Comparative Analysis of Reclaimed IMC Soils and Native Soils of Proposed Ona Mine Site

This report will compare the physical, chemical and hydrological differences expected to occur as a result of the proposed Ona mine. This analysis is the result of work conducted from research of the existing data of post reclamation soils, native soils and site specific work conducted in the period March 2002 - November 2003.

1. Land Suitability

As a starting basis for this analysis a study of the reclaimed soils of Polk and Hillsborough Counties were made. Eleven post-reclamation soils were identified in the USDA, Soil Conservation Service, published soil surveys of these counties. As the soils in Polk County were identified as the most similar to the expected post-reclamation soils on Ona emphasis is placed on this data for this analysis. A study conducted by the Central Fl. Regional Planning Council titled "Proposed Land Suitability Index for Use in Hardee County", (June,2002) of which I was a co-author, analyzed the pre and post reclamation soils proposed for the Ona mine. A draft IMC Phosphates Inc. Post Reclamation Soils map dated April 19, 2000 is the basis of this analysis. It is estimated that upon completion of the Ona mine reclamation the soil will consist of 7,072 acres of sand tailing fill, 6,896 acres of phosphatic colloidal clays, 5012 acres of overburden, 4903 acres of preservation, and 338 acres of unmined disturbed soils. In the above referenced study an comparison was made of the pre and post mining land capability classes(LCC) using the USDA, Soil Conservation Service, Land Capability Classification System(LCC). A index of suitability for agricultural and urban land uses was then developed using the LCC. The index rated the soils from 1 through 10, with 1 being the best and declining to worst being 10. The most striking finding in the study was the marked decline in agricultural suitability in the post-mined reclamation soils. The index of pre-mined soil shows 70 percent of the soils having an index of 1 and 2. The post-mined soil shows a move to an index of 4 or above, a 45 percent change to index 4 and a 19 percent change to index 5. This is very significant given the long term likelihood than Hardee County's economy will continue to be based on agricultural land uses. **Figures 1 and 2 illustrate the changes in agricultural suitability pre mining to post reclamation on Ona.**

2. Physical Characteristics

Physical characteristics of 20 reclamation sites were observed and sampled during the period July-Nov. 2003. The major vegetative landforms on the Ona site were observed and soils sampled during the period of Aug. - Nov. 2003. The method of observation was direct inspection of the soil profiles to a depth of 2 meters, if possible. Soil descriptions were taken at each sampled site. Soils were described using the UDSA, Soil Conservation Service, Soil Taxonomy Classification System. The major conclusion of this analysis is a lack of any attempt to reclaim the near surface physiology of the reclaimed

soils. The reclaimed soil physiology is in all instances completely different within the 2 meter depth than that of the pre-mined native soils. The 2 meter depth is considered the basis of soil formation and the soils ability to sustain plant growth. The most significant differences are:

1. Lack of topsoil (A horizon)
2. Increased clay content in the near surface horizons
3. Un-natural textural stratification
4. Increased bulk densities
5. Decreased organic matter contents
6. Unpredictable permeability rates
7. Slope and contour of reclaimed soils

The result of these differences is apparent in both upland reclamation and wetland restoration soils. The observed upland reclamation sites had no topsoil in many instances. Where topsoil was reclaimed, in many instances it was darker soil material from excavated B and C horizons of the native pre-mined soils. Mulching of topsoil was observed in some of the restored wetlands sites. Of the reclaimed wetland sites only 3 were described as containing an A horizon(surface topsoil). The increase in clay content was quite apparent in most reclaimed sites. Un-natural textural stratification occurs in all reclamation soil profiles. This stratification results in unpredictable permeability rates, perched water tables,and water tables not reflective of the targeted reclamation land use. The variability of the water table will be discussed in the hydrology portion of this report. Soils naturally occur in distinct land forms from higher to lower elevations in the landscape. The soils generally form in distinct patterns called catenas. Catenas in Florida soils most often form as a result of a variable water table from excessively drained soils to very poorly drained soils going from higher to lower elevations in the native landscape. This natural relationship between the soil and water table elevations does not exist in reclaimed sites. It is my opinion the slope and contours of reclaimed sites do not reflect the pre-mining landforms. **Figures 3 and 4 illustrate the high degree of variability in post reclamation IMC soils.**

3. Chemical Characteristics

A total of 55 soil samples were taken from the 20 reclamation sites visited. A total of 19 native soil samples were taken from the Ona site. The samples were tested to determine the pH values. The tested pH values range from 20 to 43 percent higher in the reclaimed soils than the native soils on Ona. This a significant increase given the native soils on Ona and the resulting plant communities formed in acidic conditions. There is a lack of or reduced concentration of soil organic matter(SOM) in the soil surface horizons in all the reclaimed sites. The content of SOM in soil is a function of soil formation factors. In the reclaimed soils the amount of SOM is directly proportional to the effect of climate, vegetation, topography, parent material and time on the surface horizons. The two most critical factors are parent material and time, followed very closely by the vegetation. In many instances the parent material placed on the reclaimed sites bears no resemblance

both physically and chemically to the near surface horizons found in the native soils on Ona. The sandy soils in Florida generally do not contain large amounts of SOM. The SOM content is however very important to the diversity and survival of the unique plant communities found on South Florida landscapes. The plant communities and soil have formed together over a short geologic period of 5,000 to 15,000 years. The unique Spodosols formed in South Florida flatwoods are the direct result of the symbiosis of plants, SOM, hydrology and time. The proposed Ona mine will destroy the spodic horizon and this soils unique plant relationship on approximately 65 percent of the Ona site. The soil microorganisms which contribute heavily to the decomposition of vegetative material are non existent at the beginning of reclamation and restoration of soil post mining. There is a direct correlation of SOM content with soil microorganisms, cation exchange capacity and soil pH. Lower SOM values will exist in reclaimed soils for an undetermined amount of time. This chemical imbalance will result in less humic and fulvic acids within the surface horizons of reclaimed soils. These organic compounds help in the formation of SOM which increases the water holding capacity of the soil. SOM can hold up to 20 times its weight in water. This is particularly important for sandy soils during extended dry periods which commonly occur in the winter months in Florida . There is visual evidence that reduced SOM has affected the growth of the post mine vegetation both in quantity and quality. **Figure 5 illustrates the significant pH increase in IMC reclaimed soils.**

4. Soil Hydrology

Although I am not a hydrologist the soil classification system used by the USDA, Soil Conservation Service classifies soils using water table elevations as one of the main diagnostic criteria of the system. I have classified soils under this system in Florida since 1978. I have observed the natural water table elevations occurring in South Florida soils within soil borings and with monitoring wells in all native landscape positions. The near surface hydrology of the reclaimed upland soils has not been re-established in my opinion on nearly all of the sites visited. The targeted upland reclamation landforms observed ranged from flatwoods to xeric scrub. In each site visited direct observation and recording of the water table depth was attempted. The period of the site visits coincided with the summer rainy season during an above normal rainfall year. There was significant variation of water table depths within the reclaimed areas and between similar targeted upland reclamation sites. Comparisons of water tables on the proposed Ona site uplands were made to confirm the conclusion of this high variability. Hydrology in the restored wetland sites was highly variable. In some instances water tables appeared to be extremely high for the target. In others the water tables were well below normal, especially in some of the stream restoration wetlands. Most of the restored wetlands had an established outfall structure to maintain water levels, many of these either were not at correct elevations or not maintained. As mentioned before the natural soil catenas are non existent in the reclaimed sites. The normal lateral flows of water between uplands and wetlands which occur in native soils have been severed by the mining operation. It appeared from our observations that there was little or no connection at many of the sites. As stated, the un-natural textural stratification both in the upland and wetland reclamation soils is the major contributor to this lack of a normal hydrologic profile in the near surface reclaimed soils. It was not

uncommon to observe dry soil horizons within a boring in which the water table was well above the surface. This is the result of the undifferentiated placement and settling of the near surface reclaimed soils. The long term affect of the un-natural water table depths and lack of fluctuation will be a reduction in the quality and quantity of the flora and fauna on reclaimed soils.

Conclusions

The soil is the basic building block of all that will or can occur on earth. Soil is the result of climate, vegetation, topography, and time acting on parent material. There is no soil in my opinion in the reclaimed sites. It is unconsolidated soil material. It does support plant growth but certainly not in the quality or quantity of native soils. Reclamation should return the “soils” to a suitable intended use similar to the pre-mining expectation. Reclamation fails this in attempting to restore native cover. It also fails this for future conversion to viable sustainable agricultural land uses. Urban land uses on reclaimed soils have severe limitations.

Chapter 62C-16-0051, Fl. Administrative Code, Reclamation and Restoration Standards establishes the minimum standards and criteria for approval of a reclamation program. The mining industry has failed in many areas of maintaining the minimum requirements of this code. Reclamation practiced by IMC does not work because the minimum standards were neither established or maintained. Sub-paragraph 3 of the code is titled Soil Zone. Subscript (a) of this part encourages the use of top soil. As stated previously only minimal effort has been made to topsoil the reclaim sites and mainly in wetland restoration sites. Subscript(b) of this part states where topsoil is not used, the operator **shall** use a suitable growing medium for the type of vegetative communities planned. As stated, the targeted communities represented by IMC and some even released by the FDEP failed to meet the Sub-paragraph 9, Revegetation standards of the code. It is my opinion they fail not by a lack of trying to re-establish the native vegetation but as a direct result of the poor near surface reclamation “soils”. At present there is no suitable growing medium present on the reclaimed “soils”. These “soils” no longer contain the basic structure both physically and chemically of the pre-mined native soils, throw in the lack of normal hydrology in the near surface and the sites are doomed to fail. To consider these sites reclaimed is unacceptable. The wetlands have not been restored acre-for-acre and type-for-type. The uplands have not been reclaimed to a suitable intended native land use or suitable future agricultural/urban land use.

Lew Carter
Soil Scientist

Figure 1. Map of existing agricultural suitability - proposed Ona Mine.

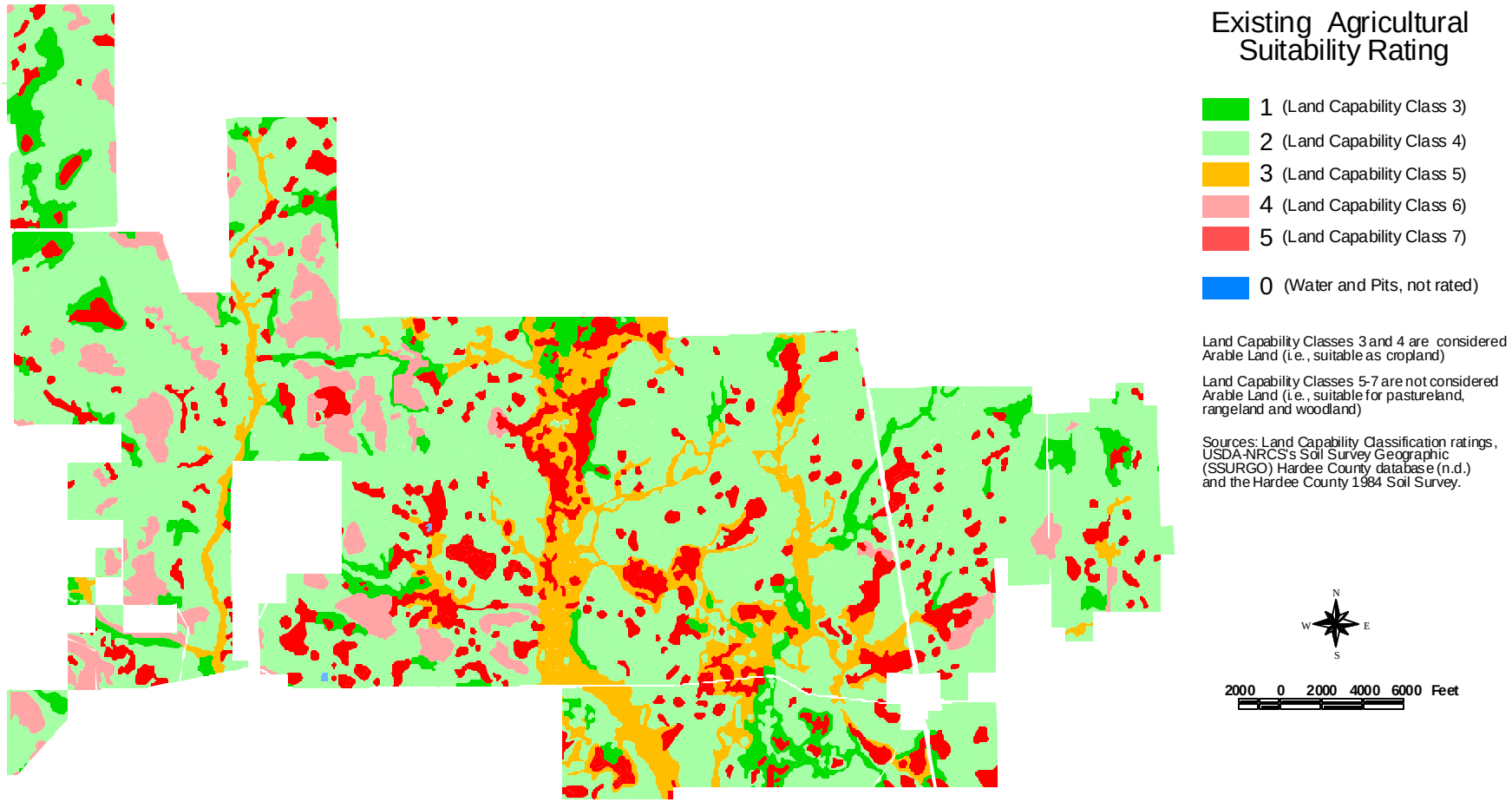
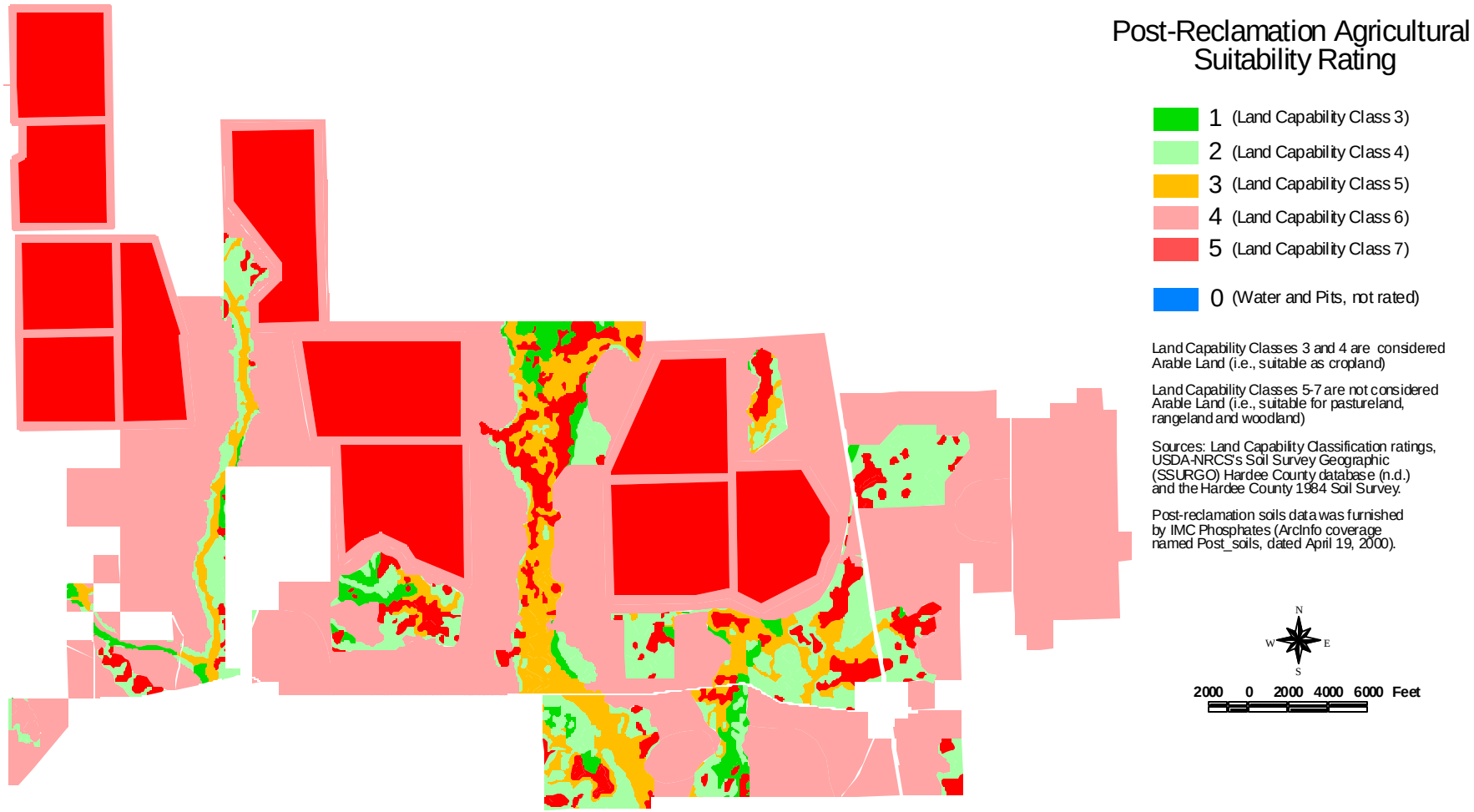
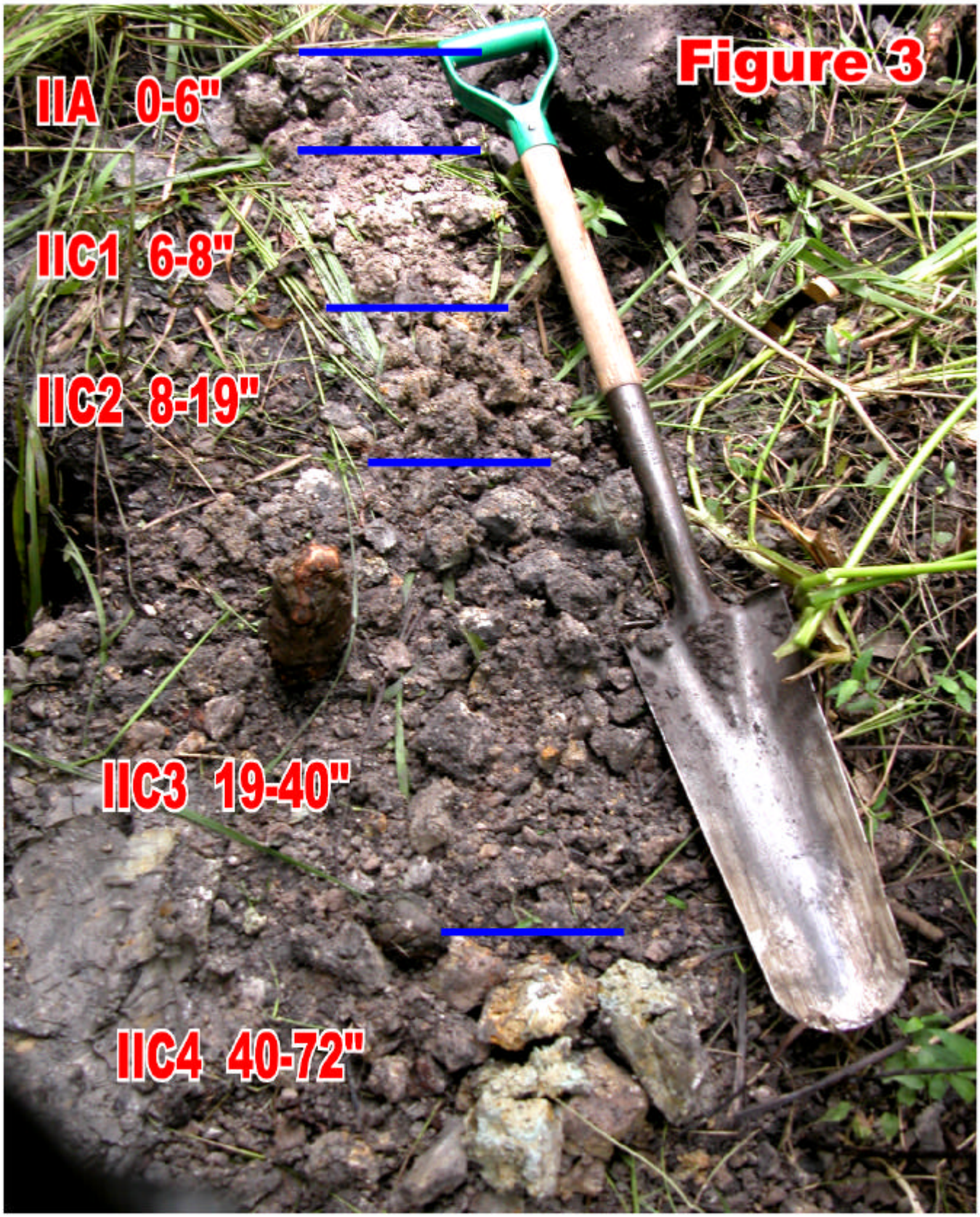
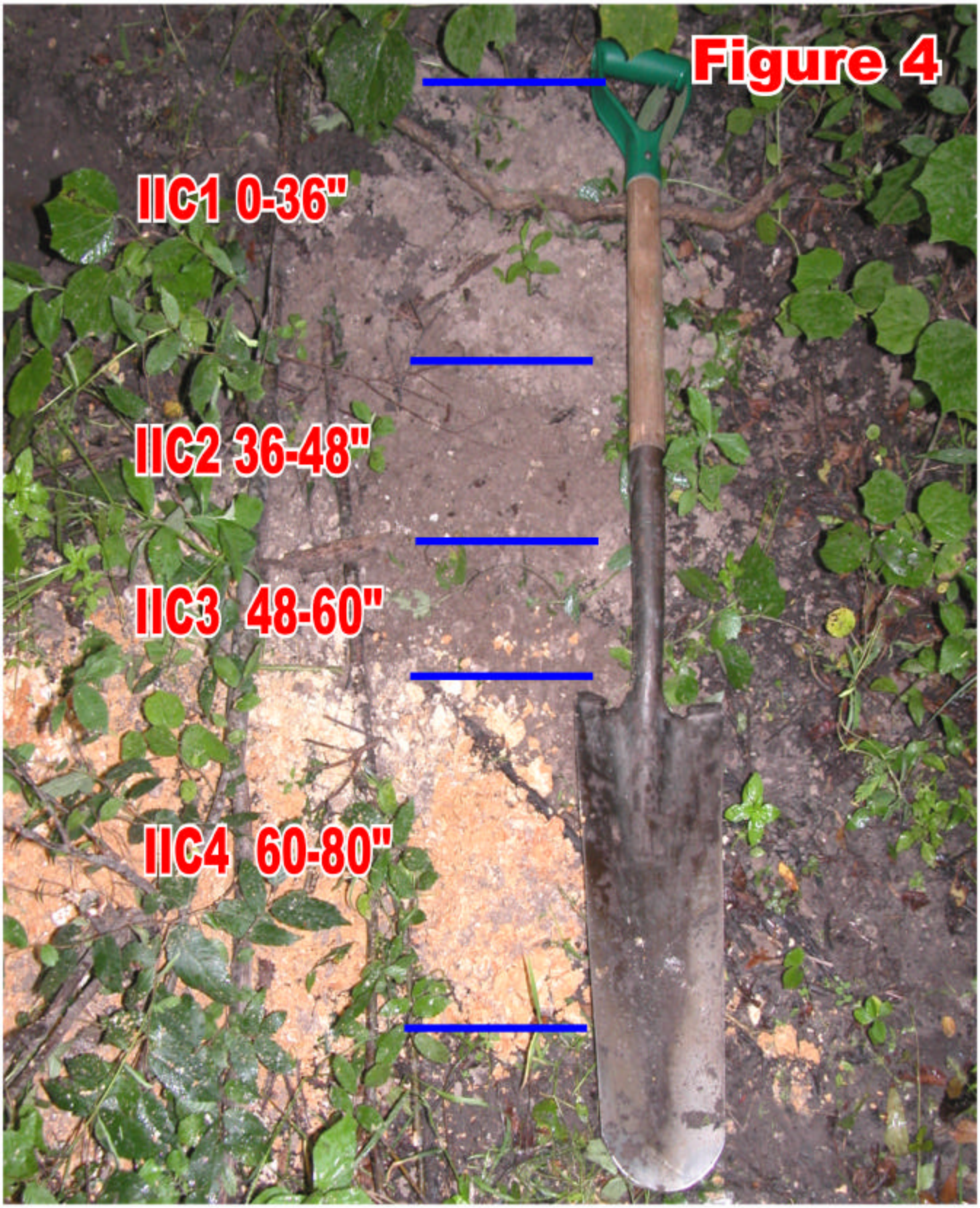


Figure 2. Map of future agricultural suitability - proposed Ona Mine.





SB1 84(5)	Polston Engineering P.O. Box 588 Sebring, Fl. 33871
Wetland Reclaim Site	



SB1 Jamieson Junior Stream Reclaim Site	Polston Engineering P.O. Box 588 Sebring, Fl. 33871

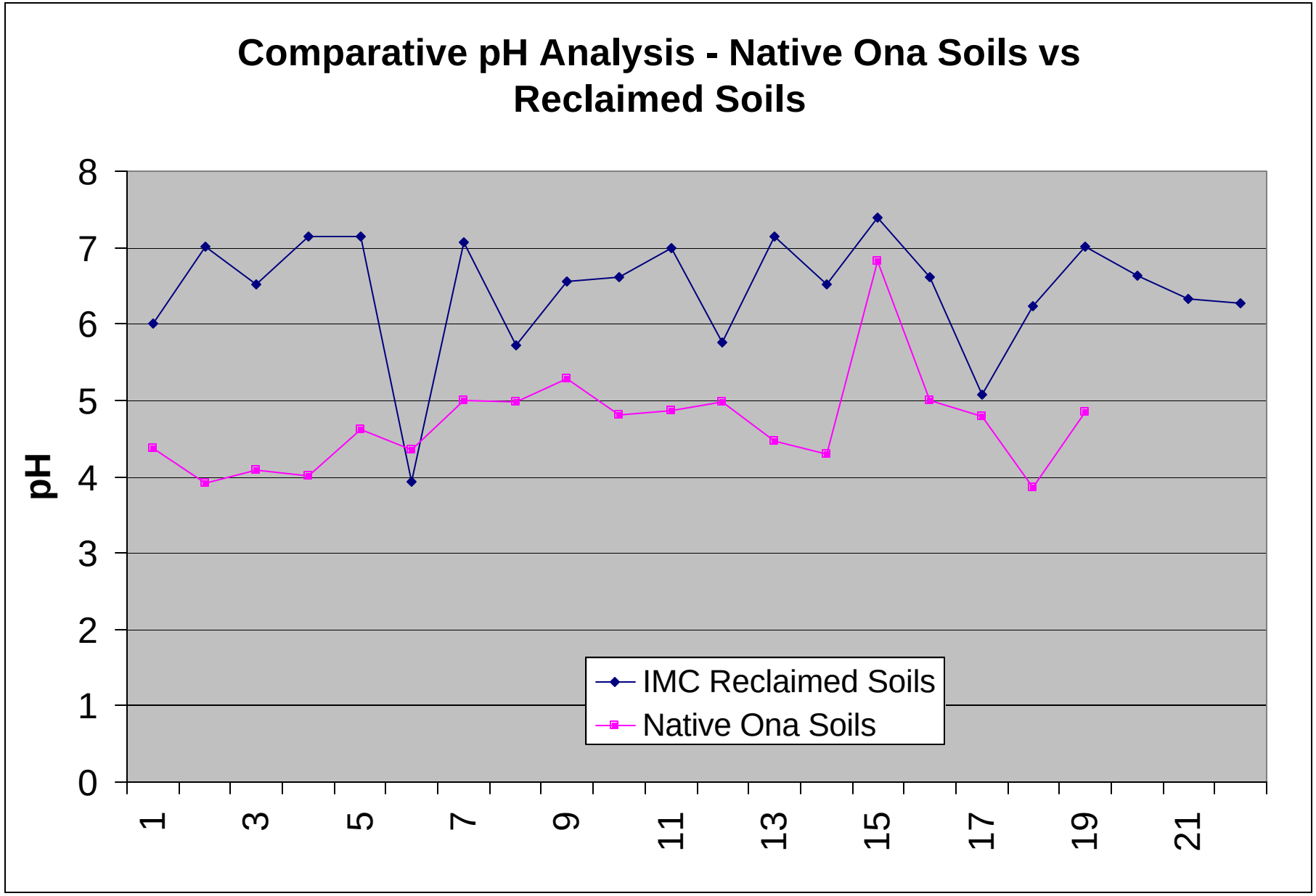

Comparative pH Analysis - Native Ona Soils vs Reclaimed Soils
pH
8
7
6
5
4
3
2
1
0
1
3
5
7
9
11
13
15
17
19
21
IMC Reclaimed Soils
Native Ona Soils

Figure - 5