Long Island Duck Farm History
and
Ecosystem Restoration Opportunities
Suffolk County, Long Island, New York

February 2009

US Army Corps of Engineers
New York District

Suffolk County, NY

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1.0 Introduction

The U.S. Army Corps of Engineers, New York District (District), in partnership with the Department of Planning, Suffolk County, New York has developed this report to assist the County in evaluating and prioritizing acquisition of former duck farms for open space purposes. The County anticipates that these properties will be acquired as park lands and requested the District's planning assistance to develop a screening tool to aid in the identification of properties suitable for ecosystem restoration, in conjunction with passive recreational activities. This study is authorized under the Planning Assistance to States (PAS) authority which is executed in accordance with the provisions of Section 22 of the Water Resources Development Act of 1974 as amended. This law authorizes the Corps to provide technical assistance to support the preparation of comprehensive water and related land resources development plans including watershed and ecosystem planning.

2.0 Purpose

Suffolk County is currently considering acquiring ten former duck farms for the purposes of water conservation, open space preservation and passive recreation. During the mid-1900s, duck farming on Long Island was a major economic industry; producing approximately two-thirds of the duck consumed in the nation. However, the lack of regulations and the absence of conservation practices aimed at controlling non point source pollution in the form of effluent during the height of the industry resulted in the degradation of wetlands, floodplains and adjacent upland areas, and water quality to streams and receiving bays.

The objective of this report is to assist Suffolk County in detailing the environmental concerns associated with past duck farming and their implications for ecosystem restoration, to outline ecosystem restoration measures that can be implemented on the sites and to provide a tool in assessing and prioritizing restoration of former duck farms.

3.0 History of Duck Farming on Long Island

A comprehensive account of the history of duck farming on Long Island is included in Appendix A. As a summary, the Long Island duck industry appears to have begun on Long Island in the Speonk/Eastport area. The raising of ducks did not become a full-time industry on Long Island until sometime between 1880 and 1885; prior to that time the raising of ducks was a supplemental activity to farming and fishing.

Duck farms abounded on Long Island during the majority of the twentieth century, and Long Island duck was among the most famous of the world's regionally named products. During the peak production years of the Long Island duck industry, which spanned the 1940s, 1950s and early 1960s, duck farms could be found on almost all the freshwater streams in the Riverhead, Eastport and Moriches areas. By the end of the 1930s, about six million ducks were produced on approximately 90 farms located in Suffolk County and towards the late 1940s and early 1950s, the approximately 70 duck farms located in Suffolk County produced about two-thirds of all the ducks eaten in the United States. At that time, the duck industry was as economically important as the entire commercial fishing industry in the State.

Production peaked around the late 1950s and early 1960s with an annual yield of 7.5 million ducks. The number of active farms had been reduced to 48 by 1963. Of this total, three farms were located on tributaries to Bellport Bay; 30 farms were on tributaries and coves along Moriches Bay; one farm was located on Mecox Bay; and 14 farms were on tributaries to and the shoreline of Flanders Bay.

A number of factors contributed to the decline of the duck industry on Long Island. However, one of the primary causes was the implementation of animal waste pollution control programs and regulations implemented at the local, state and Federal levels to prevent effluent from directly discharging into waterbodies. These programs and regulations spanned over twenty years and included:

Phase 1: Removal of ducks from open waters (diking duck runs from main stream).

Phase 2: Removal of settleable solids and floating solids from the waste stream (lagoon system) before discharge to surface waters.

Phase 3: Disinfecting effluent.

Phase 4: Removal of nutrients. Treatment facilities had to be constructed and in operation by April 1968. (Cosulich 1966)

As a result of the continuing costs of upgrading their treatment plants to comply with the ever more stringent pollution control requirements, many of the duck farmers folded or relocated to the Midwest, where costs were cheaper and environmental regulations less rigorous.

4.0 Environmental Impacts

Inventory work by the County indicates that approximately 2,000 acres of upland property and almost 20 miles of shoreline along freshwater creeks/rivers and estuary tributaries – primarily in the Towns of Brookhaven, Riverhead and Southampton – were utilized during the last century in Suffolk County for duck production. Given that the peak of the duck farming on Long Island predated the laws and regulations that were meant to control runoff and pollution, much of the effluent ran untreated into streams that then discharged into Long Island's bays.

As environmental laws and regulations were created, duck farms began implementing conservation practices to reduce waste runoff into waterbodies. Common conservation practices on the farms included waste lagoons, artificial swim areas, fencing to prevent the ducks from accessing the streams, and dikes to prevent farm runoff from entering the stream. Although these conservation measures addressed the more broad environmental impacts, it did not account for site specific impacts such as the loss of floodplain and wetlands as well as changes to stream morphology, sediment composition and water quality resulting from the development of the farm prior to implementing these measures.

4.1 Duck Waste Statistics

To better characterize the impact the duck farm industry has had on regional ecology, the amount of effluent produced by duck farms has been computed. The pollution load from the 34 duck farms operating in Suffolk County during 1968, which raised about 7 million ducks that year, was calculated. In total, the loads were as follows (Davids and Cosulich 1968): 70 tons total solids/day (43 tons suspended solids/day); 11 tons of Biochemical Oxygen Demand (BOD)/day; 4 tons phosphates/day; 2.5 tons nitrogen compounds /day; and 40 billion-trillion M.P.N of coliform organisms/day.

According to Dr. William Dean, the former director of the Cornell University Duck Research Laboratory, an average human excretes about 7,300 grams (g) of nitrogen (N) per year, or 20 g N per day. One market duck excretes 93.6 g N over its seven week life cycle, or 1.91 g N per day. Including the N fraction attributed to one breeder duck for each market duck produced (0.029 g N per day) gives a total N loading rate of 1.94 g N per day for each market duck (W. Dean, personal communication). Dividing 20 g by 1.94 g gives a nitrogen equivalency of 10.3 market ducks per one person.

To illustrate this further with respect to land use, the Robinson Duck Farm in South Haven adjacent to the Carmans River will be used as an example. At its peak, this farm utilized 13.4 acres of pens (including swim pond area) to grow 200,000 ducks per year, and the average density of ducks at any one time was calculated to be 6,716 ducks per acre of pens (Eberhard n.d.). Using the relationship above, the daily nitrogen output from 6,716 ducks per acre during the growing season would be equivalent to the daily nitrogen output from 652 people. The corresponding human population density of 652 people per acre is over six times the population density of Manhattan Island (105.3 people/acre) in 2002. In comparison, the overall population density in Suffolk County was 2.47 people per acre in 2002.

4.2 Off-site Impacts of Duck Farm Operation

The off-site impacts of duck farms were apparent in both the degraded quality of receiving surface waters, as well as by the alteration of stream and tributary bottom habitats as a result of the deposition of thick layers, or so-called blankets, of duck sludge. The off-site impacts also manifested themselves in the curtailment of commercial and recreational activities due to the contravention of water quality standards for shellfishing and swimming, and the use of shoreline sites (many located in parkland) for the upland disposal of duck sludge dredged from creek bottoms by Suffolk County (Travelers Research Corp. 1970).

On the order of 7.5 million ducks per year were grown in Suffolk County during the peak of the duck industry circa 1960. The magnitude of production was reflected in the significant effluent waste loadings in the forms of suspended solids, nutrients, and coliform bacteria, much of which entered Flanders Bay, Moriches Bay, and Great South Bay via streams and tributaries. The effluent discharged from the duck farms dramatically impacted the water quality of the freshwater streams and bays, altering phytoplankton assemblages, benthic communities, and the biogeochemistry of the systems.

Prior to the increase in duck effluent, the south shore estuaries were composed of a mixed algal assemblage, dominated by larger phytoplankton species, such as diatoms (~5 µm) (Ryther 1954). However, following the rise in duck farm production along the south shore, the phytoplankton composition began to shift to a unialgal community, dominated by smaller forms (1-4 µm) or chlorophytes (Ryther 1954; Nichols 1964; Lively et al. 1983; Carpenter et al. 1991).

Consequently, blooms as concentrated as tens of billions of cells per liter turned the bay a pea green color during the summer months due to the green tides (Carpenter et al. 1991).

The algal shifts were directly correlated with the increase in nitrogen-rich excretory products generated from the local duck farms. The most common excretory product, uric acid, is converted to urea via bacteria in seawater (Carpenter et al. 1991). Unlike larger phytoplankton, smaller forms are able to directly assimilate urea due to the presence of specific enzymes, giving them a competitive advantage over many of the common diatom species (Carpenter et al. 1991). Additionally, the physical nature of the south shore estuaries including, low flushing rates and shallow water depths, led to a rise in water temperatures in back-bays and a retention of large concentrations of nutrients, further fueling algal growth (Ryther 1954).

The increase and decomposition of organic matter, derived directly from the duck waste as well as the increase in algal biomass, contributed to anaerobic benthic conditions impacting flora, such as submerged aquatic vegetation; and fauna, such as benthic invertebrates and foraminifera. Dense algal blooms prevented light penetration to the benthos, causing plant decay and additional organic deposits (O'Connor 1972). These organic rich sediments, often several feet deep, became soupy, black, clayey silt that had a rich odor of hydrogen sulfide, so potent that homeowners adjacent to Moriches and Great South Bays complained that the paint on their homes was being discolored (Nichols 1964; O'Connor 1972). Ecological degradation that was associated with the accumulation of nutrients throughout the estuarine bays continued throughout the history of the duck industry, and was heightened when the Moriches Inlet was temporarily closed (Nichols 1964; Lively et al. 1983) in the early 1950s.

4.2.1 Duck Sludge Deposits

As previously discussed, prior to the late 1950s/early 1960s, duck farm operations were not legally required to install facilities to eliminate the discharge of settleable solids to surface waters. Therefore, thousands of tons of duck farm waste had freely entered, accumulated and polluted streams and adjacent wetlands for decades prior to implementation of a regulatory program.

As the duck waste entered surface waters, heavier suspended particles settled to the bottom near the discharge point, while lighter particles were distributed tidally until they too settled throughout the estuaries. These settled particles of decomposing organic matter created blankets of sludge that consisted of a homogeneous, black, plastic material with a strong, unpleasant odor. Duck waste is a concentrated source of bacteria, nitrogen, phosphorus, potassium and BOD. The organic content of duck sludge deposits is typically higher than that found in naturally occurring muds.

The decomposable organic matter depleted dissolved oxygen, and anaerobic digestion resulted in generation of hydrogen sulfide gas (Federal Water Pollution Control Administration 1966). The anoxic condition during warm summer months reduced species diversity, biomass and numbers of benthic invertebrates in those areas that were highly impacted. The high organic content and fine grained texture of duck sludge also made it an unsuitable substrate for shellfish setting and growth.

The volume of sludge in these creeks was significant. A 1968 field survey estimated that over 7.3 million cubic yards of sludge were deposited on creek bottoms tributary to Moriches Bay (Forge River, Old Neck Creek, Terrell River, Tuthill Cove, Seatuck Creek, East River, etc.) at that time (Dona 1968). Deposits were reported to be up to 10 feet thick in some areas, and the sludge was covered by only a few inches of water.

The enforcement of additional wastewater treatment requirements in the 1960s/1970s resulted in the decline in the number of operating duck farms and a substantial reduction in the volume of effluent discharged. However, duck sludge deposits are still prevalent in tidal creeks and tributaries in local waters.

Former duck farm sites have been developed for private residential and commercial uses. These new uses often mask the origin of shoreline features that were created when the farms operated. In many instances, the relict shoreline features (berms, swim ponds, etc.) remain left as is, to avoid complicated and expensive environmental review/permit procedures. Opportunities in the future may exist for coordinating the restoration of these privately owned shoreline areas in conjunction with management of adjacent underwater lands that are owned by the public.

4.3 On-site Impacts of Duck Farm Operation

Duck farms needed access to a source of fresh water which necessitated their location along freshwater streams and the upper reaches of tidal tributaries (where waters were only slightly brackish). Typical site modifications involved various types of disturbance, e.g., vegetation clearing, land surface elevation changes for construction of buildings, pens and yards; hydrological modifications for water flow/control in swim ponds and tidal lagoons, and for waste treatment. Some of the larger duck farms included areas devoted to the production of field crops.

Duck farm operation and abandonment created conditions that are ideal for invasive species. As an example, dense stands of *Phragmites* have colonized former swim ponds and along the shores of tidal lagoons. Conditions that favor *Phragmites* establishment include soil disturbance and upland buffer removal, hydrological changes /land surface elevation in wetlands due to the placement of fill for construction of berms and dikes; and high nutrient loading in fresh water/low salinity environments associated with duck waste discharge.

5.0 Sediment Sampling Results

Waste from contained animal feeding operations such as duck farms contain certain nutrients and pathogens that in excessive levels, cause adverse impacts to water quality and aquatic habitats as well as posing health concerns for humans.

This section will discuss, as representative examples, the results from sediment sampling of the Gallo Duck Farm, Mill Pond and Robinson Duck Farm, predominant nutrients and pathogens of concern, and any special considerations that should be given during restoration activities.

5.1 Sediment Sampling Efforts

Understanding the site conditions at each candidate farm will be crucial in prioritizing ecosystem restoration efforts. To determine the presence and extent of nutrients, pathogens and other contaminants resulting from duck farm operation, the District and Suffolk County conducted sub-surface soil and sediment sampling on the former Gallo Duck Farm located along the eastern branch of Mud Creek, Mill Pond along the Forge River and Robinson Duck Farm along the Carmans River.

Sediment samples were analyzed for Volatile Organics (VOAs), Semi-Volatile Organics (SVOAs), Pesticides, PCBs, Priority Pollutant Metals (PP Metals), E-Coli, Kjeldahl Nitrogen, Total Phosphorous, Total Organic Carbon (TOC), and Total Percent Solids. Overall, the findings of the sediment sampling were consistent with the types of contaminants found in contained animal feeding operations; increased levels of nitrogen, phosporus, organic carbon and E.coli. In regards to E. coli, it should be noted that the sediment sampling on the Gallo farm only reported the presence of fecal coliform but not colony volume. Tests that can identify the amount of E. coli in the soil may want to be conducted on the candidate farms in order to understand the full extent of fecal coliform content on the site.

More serious contaminants such as VOAs, SVOAs and metals were not found on most of the sites. The exception is Mill Pond, which was found to have levels of beryllium and nickel that exceed the standards outlined in the New York State Department of Environmental Conservation Technical Administrative Guidance Memorandum (TAGM) and warrants further testing to determine the full extent of the contamination. A more detailed discussion of the sampling results is included in Appendix C.

5.2 Primary Nutrients from Duck Waste

Phosphorus:

In general, since phosphorus sorbs onto soil particles, it is primarily introduced into waterbodies as surface runoff. This in turn can increase the concentration of bioavailable phosphorus in surface waters leading to eutrophication. Phosphorus leaching through the soil into groundwater is typically uncommon, although it can occur in sandy soils or soils with high water tables.

There are a few options in remediating soils with high phosphorus levels. In some instances, a fixing compound such as aluminum sulfate, iron sulfate or gypsum can be incorporated into the soil to make it biologically inactive. This method does not remove phosphorus from the soil, but rather makes it unavailable for the long term and would only be effective as long as the area is not subject to erosion. Another option is planting specific plant species such as switchgrass that are effective in uptaking nutrients (Sanderson 2000).

Vegetated buffers can prevent soil runoff from entering into surface waters and thereby reduce the amount of phosphorus entering into a waterbody. Studies have shown that a vegetated buffer at least 13 feet wide in the form of a riparian wetland or grass can trap approximately 85 percent of sediment.

Nitrogen:

Ammonium, nitrate and nitrite are the compounds of concern when assessing the environmental impacts of nitrogen. Both forms contribute to eutrophication, depletion of available oxygen in water systems resulting in fish kills and a reduction in biodiversity, and the promotion of algae growth. Nitrate is highly mobile and can leach downward through the soil profile and into groundwater while surface runoff is the primary transport mechanism for ammonium.

As with phosphorus, vegetation can be used to reduce nitrogen soils in the soil. For example, poplar trees are typically used in phytoremediation of sites with high nitrogen and other contaminants (Volland, et al. 2003). The U.S. Geological Survey in cooperation with the Baltimore County of Environmental Protection in Maryland conducted a case study that found that nitrogen levels in impacted surface and groundwater can be reduced through floodplain and riparian corridor restoration, stream reconstruction and bank stabilization (Mayer 2004).

In both soil and water, nitrogen is broken down by bacteria and released into the atmosphere in an anaerobic process called denitrification. The denitrification process in aquatic sediments is complex and is dependent on many factors including but not limited pH, geology, organic matter, stream velocity, etc. A study of the Mississippi River indicated that nitrogen is naturally removed from small streams much more quickly than in large rivers. A primary reason is that the amount of nitrogen removed from water depends on the amount of water in contact with bottom sediments. Since shallow streams have more contact with the bottom sediments than water in deep, large rivers, more nitrogen is removed. Additionally, the study noted that soils immediately adjacent to streams which are wet because they receive surface or subsurface flows from higher elevations, are the most effective at removing nitrate from agricultural and other runoff waters.

5.3 Pathogens

Since the former duck farms will most likely be used for passive recreation, aerating and exposing any soil to sunlight should be sufficient to reduce the pathogens of concern. Composting has also been shown to be effective in pathogen inactivation as long as it reaches temperatures of 50^{O}C or over. In addition, vegetated buffer strips and wetlands are also effective in preventing pathogens from entering surface waters (James 2003).

Although the ability of riparian buffers to reduce pathogen contamination to waterbodies has not been widely studied, a study conducted in Minnesota using row crops indicated that a vegetated buffer at least 118 ft wide reduced total coliform bacteria to levels acceptable for human recreational use. Additional studies showed that a 2 foot wide grass strip removed 83 percent of the fecal coliform bacteria, while a 7 foot filter strip removed nearly 95 percent (Klapproth 2000).

Pathogens typically do not survive for long periods upon entering surface waters. However, their survivability can be extended if they come into contact with sediment or organic matter or in areas containing high nutrient levels and turbid water by providing a source of nutrition and reducing the amount of sunlight which penetrates the water (Klapproth 2000).

5.4 Metals, SVOAs, VOAs

Depending on the results of additional sediment testing, Mill Pond could require the development of a specific remediation plan. Some factors that need to be weighed when determining appropriate remediation methods include considering the current ecological and human health risk the contaminants pose, the ecological and human health risk they may pose when implementing the remediation plan, and remediation cost.

Common remediation methods include capping the affected area with clean material and dredging. Capping the contaminated sediment with a layer of clean material is usually the more cost effective method if it is determined that it would eliminate exposure, although this would not address any potential ground water contamination issues.

Dredging is typically performed when it has been found that the contaminants pose a significant ecological and human health risk and that their removal outweighs the environmental impacts that dredging itself can create. One item to note when considering dredging is that the sediment would require disposal at a facility specifically permitted to receive contaminated material and measures would have to be employed to reduce sediment resuspension and movement to areas outside of the remediation site.

6.0 Restoration Methods and Concepts

The presence of pathogens and elevated levels of nutrients should not prevent the County from performing ecosystem restoration on the farms particularly if the main objective is to restore native habitat and utilize the area as passive recreation. As an example, the Watershed Conservation Authority of Los Angeles is proposing to convert a former duck farm along the San Gabriel River in La Puente into a park that includes walking trails, an equestrian center, a plant nursery, and educational wetlands riparian corridor restoration. An Environmental Impact Statement was developed and can be found at http://www.wca.ca.gov/notices/duckfarm/Duck%20%Farm%20Final%20MND%WEB%20READY.pdf

The District and Suffolk County partnered in a Section 206 aquatic ecosystem restoration project to assess ecosystem restoration measures on the former Gallo Duck Farm located along Mud Creek in East Patchogue, Town of Brookhaven. A Preliminary Restoration Plan (PRP) outlining several ecosystem restoration alternatives was prepared and a feasibility study was initiated but has been suspended since 2004 due to lack of Federal funds. Currently, the County is proceeding independently. The preliminary alternatives that were developed to restore the Gallo duck farm should have applicability to other duck farms being considered by the County for acquisition subject to site specific conditions.

Restoration measures proposed for the Gallo Duck Farm included restoration of floodplain conditions through the removal of farm structures, eradicating invasive plant species and replanting with native wetland and riparian species. The PRP also proposed restoring the hydrological connections between the floodplain and stream, and streambank restoration. The Mud Creek Section 206 PRP that discusses the alternatives in greater detail is located in Appendix B of this report.

6.1 Evaluating Duck Farm Sites for Ecosystem Restoration Candidacy

A general evaluation to prioritize sites can be made through site visits, a review of aerial maps and a review of current watershed and regional management plans. Two forms, the Site

Evaluation Form and the Planning Matrix, were developed to assist prioritizing the acquired duck farms for ecosystem restoration and are included in Section 7.0. The Site Evaluation Form is to be completed during site visits to help provide a basic characterization of site conditions and will ultimately be used with the Planning Matrix to rank the farms' restoration potential. The Planning Matrix covers the more administrative aspects of determining restoration priority and will be used to score the farms.

The location and current ecological condition of a candidate farm will be a factor in determining priority sites. The ideal candidate site would have the potential of creating multiple habitat types such as upland, floodplain forest and emergent wetland and provide connectivity to similar native habitats surrounding the site or will complement other restoration initiatives within the watershed. Additional benefits would be those farms that could be restored to provide habitat for Federally and State endangered, threatened and special concern species. For example, the Mud Creek Section 206 project proposed to enhance aquatic habitat for brook trout, a rare New York heritage species. Conversely, duck farms that are situated between developed parcels or have reverted to a natural state of mostly native vegetation (e.g. floodplain forest) would be viewed as a lower priority.

One of the primary concerns the County has in performing restoration measures on the duck farms is the potential exposure of contaminants. Unfortunately, as evidenced in the soil samples taken at the Gallo Duck Farm, Mill Pond and Robinson Duck Farm, there can be a great variability of what contaminants may occur on a site. Therefore, it is recommended that all duck farms being evaluated for ecosystem restoration be tested for nutrients, pathogens, SVOAs and VOAs to characterize and quantify contaminant issues that may limit restoration measures. If the County is concerned with the cost and time of this effort, it is recommended that sediment sampling be performed on only those farms that score high in the Planning Matrix and therefore have greater potential for being restored.

In regards to cultural resources, Federal, State and many local regulations require that any project that uses public funds must undertake some form of cultural resource survey to determine potential significance and impact to these historic sites.

As each individual project arises, at least a Phase I Project, including the IA - Documentary Report and the IB - Field Survey Report, would be undertaken to determine the potential significance of the individual site.

As part of the Phase I survey, several issues that should be addressed include but are not limited to:
a) Does the site(s) retain any visual reminders of the former farm that may include structures Are they structures? Landscape features? If these remain, when were they constructed?
b) What is the projected plan for these former structures and/or landscapes?
c) Is there a potential for buried cultural resource?
d) What was on the site prior to becoming a duck farm?
e) Was a significant/historic person residing on the property?
f) Did the former farm contribute towards a significant industry or cultural history/event of the region?

g) Can any of the former features be retained in the proposed plan?

Further, beyond the standard regulatory questions outlined above, there are a myriad of research oriented questions that can be asked of these sites. For example, from an historical perspective:
a) How did they farms develop and evolve over time?
b) Were the changes based on cultural, geographic, economic or regulatory concerns?

From an environmental perspective:
a) Did the farmscape (landscape) changes occur because of regulations alone, or did some other environmental concern cause a change in layout? For instance, farms started out as open field where the ducks could roam and discard waste material directly into the watershed. This resulted in the creation of ponds that were surrounded by a series of dikes to insure that the effluent did not flow into the rivers and streams. From there, as regulations increased, separate pools were created to insure that no direct run-off made it into the waterway.

These research questions can, and should be included as part of any Scope of Work and/or plan for the reuse of these former sites. These questions can be undertaken in corporation with research institutions (i.e. colleges and universities), the County or local municipality and/or as joint efforts with other agencies (Federal and non-Federal).

6.2 Dredging

Large scale dredging projects to remove duck sludge from the bottoms of impacted waterways have been conducted in the past. The Suffolk County Department of Public Works removed about 1.5 million cubic yards of material from the tributaries in Moriches Bay prior to 1968; and about 1.6 million cubic yards after 1968 (Suffolk County Department of Planning 1985). The dredged spoil was disposed in upland sites on the mainland and barrier island, on the beach and in the ocean surf zone.

No survey designed to measure the extent of duck sludge deposits in the tributaries to Flanders Bay (Peconic River, Sawmill Creek, Terry Creek, Reeves Creek/Bay, Meetinghouse Creek) was conducted, although anecdotal information suggests that such deposits were quite substantial. The Suffolk County Department of Public Works dredged over 2.0 million cubic yards of material from these tributaries prior to 1985, all of which was placed in upland disposal sites (Suffolk County Department of Planning 1985). The extent to which aged sludge remains on the bottom in these areas is not known.

In Seatuck Cove, about 400,000 cubic yards were removed in 1972 and pumped across Moriches Bay and the barrier island for disposal in the surf zone. This strategy and method for managing duck sludge was endorsed by all government levels at that time. In another case, approximately 400,000 cubic yards of duck sludge were pumped to a disposal site in Indian Island County Park adjacent to Flanders Bay in the Peconic Estuary after removal from near-by Terry Creek, Reeves Creek and Meetinghouse Creek. Three dredging projects were conducted, with the first occurring in 1948, and the third in 1975. Typically, such sites do not re-vegetate quickly, due to fine grained, compacted, poorly-drained, organically enriched sediment, which is acidic and has a high salt content.

The Suffolk County Department of Health Services is currently conducting a feasibility study to dredge about 250,000 cubic yards of duck sludge deposits that have accumulated in Meetinghouse Creek since the last dredging cycle in 1975. Dredging, although an option in removing duck waste from waterbodies, has its own environmental impacts which include resuspension of sediments, removal of benthic species, modification of substrate and finding a suitable disposal site and can be potentially costly. Although the impacts from dredging are typically short term, both impacts and cost should be weighed against whether the long term benefits are significant enough to offset them.

Some factors that should be considered when deciding whether or not to dredge include water quality degradation issues occurring within the watershed, such as combined sewage outfall discharge, cesspool leakage and other anthropogenic pollutants. Scenarios where dredging duck waste would be beneficial are if anadromous or catadromous fish pathways will be enhanced or increased, tidal flow or hydrologic connection to wetlands will be reestablished and/or if it is substantiated that the duck sludge is the primary contributor of water quality degradation within a watershed or sub-basin.

It is recommended that as part of the Meetinghouse Creek Feasibility Study, water quality assessments be conducted within the areas that were part of the previous large scale dredging efforts to determine if dredging the duck waste has improved the water quality to an extent that impacts caused by dredging are offset. Further, a review of the current watershed management plan of the particular area under consideration for dredging should be conducted to understand what other water quality issues are occurring within the watershed.

6.3 Wetland and Streambank Restoration

Constructed wetlands are increasingly being used on contained animal feeding operations as a successful secondary treatment method for livestock effluent. The New York State Department of Environmental Conservation Agricultural Management Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection in New York State recommends reducing nonpoint source pollution through best management practice such as grassed buffers, riparian corridor and constructed wetlands (NYSDEC 1996). Further, results from a demonstration project involving stream channel restoration and riparian buffer creation in Maryland indicated an overall reduction in nitrogen in the stream (Mayer 2004). Given this, restoring riparian buffers and wetlands on former duck farms should be successful with minimal effort and without extensive soil remediation.

Existing ponds could potentially serve as valuable nesting and foraging habitat for migratory waterfowl and should be evaluated as to the feasibility of converting them into emergent wetlands through enhancement of native vegetation and re-establishing hydrologic connections with the stream and or modifying dams and berms to prevent the ponds from stagnating. Coordination should occur with groups like Ducks Unlimited to determine the potential habitat value of existing ponds and effectiveness of different restoration goals/techniques.

Additionally, it is recommended that the Natural Resource Conservation Service and the local Cornell Cooperative Extension office be included in the planning and design process given both agencies' focus in dealing with environmental impacts associated with agricultural practices.

These agencies should be able to provide recommendations of plant species that are the most effective in nutrient uptake and soil stabilization along with suggesting restoration techniques that are cost-effective and optimize habitat value.

For areas where high levels of metals, SVOAs and VOAs are not an issue, common erosion and sediment control best management practices will be sufficient during construction. Consideration should be given to phasing any earthmoving activities to prevent runoff into adjacent waterbodies. Vegetated buffers in conjunction with erosion and sediment control best management practices should be implemented and maintained between upland work and adjacent waterbodies.

For any streambank stabilization or stream channel modification, work should be performed in dry conditions to the greatest extent possible and should be limited to only what could be accomplished in one day. The use of erosion control matting to provide instant stabilization should be incorporated into any streambank stabilization projects. Additionally, any instream work should be performed outside of any critical fish spawning periods.

7.0 Planning Matrix

An example planning matrix and a supplemental site evaluation form were developed to assist in prioritizing the acquired duck farms for on-site ecosystem restoration. The Site Evaluation Form is meant to serve as the first step in completing the Planning Matrix as it will provide an initial characterization of restoration potential.

The matrix was modeled after and incorporates many of the criteria used in the Suffolk County Open Space Rating System for Natural Environments and the Suffolk County Open Space Rating System for Active Recreation, Hamlet Park, Historic and /or Cultural Park Uses lists included in the Open Space Acquisition Policy Plan for Suffolk County. Modifications to the matrix may be made if the County develops other appropriate criteria as they progress with Meetinghouse Creek and are encouraged to fit the County's goals and objectives for incorporating duck farms into their open space plan. It should be noted that the matrix can be either applied to an entire site or a component of the site if overall site restoration is not desired.

Site Evaluation Form
Farm Name:
Location:
Watershed:
Percent Coverage of Invasive Species: <25%; 25-50%; 50-75%; 75%<
Dominant species:
Percent Coverage of Shrubs: : <25%; 25-50%; 50-75%; 75%<
Dominant species:
Percent of Mature Trees: : <25%; 25-50%; 50-75%; 75%<
Dominant Species:
Number and Condition of Structures on Site:
Condition of Existing Ponds on Site (Dry, Inundated/ Stagnant, Inundated/Aerated)
Are the Existing Hydrologic Conditions Apparent (e.g. tidal, runoff, flood events, groundwater, stream fed)?
Condition of Streambanks (Eroded, Stable, Incised)
Have wetlands developed or are beginning to develop within the site?
What are the land uses of adjacent areas (Undeveloped, Residential, Commercial, Highway, etc.)?
Are there any other restoration projects currently being constructed or proposed in the vicinity of the site?

Planning Matrix	Score	Subtotal
Site Characteristics		
1. Property Size		
a) 40+ acres. 10 points		
b) Between 26-39 acres. 6 points		
c) Between 5 and 25 acres. 3 points		
2. Location		
a) Site is located adjacent to another existing public recreational area where restoration will enhance the recreational uses of both sites. 8 points		
b) Site and its proposed use will provide a recreational opportunity in an area that is presently deficient in this use or similar recreational uses. 4 points		
3. Contamination		
a) Site contains no metals, SVOAs or VOA and levels of nutrients and pathogens are either low throughout the site or are in high levels only in distinct areas of site. 10 points.		
b) Site contains no metals, SVOAs or VOA but has high levels of nutrients and pathogens throughout the site. 5 points		
c) Site has high levels of metals, SVOAs and VOA requiring further investigation into characterizing the problem and developing a remediation plan. 1 point		
4. Historical/ Cultural Resources Features		
a) Historic features can be integrated into restoration design for recreational and educational purposes. 5 points		
b) Restoration of the site will not negatively impact historic features. 3 points		
c) Historic features on the site will impact ability to restore site. 1 point		

Planning Matrix	Score	Subtotal
Ecosystem Restoration		
1. Habitat Connectivity Opportunities		
a) Site will connect adjacent properties of similar habitat. 8 points		
b) Site will expand habitat type on one side. 4 points		
c) Site is located between privately owned and already developed land. 1 point		
2. Habitat Diversity		
a) Multiple habitat types (upland, wetland and open water) can be potentially restored on site. 8 points		
b) Site restoration will enhance habitat for Federal or State endangered, threatened or special concern species. 4 points		
c) Site restoration will enhance habitat for migratory waterfowl. 4 points		
3. Sustainability		
a) Immediate upstream and adjacent areas will not negatively impact the sustainability of the site if restored. 8 points		
b) Site is adjacent to areas containing extensive invasive species that could invade the area. 4 points		
c) Site lies downstream of an area that could negatively impact restoration success. 1 point		

Planning Matrix	Score	Subtotal
Ecosystem Restoration (Continued)		
4. Potential Exposure of Contaminants		
a) Restoration of site will not expose contaminants. 8 points		
b) Restoration will involve exposing some contaminants, but can easily addressed. 4 points		
c) Restoration will require a detailed remediation plan. 1 point		
5. Migratory Pathways for key anadromous and catadromous species (i.e. brook trout, American eel)		
a) Restoration of site will enhance migratory pathways. 8 points		
b) Restoration of site will maintain existing pathways. 4 points		
c) Restoration of site will have no effect on existing pathways. 1 point		
6. Contribution to Watershed Management or Regional Comprehensive and Conservation Management Plans:		
a) Restoration of the site will advance the goals and objectives of an existing Watershed and Regional Management Plan. 10 points		
b) Restoration of the site will advance the goals and objectives of a Watershed Management Plan but may not contribute to a Regional Management Plan. 5 points		
c) Restoration of the site will provide localized benefits, but will not contribute to watershed or regional management goals. 1 point		

Planning Matrix	Score	Subtotal
Ecosystem Restoration (Continued)		
7. Operations and Maintenance		
a) Inter-municipal management agreement with Federal, state, town and/or village. 5 points		
b) Management agreement with non-profit environmental organization. 3 points		
Total (Maximum 100 Points)		

8.0 List of Preparers and Stakeholders

Agency	Name	Title	Role
Suffolk County	Thomas A. Isles	Director	Administered County participation on project.
Suffolk County Department of Planning	DeWitt S. Davies, Ph.D	Chief Environmental Analyst	Prepared Appendix D.
Suffolk County Department of Planning	Ronald Verbarg		Assisted in Preparation of Appendix A.
Suffolk County Department of Planning	Michael Mule	Environmental Planner	Coordinated logistics of soil/sediment sampling.
Suffolk County Department of Health Services	Robert Waters		Assisted with field survey work.
Suffolk County Department of Health Services	Michael Jensen		Assisted with field survey work.
Suffolk County Department of Parks, Recreation & Conservation	Nicholas Gibbons	Sr. Environmental Analyst	Coordinated access to Suffolk County parkland.
U.S. Army Corps of Engineers, New York District	Roselle Henn	Chief, Environmental Assessment Section	Project delivery team leader and County coordination.
U.S. Army Corps of Engineers, New York District	Kimberly Rightler	Biologist	Prepared Main Report
U.S. Army Corps of Engineers, New York District	Christopher Ricciardi, Ph.D.	Archaeologist	Prepared Appendix A
U.S. Army Corps of Engineers, New York District	Richard Dabal	HTRW Specialist	Conducted soil sampling.

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