Final Report

Assessing On-Ranch Provision of Water Management Environmental Services

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June 2005

Executive Summary

In May 2003 the Florida Department of Agriculture and Consumer Services (FDACS) the South Florida Water Management District (SFWMD) funded the Everglades Friendly Beef Steering Committee (EFBSC) to conduct a planning level assessment of the potential for ranch lands to generate environmental services of phosphorus control, water storage, and or other ecological benefits. Starting in July 2005, five volunteer ranchers worked with the assessment team's agricultural engineer and agricultural economist to identify sites and water management alternatives (e.g. re-hydrated wetlands, constructed wetlands, minor impoundment areas, pasture water control, and tailwater recovery) on their properties and to collect data on ranch financial and management impacts. The selection of the sites and WMAs were made by the landowner based on his or her perception of where goals of Phosphorus (P) control and or water storage would be maximized and impacts on current agricultural production minimized. The assessment team's agricultural engineer prepared a conceptual design for each identified WMA and an estimate of implementation and annual costs (e.g. operation, maintenance, monitoring).

Planning level estimates of the percent reduction in P for each type of WMA were provided by the SFWMD and a higher and lower anticipated range of P reduction was calculated for each WMA. These estimates were used to calculate for each WMA a higher and lower end estimate of the number of pounds of P controlled per year. The physical water storage capacity of each WMA was also calculated—the "size of the bathtub"— but not the potential annual acre-feet of water stored.

Data to conduct a Standardized Performance Analysis (SPA) for cow-calf operations collected from ranches were used to estimate for each ranch the "base" or pre-project ranch production and financial performance. The added investment costs required for construction and annual operation costs including depreciation of the WMA as specified by the engineering study were included in order to analyze the base plus WMA ranch production and financial performance.

Results of this analysis suggest that on-ranch water management alternatives appear to be cost-effective compared to other regional water treatment facilities. Planning level estimates of the

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dollar per pound of P controlled costs of securing these services on-ranch ranged from $44 to $163 and $19 to $108 using the lower and higher P removal efficiency estimates. On-ranch estimates compared favorably to the range in average cost per pound of P removed derived from the planning level estimates of the RASTAs of $106 to $117 and $157 to $173 for low and high removal efficiency estimates. The marginal cost per pound of P removed from increasing the RASTA to achieve greater P control is $211 or $313 for the low and high removal efficiencies.

Strategies for sharing some or all of the investment risks of providing water management services between the agencies of the state and ranchers would reduce the per unit cost of acquiring P reduction from ranchers. Reflected in these compensation estimates for on-ranch provision of water management services is the assumption that the rancher would cover all costs and so incur all risks. In the design of a program to encourage on-ranch provision of water management services, many of these costs and risks could be shared (i.e. USDA cost share programs EQIP, WRP), and relying on existing monitoring networks to facilitate measurement and documentation.

This comparative analysis, combined with the recognition that on-ranch practices could be implemented quickly, yield immediate results, have additional ecological benefits (e.g. wildlife habitat, water conservation, groundwater recharge) and provides ranchers with an additional source of income potentially forestalling conversion to less desirable land uses, provides strong evidence that further investigation is warranted.

Background

In January 2003 representatives of the Florida cattle industry joined with World Wildlife Fund (WWF) to form the Everglades Friendly Beef Steering Committee (EFBSC). The purpose of this committee is to identify opportunities to accelerate adoption of economically and ecologically beneficial practices by ranchers in the Lake Okeechobee watershed. Lake Okeechobee "the heart of the Everglades ecosystem" is in ecological decline due to, among other things, unnatural water level fluctuations and high concentrations of phosphorus. The EFBSC seeks to identify partnerships and market-based approaches that expand opportunities for generating environmental services on ranch lands while providing ranchers with an additional income stream.

In May 2003 the Florida Department of Agriculture and Consumer Services (FDACS) the South Florida Water Management District (SFWMD) funded the EFBSC to conduct a planning level assessment of the potential for ranch lands to generate environmental services of phosphorus control, water storage, and or other ecological benefit. WWF provided matching funds and five volunteer ranchers provided in-kind services. The proposal's stated objective was to provide cattle ranchers, agencies of the state, and Federal agencies better information on the cost and benefits of on-ranch P control and water storage. The information generated by this assessment would be used to decide if further investments of financial and human resources were warranted to field test implementation of on-ranch water management alternatives in the watershed.

The assessment began in July 2004. The data collection phase was completed in February 2005. Preliminary results were presented to participating ranchers' for review in February 2005. Agencies of the state were given a briefing of results in March 2005. Based on the preliminary results of this assessment WWF, representatives of the ranching industry, FDACS, SFWMD, and the McArthur Agro-Ecology Research Center submitted a $1 million proposal to the USDA for a Conservation Innovation Grant. The award will be announced in July 2005.

Assessment Methods & Process Overview

Starting in July 2005, five volunteer ranchers worked with the assessment team's agricultural engineer and agricultural economist to identify sites and water management alternatives on their properties and to collect data on ranch financial and management impacts. Participating ranches were located in Highland, Okeechobee, Desoto and Osceola counties. Three ranches drain to Lake Okeechobee and ranch size varied between 2,000 to 10,000 acres. For purposes of this report, water management alternatives (WMAs) include re-hydrated wetlands, constructed wetlands, minor impoundment areas, pasture water control, and tailwater recovery. The source of water for the WMAs could be capture of on-ranch or off-ranch storm water, or both. Off-ranch water, if available, could be pumped to the WMA when on-ranch water is limited.

Volunteer ranchers were asked to identify one or more WMAs on their property that they considered promising. The assessment team's agricultural engineer prepared a conceptual design for each identified WMA and an estimate of implementation and annual costs (e.g. operation, maintenance, monitoring). The selection of the sites and WMAs were made by the landowner based on his or her perception of where goals of Phosphorus (P) control and or water storage would be maximized and impacts on current agricultural production minimized. These decisions were reached through a consultative process that included discussions with a wide range of water management experts, the project's agricultural engineer, and other ranchers.

Planning level estimates of the percent reduction in P for each type of WMA were provided by the SFWMD. Because of the large error band around these estimates, a higher and lower anticipated range of P reduction was calculated for each WMA. These estimates were used to calculate for each WMA a higher and lower end estimate of the number of pounds of P controlled per year. The physical water storage capacity of each WMA was also calculated, but no modeling was conducted to determine the annual acre-feet of water storage potential. Essentially, the potential storage capacity—the "size of the bathtub"—was calculated, but not the potential annual acre-feet of water stored.

Data to conduct a Standardized Performance Analysis (SPA) for cow-calf operations was collected from the five ranches. After completion of the SPA analysis with the study ranches the data were used to estimate for each ranch the "base" or pre-project ranch production and financial performance. The added investment costs required for construction and annual operation costs including depreciation of the WMA as specified by the engineering study were included in order to analyze the base plus WMA ranch production and financial performance.

The assessment team prepared, with assistance from the SFWMD, estimates of the average and marginal costs per pound of phosphorus removed for the reservoir assisted storm water treatment areas (RASTAs) being planned in the Lake Okeechobee watershed. In addition, estimates of the marginal costs to store water in the reservoirs of the RASTAs. This information was used as a basis of comparison to determine whether on-ranch water management could be cost effective with the RASTAs and STAs (existing and or in planning phase).

Design and Cost of Water Management Alternatives

From the conceptual designs the assessment team's agricultural engineer estimated the costs of construction (including engineering design, surveying, environmental evaluation, permitting, structures, installation, sodding, erosion control, depreciation, O & M, and monitoring), for each alternative. Monitoring costs were included because this would be a critical element of a program to pay for environmental services. From an initial field of eleven WMAs, the assessment team selected eight WMAs on four different ranches. The WMAs eliminated from the study were either less effective variations of one of the selected WMAs or utilized an approach or technology for P control that we could not evaluate. Table 1 provides a brief description of the 8 WMAs evaluated in this assessment.

Table 2 summarizes the planning level estimates of the construction investment costs of the 8 WMAs. Total construction investment estimates, including design, permitting and construction, of the WMA varied widely ranging from $46,000 to $1.17 million. Of that total, construction investment costs range from $30,000 to $1.1 million. The three factors that had the biggest impact on construction costs were size of the WMA, the amount of dirt that had to be moved, and the number of structures proposed for installation. The total construction costs for all 8 WMA was $3.3 million and the average was $228,000. Assumptions used in estimating construction investment costs are summarized in Appendix A.

WMA Phosphorus Control Estimates

Planning level estimates of the percent P reduction achieved by a specific type of WMA were provided by the SFWMD. Thus, the percent P reduction estimates used in this assessment are generic and not site specific. In this assessment, the WMA estimates of the expected percent P reduction were converted into to a range in order to reflect the error band around each of these estimates. Table 3 provides the estimates of Percent P reduction for each WMA provided by the SFMWD and the ranges used in the analysis. An arbitrary 20% + or – was added (or subtracted) from the point estimate. In cases where the Percent P reduction provided by the SFWMD was "up-to" a specified percentage an arbitrary range was created. The ranges were used to calculate a lower- (Estimate A) and higher-end (Estimate B) of the P control potential for each alternative.

To estimate the potential pounds of P controlled per year per WMA we used the P load estimates for each type of land use served by the selected alternative. These estimates (ex. 0.72 pounds P per acre per year for improved pasture) were obtained from Bottcher and Harper, 2003, "Estimation of Best Management Practices and Technologies Phosphorus Reduction Performance and Implementation Costs in the Northern Lake Okeechobee Watershed". To derive estimates of pounds of P controlled per acre per year we subtracted from the Botcher et. al. estimates of ranch annual P load per acre per year the higher and lower end estimate of percent of P controlled per acre per year multiplied by the number of acres served by the selected WMA. These estimates were then incorporated into the individual ranch partial budget analysis described below. These results are provided in Table 4 and will be discussed in the next section.

Producer Compensation Calculation

The question addressed in the study was what would be the annual compensation per pound of phosphorus removed and onetime acre-feet of water stored that the ranch operation needs to receive to make it profitable to provide this water management service? The estimates used in this assessment assumed that the rancher would cover all costs and incur all risks. Thus the compensation must cover the total added investment cost (depreciation over expected life), equipment operation, maintenance, monitoring and documentation of environmental services, and the interest cost of the added capital investment. Producers would also expect to be compensated for the added risk associated with this investment.

To answer this question, producer data and completion of the 2003 Standardized Performance Analysis (SPA) for cow-calf operations were collected from 5 ranches that volunteered to participate in this study. Inflation adjusted historical Florida cattle price data (1994-2003) published by the USDA were used to establish prices for different categories of cattle in the analysis (see Appendix A). The ranch engineering studies described above provided data for each WMA's investment requirements, annual costs and a range of potential P control resulting from that type of WMA.

After completion of the SPA analysis with the assessment participants the data were used to estimate the "base" or pre-project ranch production and financial performance. The added investment required for construction and cost of operation and monitoring of the WMA, as specified by the engineering study, was included in order to analyze the base plus WMA ranch production and financial performance.

A partial budget analysis methodology was used to calculate the financial performance and cash flow requirements for the base ranch (prior to construction of the WMA) and the new base ranch plus WMA. The difference in the net income per acre phosphorus removal and per acre foot of one time water storage from the base ranch with the added WMA investments and operating costs are used to calculate the compensation that the rancher needs to receive for water management and phosphorus removal services to justify selling the services. The analysis captures the opportunity cost associated with lowering the stocking rate or number of breeding cows. Captured in this analysis is the fact that many ranch costs are fixed costs and do not change as herd size is reduced.

The spreadsheet-based model used in the analysis provided for a "risk" compensation rate of return of 25% on average capital investment as part of the compensation that would cover the total added cost and potential reduction in revenue with a change in the cattle and grazing system of production. This would include changes that result in lower stocking rates. In addition to the added investment cost, there are numerous uncertainties associated with the implementation of a WMA that add to the risk including but not limited to; the effect on cattle and pasture grazing production, added management requirements for implementation, and P control efficiencies of the WMA, viability and continuity of government programs.

Table 4 presents the estimates of pounds of P controlled per site/year and the $ per pound per year of compensation required to generate that control for each of the 8 WMAs. The values are planning level estimates of the compensation requirement for a range (Estimate A and Estimate B) of phosphorus control generated by the 8 WMAs. Data is presented in a way to maintain confidentiality of the individual producer's information.

Estimated efficiencies of P control in terms of pound per site per year varied due to size and type of WMA. This is reflected in the estimates of rancher compensation required to produce that P control. Using Estimate A, the lower end of the range of P control, the compensation required for producing P control ranged from $44 to $163 per pound of P controlled. These costs dropped when using Estimate B, the higher end of the P control range, and went from a low of $19 to a high of $108 per pound of P controlled.

Limitations of the Partial budget analysis. There are a number of limitations of the static analysis methodology used in this assessment.

- The uncertainty of prices, costs, and effectiveness of the investments is not captured in the methodology. Possibilities for decline in real price of cattle relative to investment and operating costs are not captured in the static analysis.
- The potential adverse or positive effect on appreciation of land values is not included in the estimated financial performance.

- Rancher data on the operation and maintenance costs of their current water management infrastructure are not being separated out in a cost center in the ranch accounting system, making it difficult to provide accurate cost projections.
- The options of using the land for citrus, sod or wildlife and recreation production and marketing are not considered in this analysis. These activities are common in the area but represent different investment and water management and product markets.
- Ranch business and resources vary substantially so a description of "one model fits all" is impossible to develop.
- The lack of more refined, site specific data on phosphorus removal rates by WMAs is a limit of this analysis. Per unit costs are very sensitive to phosphorus removal rates or acre-feet of water stored.

Estimates of Average and Marginal Costs per Pound of Phosphorus Removed From Regional Facilities.

To evaluate the potential cost-effectiveness of on-ranch WMAs the assessment estimates of ranch P control were compared with estimates of the average and marginal costs per pound of phosphorus removed from the reservoir assisted storm water treatment areas (RASTAs) being planned in the Lake Okeechobee watershed. Also presented are estimates of the marginal costs to store water in the reservoirs of the RASTAs. These estimates were prepared by Hazen and Sawyer with the assistance of SFWMD staff. The results of the Hazen and Sawyer report are summarized below and the complete report is attached in Appendix B.

Estimated Costs per Pound of Phosphorus Removed. In Table 5.1 and 6.2 two sets of estimates are provided based on two data sources: the Lake Okeechobee Watershed Project (LOWP) draft project implementation report dated September 2004 and contracted construction costs for the two stormwater treatment areas being constructed in the Taylor Creek / Nubbin Slough Basin. Almost all of the costs and phosphorus reduction data are planning level estimates and are subject to revision. Once the pilot stormwater treatment areas in the Taylor Creek / Nubbin Slough are built and operating, better information will be available.

The first set of estimates is provided in Table 5.1 and is based on planning level estimates of construction costs and phosphorus reductions associated with RASTAs in four planning Basins of the Lake Okeechobee Watershed: Lake Istokpoga watershed, Fisheating Creek, Kissimmee River, and Taylor Creek/Nubbin Slough. The costs and phosphorus reductions represent STAs and a nominal level of storage needed to achieve additional phosphorus reduction. These estimates were taken from the CERP, Lake Okeechobee Watershed Project (LOWP), Draft Project Implementation Report, USACE, SFWMD and HDR Engineering, Inc., September 2004, Figure 4-14, page 51. Based on these study results the "best buy" alternative is the one that provides a 134 metric ton phosphorus reduction per year.

The average cost ranges from $106 to $157 per pound of phosphorus removed when the total pounds removed is 278,000 pounds or 126 metric tons per year. When phosphorus removal is 311,000 pounds or 141 metric tons per year, the average cost is $117 to $173 per pound of phosphorus removed. Table 5.1 also includes the marginal cost per pound of P removed. The marginal cost is the difference between the costs at two levels of phosphorus removal divided by the difference in the pounds of phosphorus removed. The marginal cost provides an estimate of the cost of getting from the regional facility the next or additional pound of P controlled. For example, the additional cost per pound removed when increasing phosphorus removal from 126 tons to 127.5

tons per year ranges from $211 to $313 per pound removed. This marginal cost is constant at this level over the range of 126 tons and 141 tons of phosphorus removed per year.

An estimate of the average stormwater treatment area (STA) cost per pound of phosphorus removed was obtained using the contracted construction costs and estimated phosphorus reduction of the two stormwater treatment areas currently being built in the Taylor Creek / Nubbin Slough Basin. The results are provided in Table 5.2. The average cost per pound of P removed from Taylor Creek and Nubbin Slough STA's is $55 and $48 respectively.

Estimated Marginal Cost of Storage. The LOWP Implementation Report (cited above) also identified the cost effective storage sizes for each basin RASTA. The benefits of the additional storage contemplated here are beyond that needed to achieve phosphorus reduction. The marginal cost of storage is the difference between the costs at two levels of storage divided by the difference in storage. For example, the additional cost per acre-foot of storage when increasing storage from 25,000 acre-feet to 40,000 acre-feet ranges from $71 to $79 per acre-foot (Table 5.3). This marginal cost is constant at this level over the range of 25,000 acre-feet and 125,000 acre-feet of storage and this is presented in the first row of Table 5.3. The marginal cost varies by Basin, as shown in Table 5.3. The estimated marginal cost of storage in Fisheating Creek ranges from $71 to $79 per acre-foot. In the Istokpoga basin, the estimated marginal cost ranges from $77 to $86 per acre-foot. In the Kissimmee and Taylor Creek / Nubbin Slough basins, the estimated marginal cost ranges from $93 to $103 and from $113 to $126, respectively.

Assessment Analysis

Results of this analysis suggest that on-ranch water management alternatives appear to be cost-effective compared to other regional water treatment facilities. Planning level estimates of the $ per pound of P controlled costs of securing these services on-ranch ranged from $44 to $163 and $19 to $108 using the lower and higher P removal efficiency estimates. On-ranch estimates compared favorably to the range in average cost per pound of P removed derived from the planning level estimates of the RASTs of $106 to $117 and $157 to $173 for low and high removal efficiency estimates. The marginal cost per pound of P removed from increasing the RASTA to achieve greater P control is $211 or $313 for the low and high removal efficiencies. The two pilot STAs provide average costs per pound of P controlled of ranging from $48 to $55.

Strategies for sharing some or all of the investment risks of providing water management services between the agencies of the state and ranchers would reduce the per unit cost of acquiring P reduction from ranchers. This will result because some of the costs or risk will be borne by the agencies. Also, the agencies are better positioned to manage risk because they will be investing in a larger portfolio of projects than any single rancher. Reflected in these compensation estimates for on-ranch provision of water management services is the assumption that the rancher would cover all costs and so incur all risks. In the design of a program to encourage on-ranch provision of water management services, many of these costs and risks could be shared (i.e. USDA cost share programs (e.g. EQIP, WRP) existing monitoring networks to facilitate measurement and documentation).

Critical Issues in Expanding On-Ranch Water Management. A number of potential barriers and opportunities to expanding on ranch water management were also identified during the assessment. Some of these issues are relevant for both on-ranch and regional water treatment facilities. These barriers would have to be addressed in order to scale up a program that would generate enough environmental services to have an impact on the health and function of the Lake Okeechobee watershed. Key barriers identified during the assessment are:

1) **Financial costs of implementing a WMA**
   - Implementation costs (e.g. design, construction, permitting, and depreciation of the added investment, capital cost and O & M) can be significant. In the assessment construction investment costs ranged from $46,000 to $1.2 million.
   - In addition, costs associated with things such as management time, monitoring and documenting environmental performance and liability insurance are unknown and difficult to estimate at this time.
2) **Risk and Uncertainties**
   - Significant technical uncertainties exist around many aspects of on-ranch WMA design, operation and performance. Numerous factors, many of them site specific (e.g. P load concentrations, soils, proximity to canals) influence the ability of a WMA to generate desired environmental services.
   - Water management is dynamic depending on rainfall, weather events, state and federal agencies management decisions and decisions made by others up and down stream.
   - Landowners lack of confidence in agencies of the state's commitment and ability to provide sustained financial and human resources and stick to agreed upon rules.
   - The impact of WMAs on existing ranch operations and production (cattle sod, citrus, etc.), on animal health, and public nuisance issues remains unclear.
   - The impact on asset value of a WMA—adverse or beneficial—is unknown.
3) **Regulatory exposure**
   - Multiple and overlapping jurisdictions by local, state and federal agencies result in different definitions and rules, and can generate conflicting operating rules and confusion about goals and outcomes that limit ranchers ability to and interest in participating in government programs.
   - Expansion of existing wetlands for purposes of water quality improvement and storage expose landowners to changes in the jurisdictional footprint of those wetlands that would result in significant loss in asset values and limits landowner's willingness to participate.
   - The introduction of WMAs could result in the creation of feeding, nesting, and flyways for threatened and endangered species thereby increasing their populations on ranchlands. Ranchers would need a safe harbor provision
4) **Transaction Time**
   - Multiple agency jurisdiction increases the transaction time and "hassle factor" for landowners to managing a WMA.

In addition other issues related to program design need to be resolved before launching a program to pay for the provision of environmental services. Several key issues include:

1) **Defining "above and beyond"**
   - LOPP offers landowners the opportunity to be presumed in compliance with the state and federal water quality standards if they develop and implement a conservation plan. Thus, a pay for performance system would need to create a baseline of what services were required for compliance with regulatory requirements and standard good business practices and those that would be considered "above and beyond" and eligible for environmental service payments.
2) **Designing a credible and transparent systems for monitoring and reporting performance**
   - A pay for performance program requires a credible and transparent approach to document the number of units of an environmental service generated per unit of time in order to justify

a per unit payment for those services and to provide timely information for ranch manager's decision making. Monitoring in Florida's complex and highly altered natural environment is challenging,

3) **Fostering continuing innovation**
   - The site specific nature of each WMA and the complexities of the South Florida environment are not conducive to a "one size fits all approach". Today's Best Management Practices are tomorrow's standard practices. A program to provide incentives for on-ranch provision of environmental services will need to be structured to induce innovation and adaptive management.
4) **Contract design**
   - Designing a contract that balances the needs of ranchers, agencies and the public is complex and requires finding a way to satisfy the needs of:
     - ranchers for clear rules, revenue certainty, regulatory coherence, operational flexibility, and
     - agencies of the state for cost-effective approaches, administrative ease, and achievement of public mandate; and the
     - Public for accountability of public expenditures and realizing an improved environment.
5) **Payment strategies**
   - A pay for performance system requires dedicated funding, a credible monitoring and documentation process and technical support and coordination by agencies of the state to ensure program success over time.

Conclusion

The compensation payments for on-ranch provision of P control and water storage generated by this study were compared with costs and effectiveness of additional regional storm water treatment areas (STAs). The estimated incentive payments for on-ranch water management, using planning level estimates, appeared to be cost competitive with regional treatment facilities. What the study's ranch specific analysis revealed were potential opportunities to enhance P removal by adjusting particular ranch management practices, by actively managing retention time, and by treating water from nearby canals. However, because these enhancement practices would increase operational costs, reduce revenue, and increase risks to the traditional ranch enterprises, incentive payments would be needed to reward enhanced performance as well as cover WMAs costs. This comparative analysis, combined with the recognition that on-ranch practices could be implemented quickly, yield immediate results, and have additional ecological benefits (e.g. wildlife habitat, water conservation, groundwater recharge, protection against intensification, and storm water reuse) provides strong evidence that further investigation is warranted.

Table 1: Description of Selected Water Management Alternatives

Alternative One:
Installation of a cascading system of internal structures, within the existing drainage network, that will provide additional on-site retention and detention. This "step down" system, consisting of 21 new structures and structural modifications to three existing project culverts draining to a major canal, will provide attenuation over 5,800-acres of improved pasture.

Alternative Two:
Convert 189-acres of retired grove into a minor impoundment (reservoir), which will provide retention and treatment for 3,200-acres of improved pasture runoff, as well as off-ranch water from a major canal. Excavation, grading, control structure installation and installation of a system by-pass structure (to accommodate high flows) are required to facilitate the proposed use. Off-ranch water will be conveyed and treated during dry conditions, primarily during the "dry" season. This results in an increased phosphorus reduction capability over treating on-ranch runoff alone.

Alternative Three:
Installation of a cascading system of internal structures, within the existing drainage network, that will provide additional on-site retention and detention. This "step down" system, consisting of forty-one structures (eight of which have already been installed) will provide attenuation over 5,120 acres of runoff from improved pasture and grove.

Alternative Four:
Installation of a low-level containment berm around the southwest corner of the ranch that will facilitate increased retention & detention and water quality treatment. A single outfall control structure is proposed. The control structure is sized to facilitate the additional storage, while at the same time protecting the integrity of the perimeter berm. Installation of a swale, south of the south berm section, will serve to protect adjacent residences from any increase in water table due to this alternative.

Alternative Five:
Implementation of a tail-water recovery plan using previously mined areas on the ranch to provide for collection and storage of site runoff. The proposed plan includes additional excavation to allow for this collection and storage of storm water runoff from grove and sod uses. In turn, this additional storage can be pumped to a bermed storage area located roughly 4,000 feet to the east for irrigation "reuse" within sod production areas.

Alternative Six:
Provide additional storage, for 340-acres of improved pasture, within two on-site wetlands (17.5-acres and 29.8-acres) that are presently drained. This additional on-site storage is facilitated by the installation of two control structures (culvert/risers) at the north end of both wetland systems. To facilitate wetland re-hydration, plugging of any alternative outlets is necessary to "force" discharge to the receiving system via the proposed structures.

Alternative Seven
Provide additional on-site storage, for 900 acres of grove drainage, within 245 acres of wetlands that are presently drained. Structural modifications to the existing control facilities, located at the outlet of these drained wetlands, are required to detain this additional storm water runoff.

Alternative Eight
Excavate a seventeen and one-half acre settling pond at the point where all runoff leaves the ranch, which serves a drainage area of approximately 13,000-acres (consisting of row crops, pasture, citrus and residential lands). This will provide a settling point for particulate matter prior to runoff being directed to a nearby creek. Settling results from the reduction in runoff velocity (energy) at this location. Maintenance would consist of the removal of the settled material. In conjunction with the settling pond, installation of a control structure (sheet-pile weir with concrete cap), downstream of the settling pond, to maintain a permanent pool at or slightly above the existing shelf elevation. Include a "cut out" weir in the center of the channel, with flashboard capability, to allow the elevation at this point to be raised (dry season) or lowered (prior to hurricanes)

Table 2: Construction Investment Costs of 8 Water Management Alternatives and Potential Storage Capacity

Alt	WMA description	Total const. Investment Costs	Total Const. Investment Costs minus Design & Permitting	Const. Design Investment Costs	Permitting Investment Costs	Static Potential Storage (Ac-Ft)
1	Cascading System (Retention-Detention)	$288,000	$222,000	$56,000	$10,000	483
2	Minor Impoundment w/Off-Ranch Addition	$488,000	$432,000	$51,000	$5,000	756
3	Cascading System (Retention-Detention)	$1,167,800	$1,061,800	$101,000	$5,000	427
4	Earthen Berm-Wetland Rehydration	$181,000	$156,000	$20,000	$5,000	23
5	Tailwater Recovery	$268,000	$209,000	$49,000	$10,000	107
6	Wetland Rehydration	$46,000	$30,000	$11,000	$5,000	43
7	Wetland Rehydration	$65,000	$30,000	$30,000	$5,000	150
8	Settling Pond	$586,000	$294,000	$282,000	$10,000	18

Table 3: Estimated Phosphorus Reduction Rates under Various Water Management Practices

On-Ranch Water Management Alternatives	Percent P reduction	Low & High Range Estimates Used in the Assessment	Factor	Source
Installation of a cascading system of control structures to provide increased retention/detention (and soil storage) across improved pasture (results in wetland re-hydration). Retention evaluated in 0.25" increments up to two inches.	Approximately 10% P reduction for each 0.25" detention	(8% to 12% P reduction / each .25" detention)	Volume	Zhang and Whalen, 2005
Retention/Detention over drained hydric soils. Wetland re-hydration.	up to 70%	(30% - 70%)	30% by volume and 40% by P conc.	Birkitt Environmental Services, Inc. 2003
Tailwater recovery system to collect grove-sod runoff for reuse on sod production.	30%	(24% to 36%) (+/- 20%)	Volume	LOADSS
Wetland creation system to "polish" stormwater runoff from improved pasture, via gravity flow through	up to 70%	(30%- 70%)	30% by volume and 40% by P conc.	Birkitt Environmental Services, Inc. 2003
Minor above-ground impoundment (reservoir) to treat runoff from improved pasture.	30%	(24% to 36%) (+/- 20%)	Volume	LOADSS

Table 4: Producer Compensation Required per Pound of P Removed*

WMA	Lower Efficiency P Control Estimate		Higher Efficiency P Control Estimate	
	Lb of P Per site/yr	$/lb of P controlled	Lb of P Per site/yr	$/lb of P Controlled
1	1,670	$84	3,341	$42
2	1,053	$130	1,329	$82
3	1,475	$150	2,949	$75
4	533	$52	1,290	$22
5	284	$163	426	$108
6	74	$160	172	$68
7	235	$44	548	$19
8	631	$104	1,263	$52

See text for definition of the components of the total compensation cost.

Table 5: Estimates of Average and Marginal Costs per Pound of Phosphorus Removed Using RASTAs in the Lake Okeechobee Watershed and Marginal Costs of Water Storage

Table 5.1
Summary of Estimated Average and Marginal Costs of Reservoir Assisted Stormwater Treatment Areas in the Lake Okeechobee Watershed to Reduce Phosphorus Loads to the Lake, 2005 dollars (a)

Annual Phosphorus Reduction		Average Cost per Pound of Phosphorus Removed (b)		Marginal Cost per Pound of Phosphorus Removed (b)	
Metric Tons	**Pounds**	**Low**	**High**	**Low**	**High**
126.00	277,830	$106	$157		
127.50	281,138	$107	$158	$211	$313
130.00	286,650	$109	$161	$211	$313
132.50	292,163	$111	$164	$211	$313
135.00	297,675	$113	$167	$211	$313
137.50	303,188	$115	$170	$211	$313
140.00	308,700	$116	$172	$211	$313
141.00	310,905	$117	$173	$211	$313

(a) Based on phosphorus reduction and construction cost data found in CERP, Lake Okeechobee Watershed Project, Section 4.0 Development of Alternative Plans, 4.1 Formulation of Alternative Plans for the Okeechobee Watershed, Draft Project Implementation Report, US ACE, SFWMD and HDR Engineering, Inc., September 2004, Figure 4-14, page 51.
(b) Includes capital cost amortized over 50 years at 5.13% discount rate and annual operations, maintenance, repair, renewal and replacement cost.

Table 5.2
Average Cost Per Pound of Phosphorus Removed Using Two Pilot Stormwater Treatment Areas in the Taylor Creek / Nubbin Slough (a)

Item	Taylor Creek STA (780 acres)	Nubbin Slough STA (193 acres)	Total
Ave. Cost per pound of P removed	$55	$48	$49

(a) These STAs do not include a reservoir.

Table 5.3
Estimated Marginal Storage Costs Associated with LOWP RASTAs, 2005 Dollars (a)

Basin	Range of Storage Capacity in Acre-feet		Marginal Cost per Acre-Foot of Additional Storage	
	From	**To**	**Low**	**High**
Fisheating Creek	25,000	125,000	$71	$79
Istokpoga	25,000	225,000	$77	$86
Kissimmee	24,000	120,000	$93	$103
Taylor Creek / Nubbin Slough	25,000	135,000	$113	$126

(a) Source: CERP, Lake Okeechobee Watershed Project, Section 4.0 Development of Alternative Plans, 4.1 Formulation of Alternative Plans for the Okeechobee Watershed, Draft Project Implementation Report, US ACE, SFWMD and HDR Engineering, Inc., September 2004, Figures 4-15 through 4-18, pages 53 to 56. Includes capital costs only, not annual OMRR&R costs. High estimate is taken directly from report cited above. Low estimate is 90% of the high estimate to take into account efficiencies and synergies which are expected to be achieved when the RASTAs in the four basins are optimized together.

Appendix A: Specific Assumptions Used in the Partial Budget Analysis and WMA Construction and Compensation Required Estimates

- Based on cow-calf 2003 costs and productivity for assessment ranches
- A cash lease rate of $90 per breeding cow in the base herd was used for grazing land cost. This is the fixed land cost used in the analysis.
- Opportunity cost of average added investment was set at 7 %.
- A hired management equivalent was included for owner operators.
- The income and costs are from the cow-calf enterprise based on weaned calves and do not include retained ownership beyond weaning.
- Replacement heifers are raised rather than purchased.
- Ranch debt servicing or costs are not included nor are the impact of herd liquidation caused by a decrease in stocking rate. This is a limitation of a type of analysis.
- The added capital required to support the annual operating cost is not captured in this analysis. Operating costs are however, low compared to the non cash depreciation cost of the investment.
- The replacement cost of ranch’s current permanent infrastructures is estimated but only operating costs are included in base operating costs.
- A compensation that would give an annual return of 25% on average added investment is included in cost to cover potential risk associated with the water management.
- Federal income tax adjustments are not captured in this evaluation.
- An average economic life of 25 years for the water management investment;
- NRCS equipment and installation cost estimates and construction standards were used to estimate costs
- Straight line depreciation with zero salvage value was used in this evaluation;
- Monitoring cost was set at 5% of total added investment;
- Pumps have a 5% maintenance cost in addition to operating fuel;
- Maintenance costs for dikes are estimated at 1% of original cost; and
- There was a contingency cost equal to 30 % of total investment cost in the added water management investment cost.

Appendix B: Ranch Model Description and SPA and Cattle Price Assumptions

Ranch Model Description

The SPA spreadsheet based ranch model used in the assessment and provided to each participating rancher has the following components.

1. A cow-calf ranch herd budget with production, resource and financial data that are used to calculate the ranch financial net income and cash flow. Fixed and variable costs are separated so change in the cattle stocking rate can be viewed.
2. A cattle pricing sheet that calculates the value of other categories of cattle based on the historical high volume feeder cattle market period of June to September. The base price category is 450-500 pound weaned steers inflation adjusted for the 1994-2003 period.
3. A Standardized Performance Analysis (SPA) report is provided to facilitate comparison to actual ranch performance measures and data in the cow-calf SPA data base.
4. A summary of the associated WMAs investments and costs including depreciation, operating, maintenance, monitoring costs for the base ranch and then the added investment with the "new" ranch providing management and phosphorus removal services. This model includes an opportunity cost of capital required for the added services.
5. A summary of the budgeting model's description and financial results. This report provided the input for the model that combines the results comparing the base to the new ranch with the added water investment that calculated the compensation requirement for the service provided.
6. Reporting tables are generated to show the phosphorus reduction and water storage results of alternatives.

South Florida Cattle Prices

It is important to establish a reasonable cattle price levels and relationships to measure the financial performance of the cow-calf enterprise. This is both to establish a base line profitability measure but also to measure the expected financial impact of a change in financial performance when ranch water management changes. Described here is the data and methodology followed to provide South Florida cattle prices.

Price Data

Historical USDA Marketing Service from the Okeechobee auction market data for different categories of cattle was used to develop historical price series. This is a market used by case ranches. Data was acquired for the 1994-2003 period that basically crossed a cattle price cycle. The on-ranch base is 2003 so prices were deflated by the Consumer Price Index with 2003 as the base year. In this way historical prices are adjusted to be comparable to the costs in 2003.

Average Florida prices are published by the USDA and these prices were reviewed and show a similar historical cycle as Okeechobee market. The Florida state average data was used to estimate 1996 data that was not in the Okeechobee auction market price series.

Currently case ranches are using the video and internet markets for feeder cattle but historical information is not available on these markets that cross a price cycle. It can be observed in the graphs that are presented when deflated prices of the base cattle category 450-500 pound steers have not been all that variable over time. Seasonal prices are also a consideration but case study producers market feeders across the June to September period. Choosing the annual average represents a middle pricing selection.

Price Relationships

The base category of cattle chosen was the Okeechobee market 450-500 pound feeder steer. This is the most representative of the cattle weaned by case study producers. The historical relationship between the category of cattle and weaned heifers, cull cows, replacement heifers and bulls was defined by using a linear regression relationship between categories using the 450-500 steer bases. In this way the base steer price can be used to calculate the prices for other categories and also capture a potential change in weaning weights associated with change in the ranch water and land resource management.

The current marketing costs including commissions, yardage, insurance and beef check off totaling 4% of gross sales was used to calculate net pay weight price. Transportation cost to markets was part of the operating costs.

The net historical base price chosen for the 450-500 feeder steer was $90.16 per cwt. which is below 2003-2004 prices but reflective of repeated cattle price cycles.