrico Swamp open water areas, in February. The bottom samples in these two locations were slightly higher and 1.55 mg/l NO<sub>2</sub> was detected at the south station in February.

In Payne Creek, the highest level of NO<sub>2</sub> was 0.39 mg/l at PC-2, in August. Otherwise there were no readings over 0.05.

The levels of NO<sub>2</sub> in wells were quite low and generally not detected or less than 0.05 mg/l, except for the two contaminated wells. Well 2 had 4 mg/l NO<sub>2</sub> in February and Well 3 had 2.05 and 2.75 mg/l in August and February. The May levels for both of these stations was less than 0.01 mg/l.

NO<sub>3</sub>. Nitrate levels in the open water were also quite low. However, in February the south station in Agrico Swamp had levels of 2.55 and 3.45 in the surface and bottom samples and the north station had surface and bottom sample levels of 2.12 and 4.30 mg/l. In Payne Creek nitrate was not detected in November or May. The highest observed value was 1.1 mg/l at PC-1 in August.

All wells had less than 0.2 mg/l NO<sub>3</sub>, except for Wells 2, 3, and 5. Well 5 had 0.39 mg/l NO<sub>3</sub> and the contaminated Wells 2 and 3 had 12.25 mg/l NO<sub>3</sub> during the February reporting period which exceed the State standard of 10 mg/l NO<sub>3</sub>. These three wells had less than 0.02 in the following reporting period.

NH<sub>3</sub>. Surface samples from the open waters had very little ammonia in either of the Agrico Swamp stations or the ambient station. None was detected during November and samples during the other

reporting period averaged less than 0.06 mg/l. The samples from the bottom of the north station was comparable, but the bottom sample from the southern location yielded 0.34 and 0.51 mg/l in February and May.

The NH<sub>3</sub> levels in Payne Creek were lowest at PC-4 which averaged only 0.04 mg/l. The other three sampling stations each had mean values over 0.22 mg/l.

The Hardee County wells had NH<sub>3</sub> values ranging from 0.08-0.69 mg/l with a mean of 0.22 mg/l. This compares favorably with the Agrico Swamp Wells 4 and 5, which ranged from 0.13-0.43 mg/l. On the other hand, Wells 2 and 3 ranged from 0.11 to 20.88 mg/l with a mean of 11.62 mg/l. As reported in Erwin, 1984 these two wells are suspected of being contaminated.

Kjeldahl Nitrogen. The mean value for all open water samples in Agrico Swamp was 1.95 mg/l of Kjeldahl nitrogen. The surface samples from the south sampling station had the lowest average value (1.54 mg/l) and compared favorably with the ambient station in the three periods that the latter station was sampled. In Payne Creek the Kjeldahl nitrogen levels ranged from 0.20 at PC-3 (May) to 1.44 at PC-2 (February). The two stations upstream of the Agrico Swamp discharge points averaged 0.73 mg/l, while the downstream stations averaged 0.43 mg/l.

Within Agrico Swamp Wells 2 and 3 showed high concentrations of Kjeldahl Nitrogen. The mean value was 23.16 mg/l for these two stations, whereas the mean for the other two stations (Wells 4 and 5) was 0.60 mg/l. This compares favorably with the mean of 0.63 mg/l recorded for the four Hardee County wells. Wells 1 and 7 were slightly lower, with an average of 0.13 mg/l.

Total Nitrogen. As expected, the values for total nitrogen in the contaminated Wells 2 and 3 were quite high, averaging 27.38 mg/l. The high values for ammonia and Kjeldahl nitrogen are responsible for the high total nitrogen in these two wells and confirm the earlier supposition of biological contamination of the two wells. As previously mentioned, reports on these two wells will be discontinued. The mean values for Wells 4 and 5, 1 and 7, and the Hardee County wells were 0.70, 0.20, and 0.68, respectively.

Total nitrogen in the open water areas were low, averaging 2.7 mg/l in the surface samples and 3.6 mg/l in the bottom samples of Agrico Swamp. The ambient open water surface samples averaged only 1.2 mg/l, but did not include May samples.

In Payne Creek, the two stations upstream of the Agrico Swamp discharge points each had a yearly average of 1.1 mg/l total nitrogen. The two downstream stations had means of 0.65 (PC-3) and 0.45 (PC-4).

Gross Alpha. In the Agrico Swamp open water samples values for gross alpha ranged from 0.05 to 8.10 picocuries per liter with a mean of 3.4 pCi/l. There were no apparent differences between seasons or sampling stations. During the three periods that it was sampled, the ambient station had values ranging from 0.5 to 1.3 pCi/l.

Lower values for gross alpha were observed in

the wells in and adjacent to Agrico Swamp. The mean values for wells within the project was less than 0.8 pCi/l and 0.87 for Wells 1 and 7. On the other hand, the gross alpha measurements from samples in the Hardee County wells ranged from 0.2 to 13.1, with a mean of 5.18 pCi/l.

In Payne Creek, gross alpha averaged less than 1.4, with a range of less than 0.1 to 14.0 pCi/l. The high reading was from PC-1 in November.

Water samples taken during the 1983 - 1984 reporting period indicated that State water quality standard for gross alpha (15 pCi/l), maximum were exceeded during August in samples from the open water area (21.2), Well 2 (24.5) and Well 4 (19.0). Samples taken during August of the current reporting period yielded only 4.7, 0.9, and 1.2 pCi/l for these three stations. Erwin, (1983) reported gross alpha listed as high as 39.4 pCi/l in open water. No water samples taken during this reporting period exceed the State standard for gross alpha. This is a positive trend indicating stabilization of the area.

Lead. Lead was detected in only one sample (0.01 mg/l) inside the project. A few findings of lead up to 0.04 mg/l were found in the Hardee County wells and Payne Creek.

IRON. The State water quality standard for iron is a maximum of 1.0 mg/l for surface water. Open water sampling detected an average of 1.35 mg/l iron at the ambient station and less than 0.2 in the Agrico Swamp samples. In Payne Creek the mean value for iron from samples at the four stations was 1.25 mg/l. This average was substantially elevated by the detection of 5.60 and 4.77 mg/l at PC-2 and PC-3 during the drought in May. At present, the cause for this increase in iron content has not been determined, but it could have been caused by low water flow conditions together with the presence of galvanized metal stands used for benthic sampling.

The mean values for iron samples in both surface and bottom samples in the Agrico Swamp open water areas were less than 0.23 mg/l. Samples from the ambient station were somewhat higher averaging 1.35 mg/l iron. The wells within Agrico Swamp had considerably more iron, averaging 8.33 mg/l. Well 4 had the highest mean of 14.63, while Well 5 had the lowest mean of 3.22 mg/l. Wells 1 and 7 had means of 0.54 and 1.47, respectively. The deeper wells in Hardee County only had approximately 2.0 mg/l iron.

Arsenic. Analyses down to 0.001 mg/l detected no arsenic in any of the surface water samples. Several wells sample test detected trace amounts of arsenic, the highest being 0.005 from Well 18 in Hardee County and 0.004 in Well 7, just south of Agrico Swamp.

Cadmium. Cadmium was detected at all stations in August, but only at levels between 0.01 and 0.03 mg/l. During the other three reporting periods no cadmium was detected.

Manganese. Manganese was also detected at all stations in August at levels of 0.01 to 0.18 mg/l. Little or no manganese was detected in November or February. Only Well 2 (0.10) and Well 3 (0.08) had detectable amounts in May.

Biological Oxygen Demand. The Agrico Swamp open water area showed marked seasonal changes in BOD mg/l. Mean values were 10.4 (August), 8.7 (November) 7.3 (February, and then jumped to 20.5 in May. This was during the prolonged drought when the areas covered by water were considerably reduced, thereby concentrating the biological activity. The ambient station had BOD values that ranged from 2.0 to 3.9, but no sample could be taken in May due to dry conditions.

Water samples from Payne Creek also showed a general increase in BOD during May, rising from a mean of 1.6 in February to 4.3 in May. The samples from the other periods averaged about 1.5 mg/l, except for one reading from PC-1 in August of 6.7 mg/l.

#### Conclusion

Surface water and groundwater within Agrico Swamp are of good quality and the area has apparently stabilized from the effects of previous mining and reclamation. The only water quality test parameter generally nonconforming to State water quality standards is pH. The high pH values obtained in open water samples do not appear to be causing any adverse effects and in fact may be responsible for the binding of phosphorus, and perhaps fluoride and other elements thereby enhancing water quality. The high pH of the open water areas are not affecting the groundwater or Payne Creek.

It is recommended that after one additional year of quarterly water quality monitoring, if no adverse effects are noted, then monitoring should be reduced to biannual sampling. Sampling should be conducted in March and August, which correspond to the dry and wet seasons.

The water in Payne Creek also appears to be of good quality, but should continue to be monitored quarterly due to the possible impact of adjacent mining and reclamation projects.

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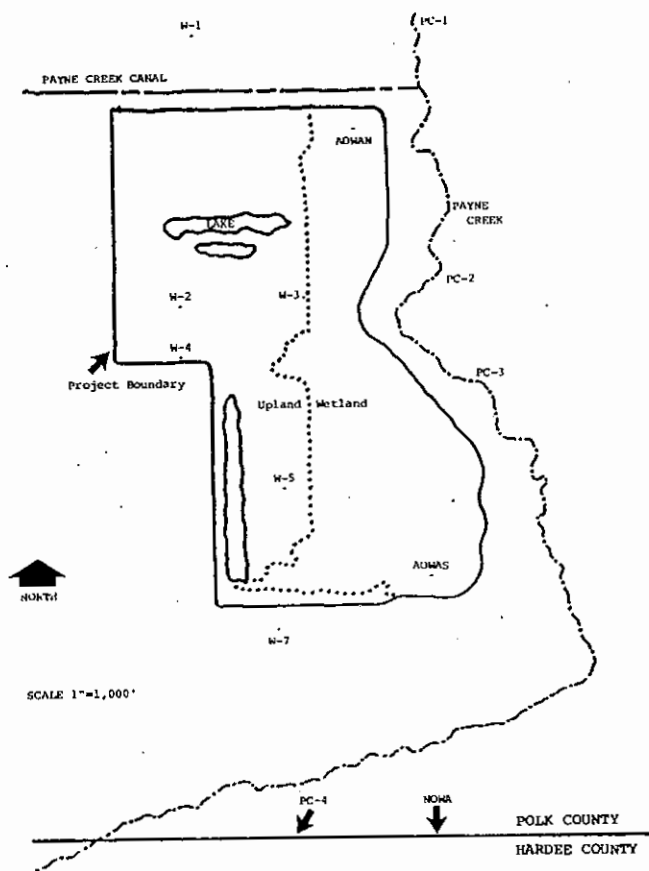
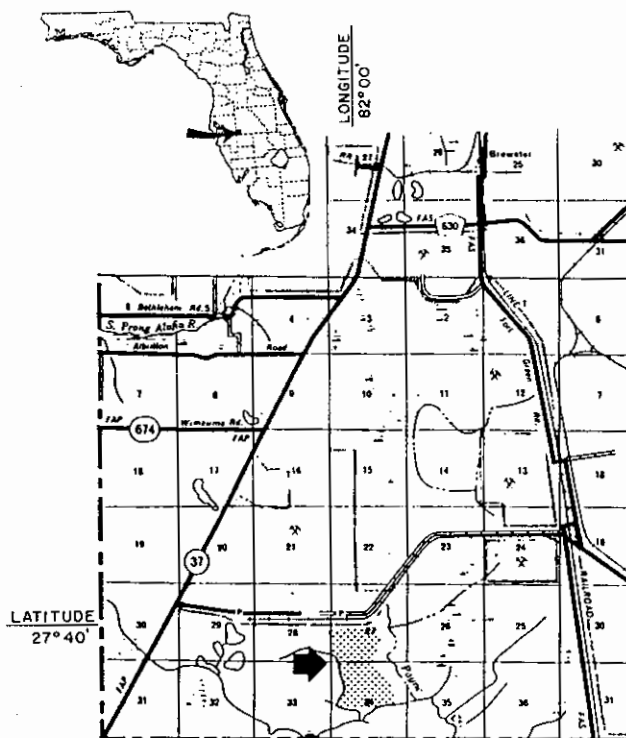


FIGURE 1. Location of sampling stations at Agrico Swamp, Payne Creek and vicinity.



Location of study site in Florida. Insert shows location of site within the state.

