IV. Solano County Mosquito Abatement District Component

RESOLUTION OF ADOPTION OF THE SOLANO COUNTY MOSQUITO ABATEMENT DISTRICT COMPONENT TO THE SUISUN MARSH LOCAL PROTECTION PROGRAM

WHEREAS, Assembly Bill 1717, The Suisun Marsh Preservation Act was enacted into law in 1977; and

WHEREAS, AB 1717 requires each local government or special district to prepare its component of a local protection program; and

WHEREAS, AB 1717 further requires each local government or special district components to be consistant with the provisions of AB 1717 and the policies of the Suisun Marsh Protection Plan; and

WHEREAS, The Solano County Mosquito Abatement District a special district having jurisdiction within the primary and secondary management areas of the Suisun Marsh; and

WHEREAS, The Solano County Mosquito Abatement District has prepared its component which delineates its management policies and that these policies are consistant with the provisions of AB 1717, the Suisun Marsh Protection Plan and the applicable provisions of the California Health and Safety Code; now therefore be it

RESOLVED that the management policies described within the component shall be utilized as policy guidelines for the protection of man and animals from mosquito borne diseases, pestiferous mosquitoes and for the protection and enhancement of the Suisun Marsh.

Adopted at the regular monthly meeting of the Board of Trustees of the Solano County Mosquito Abatement District at 8:30 p.m. this 14th day of January 1980.

Signed: Clarence Golomb
President, Board of Trustees

ATTEST: Melvin Frohrib
Secretary, Board of Trustees

SOLANO COUNTY MOSQUITO ABATEMENT DISTRICT

MANAGEMENT POLICIES FOR PRIMARY AND SECONDARY AREAS

OF THE SUISUN MARSH

COMPONENT OF THE SUISUN MARSH LOCAL PROTECTION PROGRAM

CREDITS AND CITATIONS

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Adopted at the meeting of the Board of Trustees, Solano County Mosquito Abatement District this 14th day of January 1980

Clarence Golomb, President
Eugene Kliewer, Vice President
Melvin Frohrib, Secretary
Raymond Church, Trustee At Large
John Kinloch, Trustee
Milton Wallace, Trustee
Allan Witt, Trustee
Roger Deane, Trustee

Embree Mezger, Manager-Entomologist

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INTRODUCTION

Historical Background

Historically, pest and disease carrying mosquitoes have been produced in large numbers in the marshes of Solano County, the San Francisco Bay Area and other coastal counties of California. These mosquitoes caused severe discomfort in residential areas, limited outdoor recreation, inhibited real estate development and disrupted agricultural workers from harvesting crops. To alleviate the problem local civic groups organized anti-mosquito campaigns and approved the formation of Mosquito Abatement Districts under the provision of the California Health and Safety Code, The Mosquito Abatement Act of 1915. Solano County Mosquito Abatement District (SCMAD) was formed in June, 1930, specifically at the request of the local taxpayers of Solano County to abate mosquitoes migrating from local marshes, principally from marshes of the Suisun and San Pablo Bay Marshes.

Marsh management practices have developed over a period of many years to successfully reduce the production of mosquitoes in marsh habitats. The principal practices involve water management such as construction of ditches to circulate tidal water (source reduction), controling water levels on duck clubs and biological and chemical control methods.

SCMAD, a county-wide agency, has jurisdiction over the primary marsh areas and secondary upland management areas. There are distinct management control practices in secondary upland areas as opposed to primary marsh areas. Mosquito control in secondary management areas relate to upland watershed, such as creekside and drainageway development, sedimentation, land development and agriculture. In the primary area mosquito control practices are concerned with water management of duck clubs, irrigated livestock pasture lands, and tidal marshes.

SCMAD has been successful in reducing and suppressing the production of mosquitoes in primary management areas, except those problems caused by fall flooding of duck club lands for the purpose of duck hunting. Such flooding frequently results in the production of literally billions of mosquitoes which migrate into the populated areas surrounding marshes, and result in severe discomfort to area residents.

The District is empowered under the California Health and Safety Code (Chapter 5; Article 4; Sections 2270-2289) to take all necessary or proper steps for the extermination of mosquitoes,

flies, or other insects within the District boundaries or in territories outside the District which are a source of migrating pests into the District.

The District has worked closely with other agencies and private landowners to develop educational programs which foster a better understanding of mosquito control. Experience has shown that many mosquito problems can be reduced through better knowledge of mosquito prevention, particularly through water management practices advocated by the SCMAD.

Coordination and cooperation among agencies and private property owners is vital in order to avoid creation of unnecessary conditions conducive to mosquito production. Certain projects may require a contract arrangement between the owner and SCMAD. The contract would provide for surveillance and control measures that may become necessary.

Health and Economic Impact of Mosquitoes

Mosquitoes are vectors of numerous human and animal diseases. The most important and potentially dangerous are the mosquito-borne encephalitis viruses which infect man as well as animals. Wild birds, such as blackbirds and sparrows, act as reservoirs for these viruses which are transmitted from birds to humans and horses via several species of mosquitoes. Another disease of growing importance in marsh areas is dog heartworm, an internal parasitic worm transmitted between dogs and wild canines (coyote, fox) by mosquitoes. Although all types of dogs are vulnerable to infection those breeds used extensively as retrivers by hunters in the marsh receive significant exposure. It should be noted that human infections also occur, and have been confirmed in California. In addition to the disease threat is the severe nuisance created by numerous biting mosquitoes. Passive recreational uses of the marsh such as hiking and bird-watching expose people to mosquito contact. Farm workers are frequent victims of biting mosquitoes during harvesting and other farming activities near areas with large mosquito populations. Livestock exposed to large numbers of mosquitoes are detracted from feeding and suffer weight losses.

BIOLOGY OF MOSQUITOES

General Biology

Mosquitoes are two-winged insects with biting and sucking mouth parts suitable for the penetration of skin and sucking of blood from many animals. They are probably best known for their

importance as pests and as vectors of many animal and human diseases. They are widely distributed throughout the world, locally reaching their greatest abundance in the spring, summer and fall. Mosquitoes develop through a process known as metamorphosis, passing through four successive developmental stages namely the egg, larva, pupa and adult. The principal characteristics of these four stages are described briefly:

Egg -- The female mosquito at the time of egg laying instinctively selects the habitat for the immature aquatic stages. Most Aedes (acommon genus) found in marshes deposit their eggs singly in moist depressions where they may remain dormant for months or even for several years, and are known as floodwater species. Most frequently eggs laid by Aedes in the spring and summer usually do not hatch until flooded the following year. The warmth of spring waters and the drying of Aedes eggs stimulates hatching. When water is allowed to cover the eggs after a drying period, hatching occurs. Thus, once the marshes are wet in warmer months any draining and subsequent flooding will often cause mass hatching and a potentially severe mosquito problem. Other genera of mosquitoes are Culex and Culiseta, which also occur in the Suisun Marsh. They lay eggs in rafts containing a hundred or more eggs glued together. These are deposited upon the surface of the water to await hatching into larvae.

Larva -- After the egg of a mosquito has been in contact with water for a few hours or days a larva hatches by cutting its way out of the egg by means of the egg breaker on the top side of the head. During growth the larva sheds its skin or molts four times; the stages between molts are called instars. As mosquito larvae require air they come to the water surface at frequent intervals to breath. The food of mosquito larvae consists chiefly of small plants and animals and particles of organic matter which are swept into the mouth by the mouth brushes or by nibbling. Many species of mosquitoes complete the aquatic cycle in about 7 to 10 days when conditions are favorable, but other species require more time, even several months. Aedes utilize temporary pools as aquatic habitats and may pass thorugh the larval stage in 4 to 6 days.

Pupa -- The pupal stage appears with the fourth molt. Because it is lighter than water and non-feeding the pupa rests at the surface unless disturbed and then dives in a jerking, tumbling motion. A large pair of air tubes in the head area enables the pupa to break the surface film and obtain air. At the end of this stage the pupa extends its abdomen nearly parallel to the water surface in preparation for the emergence of the adult.

Adult -- The adult swallows some of the air within the pupal

skin and exerts internal pressure by muscular action to split the dorsum of the head area, thus enabling it to emerge. The adult slowly works its way out, using the cast skin as a float until its body can dry and harden.

Female mosquitoes are best known because of their blood-sucking habits and because they often are vectors of important diseases of man and animals. However, not all female mosquitoes suck human blood; some restrict their feeding to birds, amphibia, reptiles, and other nonmammalian hosts. Many species probably utilize juices of fruits and nectar of plants for food. The mouth parts of male mosquitoes are not developed for sucking blood, and as a result do not feed on man and animals.

Many female mosquitoes restrict their feeding to nighttime or the twilight hours of morning and evening, although some feed during the daytime in the shade and even in bright sunlight. Culex usually feed only at dusk, and only a few species are avid feeders on man. Culex erythrothorax will attack man and warm-blooded animals indiscriminately during the daytime, even in bright sunlight, when their resting places are disturbed. Most of the Aedes readily attack man and other warm-blooded hosts during daytime and evening and are noted for their aggressive feeding habits.

The adult females of some species pass the winter in hibernation in protected places, whereas many others over-winter in the egg stage.

The flight habits of mosquitoes vary greatly with the different species. Several of the Aedes, particularly the salt-marsh species, are notorious wanderers, often migrating 20 miles or more from their aquatic habitats; daytime and twilight flights of 5 to 10 miles are common. Culex are not noted as strong fliers and do not move far from their aquatic habitats; however, many exceptions have been recorded by recapturing marked specimens.

"Mosquito breeding" and "mosquito breeding places" in the published literature generally refer to the developing aquatic life stages of the mosquito and to the water-holding depressions, sites or containers in which these stages occur. A site becomes a source when it holds water suitable for mosquito development and mosquitoes are produced if left uncontrolled.

* Much of the descriptive information in this section was taken from Mosquitoes of North America, Carpenter and LaCasse, 1955, University of California Press, Berkeley.

Mosquito Species In The Primary and Secondary Management Areas of The Suisun Marsh

The most important mosquitoes found in the primary marsh area are: Aedes dorsalis (Pale Marsh Mosquito), Aedes melanimon (Dark Marsh Mosquito), Aedes squamiger (California Saltmarsh Mosquito), Culex tarsalis (Encephalitis or Sleeping Sickness Mosquito), Culex erythrothorax (Tule Mosquito), and Culiseta inornata (Winter Mosquito). Most prevalent species in secondary area are: Culiseta incidens (Creek Mosquito), Culiseta inornata, Culex tarsalis, and Culex pipiens (Foul Water Mosquito). All of these species are briefly described below.

Aedes dorsalis (Pale Marsh Mosquito) — Larvae are primarily found along the coastal areas in both saline and brackish tidal marshes and ponds as well as fresh water marshes and temporary pools in overflow areas. A freshwater variety may be found in lakes and rain pools. The adults are vicious biters in both daytime and evenings. They have been known to fly in excess of 20 miles.

Aedes melanimon (Dark Marsh Mosquito) — The larvae are primarily found in semi-open, sunlit, temporary agricultural sources, resulting from irrigation, rain, seepage, etc., and are often found in company with A. nigromaculis. Adults are vicious biters, attacking during the day and early evenings, and capable of flying several miles.

Aedes squamiger (California Saltmarsh Mosquito) — The larvae are found in salt marsh areas resulting from tidal overflow or rains. Adults are vicious daytime and early dusk biter, and undergo an annual flight from their larval sources.

Culex erythrothorax (Tule Mosquito) — Large larval populations occur in ponds, lake margins, irrigation and drainage canals, swamps and marshes, all of which usually contain a heavy growth of tule-type vegetation. The adults are active at dusk, but will bite man readily during the day when their habitat is invaded.

Culex pipiens (Foulwater Mosquito) — The larvae of this species are usually found in such foul water sources such as septic tanks, dairy drains, industrial and municipal sewage treatment impoundments, catch basins, street gutters, artificial containers, and even in cemetary vases. The mosquitoes bite at dusk or later and may be commonly found inside dwellings.

Culex tarsalis (Encephalitis or Sleeping Sickness Mosquito) — The larvae may be found in a surprising variety of sources such as:

irrigated pastures, rice fields, stream margins, and in brackish and sewage waste sources. The adult is a strong flier and bites both fowl, other animals and man, and readily enters houses. This species is known as the chief vector of western equine and St. Louis types of encephalitis, and is the most common and widespread species in California.

Culiseta incidens (Creek Mosquito) — Larvae are found in a wide variety of sources such as streams, brackish water pools, log ponds, stagnant and polluted pools, clear or semi-clear pools with partial shade, and artificial containers. In some areas the adults bite man, but ordinarily feed on fowl and domestic animals. It is most abundant during the seasons of cool, moderate temperatures, and is most numerous in early spring and late fall.

Culiseta inornata (Winter Mosquito) — Larvae are found in stream pools, marshes, temporary rain pools, occasionally in artificial containers, and have been found in brackish water with A. squamiger. Adults will bite man, but they are particularly bothersome to livestock.

ABATEMENT AUTHORITY

Background Statement

California Health and Safety Code

The Solano County Mosquito Abatement District (SCMAD) is empowered to and may, under The California Health and Safety Code (Division 3, Chapter 5, Article 4, Sections 2270 thru 2289) abate mosquitoes and other insect pests. A summary of the most pertinent of these laws are as follows:

The District Board of Trustees may:

Take all necessary or proper steps for the extermination of mosquitoes, flies, or other insects either within the District boundaries or in territories outside the District which are a source of migrating pests into the District. (Section 2270a)

Build and maintain necessary dikes, levees, cuts, canals or ditches upon any land. (Section 2270d)

Enter without hinderance any land, within or without the District, for the purpose of inspection to ascertain whether breeding places

of mosquitoes, flies or other insects exist; or to treat with appropriate chemical or biological control agents any such breeding places. (Section 2270f)

When a nuisance specified by the Chapter exists upon any property the Board may notify in writing the owner or agent of the existance of the nuisance. (Section 2274)

The notice shall:

State the finding of the District that a public niusance exists. (Section 2275a)

Direct the owner to abate the nuisance within a specified time. (Section 2275b)

Direct the owner to perform, within a specified time, any work necessary to prevent the recurrence of breeding in the places specified in the notice. (Section 2275e)

Inform the owner that failure to comply with the notice shall subject the owner to civil penalities of not more than $500 per day for each day the nuisance continues after the time specified for abatement. (Section 2275d)

Inform the owners that they may appear before the District Board before complying with the requirements of the notice. (Section 2275e) Where they may give testimony in their behalf. (Section 2280)

If the nuisance is not abated within the required time, the Board may abate the nuisance by destroying the larvae or pupae and by taking appropriate measures to prevent the recurrence of further breeding. (Section 2282)

The cost of such abatement of a nuisance shall be repaid to the District by the property owners. (Section 2283)

Permits and Agreements

Other public agencies, in particular the U.S. Army Corps of Engineers and the S.F. Bay Conservation and Development Commission (BCDC), have jurisdictional authorities with SCMAD in marsh areas. As a result, SCMAD as a cooperating agency of the State Health Department has permits from these agencies in order to effectively

carry out the District duties. These permits, as well as SCMAD's cooperative agreement with the Health Department for pesticide usage and environmental modification, are described below. SCMAD is also obligated to comply with standards and regulations regarding mosquito control set by the United States Environmental Protection Agency, California Department of Food and Agriculture and Solano County Department of Agriculture.

1. U.S. Army Corps of Engineers

   The California Department of Health Services and SCMAD as a cooperating agency is authorized under General Permit No. 10918-98 to conduct abatement activities in navigable waters. Maintenance activities such as replacement of water control structures, ditching, filling and levee repair are allowed under this 5-year permit as well as certain amounts of new work. The permit requires that water quality standards be maintained and that fish, wildlife and natural habitats be minimally affected.

2. S.F. Bay Conservation and Development Commission

   The California Department of Health Services and SCMAD as a cooperating agency is authorized under Permit No. M77-37 to perform maintenance and new work in BCDC's jurisdiction. Work authorized under this 5-year renewable permit is essentially the same as that granted by the Army Corps of Engineers.

3. California Department of Health Services

   Under the annually renewed cooperative agreement between the Dept. of Health Services and SCMAD, the District agrees to calibrate and maintain in a operational condition all pesticide application equipment, prepare records and reports regarding pesticide use, report any suspected adverse effects of pesticides. The SCMAD further agrees that district employees are certified pest and vector control technicians, and agrees to comply with requirements of any permits issued to the Dept. of Health Services pertaining to environmental modification to achieve pest and vector prevention.

4. United States Environmental Protection Agency

   Through the cooperative agreement discussed in (3) above SCMAD is obligated to comply with EPA standards and regulations regarding the storage and application, and proper maintenance and calibration of equipment used to apply registered pesticides used for mosquito control.

5. California Department of Food and Agriculture

   SCMAD must adhere to the application rates established in California for registered pesticides and must comply with regulations pertaining to application, recording and reporting of all uses of economic poisons.

6. Solano County Department of Agriculture

   This agency receives records and reports of materials used, locations and methods of application, and rate of application for pesticides and other economic poisons used in Solano County.

General Polices for Mosquito Prevention Practices

The following recommendations for mosquito prevention practices are considered appropriate for effective mosquito control without producing deleterious effects to wildlife and their habitat.

1. When necessary trained SCMAD personnel will use appropriate control practices to prevent or abate mosquito and other pest nuisances. Control practices will be used only when necessary and will minimally affect fish, wildlife, natural habitat and water quality.

2. Private property owners and public agencies owning land in primary and secondary marsh areas should consult with the SCMAD to determine the most effective methods for mosquito control.

3. Plans for expansion or alteration of uses, and/or restoration or marsh areas must have appropriate water management plans. The plans must be developed in cooperation with the SCMAD to ensure adequate mosquito control.

4. The SCMAD will assist all private property owners and public agency land owners to achieve adequate prevention of mosquitoes through the use of its staff and equipment.

MANAGEMENT POLICIES FOR INTEGRATED MOSQUITO CONTROL*

A. Drainageway Construction and Maintenance Practices

Background Statement

Mosquitoes breed in creeks and ditches where ponding occurs due to obstructions, overflow of banks, excessive siltation

*Definitions for many of the technical terms in this section may be found in the Appendix, Section VI.

and back-eddys created from low water flow during dry months. Consequently, modification of drainageways (digging, and filling, etc.) is often necessary to allow free flow of water. Construction of new ditches must be undertaken to maintain adequate circulation of water.

Although obstructions and ponding in creeks and ditches most often occur naturally, alterations to water flow also arise from new construction, refuse deposits and agricultural activities. The correction and costs of such alterations become the responsibility of the person(s) or agency(s) involved when mosquito production results, any abatement expenditures incurred by SCMAD may be billed to the responsible party, pursuant to the proceedures set forth in the California Health and Safety Code, Sections 2274 et. seq.

SCMAD constructs one type of drainageway to adequately drain low lands in the marsh. Spreader ditches are small ditches (18 inches by 18 inches) which drain into main ditches or tidal water sloughs. Main ditches direct flow to a water control outlet structure and thence into a tidal water slough.

SCMAD will assist property owners by providing its lightweight tractor and plough at a nominal hourly charge (see Contractual Agreement, Section V) to construct and maintain spreader ditches.

Policies for Management of Drainageway Construction and Maintenance

1. Water control structures (flap gates, slide gate, weir box, etc.) should be maintained in working condition to facilitate the flooding and complete draining of managed wetlands.

2. Clear and retrench spreader ditches approximately every three years.

3. Excavate or dredge existing main ditches when necessary.

4. Repair levees and remove debris and vegetation which are obstructing natural stream channels if such materials create a situation which may endanger public health and safety.

5. Fill isolated potholes (depressions found in marsh areas) which may create mosquito problems and cannot feasibly be connected to circulating water.

6. Connect pools (depressions found in streambeds) to the main flow of water by minor hand ditching when it appears that they are problem mosquito breeding sites.

7. Maintain all access roads and levees in good repair to allow continuous mosquito surveillance, and provide access for

control equipment.

8. Install and maintain water control structures whenever possible to expedite flood water removal.

B. Water Management Schedules

Background Statement

The SCMAD in cooperation with the Suisun Resource Conservation District, U.S. Soil Conservation Service and the California Department of Fish and Game has participated in the preparation of various water management schedules for duck clubs in the Suisun Marsh.

These schedules will form a segment of the Suisun Resource Conservation District Component and therefore are not presented here as part of the SCMAD Component.

The SCMAD recommends and encourages the use of these schedules by all duck clubs in the Suisun Marsh.

C. Leveed Irrigated Pastures

Background Statement

There are several hundred acres of managed wetlands which are irrigated from tidal slough water and are used for pasture grazing by livestock within the Suisun Marsh. Marsh mosquitoes are invariably produced from standing water left more than 5 days. Thus, in order to maintain good forage pasture without producing mosquitoes, a flood/drain cycle during high tides of 6 feet must be carried out.

Policies for Management of Leveed Irrigated Pastures

1. To enable complete flooding, flood only during a series of high tides (6 feet).

2. Set water control structures open to drain within 5 days; drainage capacity should be a minimum of 5 days to allow complete draining of wetlands.

3. Spreader ditches should be placed in appropriate intervals to ensure complete drainage.

4. Spreader ditches should be properly connected to each main ditch with a water control structure to enable a one way flow during drainage.

5. Disc cracked ground as needed.

6. Maintain and repair water control structures.

D. Tidal Marsh Management

Background Statement

Historically, tidal marshes in Solano County were prolific sources of mosquitoes, an aggressive, migrating, day-biting species. In addition to direct abatement, water management practices have been developed by SCMAD to prevent the production of mosquitoes in tidal marshes. The principal prevention method consists of the construction of ditches to circulate tidal water into sloughs and bays to avoid ponding. The following recommendations should be followed to reduce the mosquito production in tidal marshes.

Policies For Tidal Marsh Management

1. All marsh lands should be periodically surveyed to determine if ditches and drainage water control structures are properly placed to ensure effective drainage.

2. Ensure that all spreader ditches are constructed and maintained free and clear of debris and vegetation. Clear and retrench approximately every three years.

3. Spreader ditches should be properly connected to a slough via a main ditch or by having a flapgate, wier box or other adequate water control mechanism.

4. The drainage capacity of the drainage systems (spreader and main ditches) should be no more than 5 days to ensure full removal of water from the surface of the marsh prior to potential mosquito production.

5. To ensure the effectiveness of the drainage system and water control structures for the prevention of mosquitoes, SCMAD will conduct surveillance after each bi-monthly high tide.

E. Salt Marsh Restoration of Exterior Levee Lands

Background Statement

These lands were originally tidal marshes, vegetated areas subject to daily tidal action. These lands were reclaimed for agricultural and other uses by the construction of levees and the installation of one or more water control structures to control the inflow and outflow of water. The Suisun Marsh Protection Plan recommends the restoration of former tidal marshes to tidal action where and when possible.

Salt marsh restoration projects on former exterior areas generally have a great potential for producing large numbers of mosquitoes.

Removing or breaching the levee will subject the sites to tidal flow. The extent of tidal flow depends, of course, on the relative elevation of the site to tide. Tidal flushing itself does not create mosquito problems. Mosquito problems arise from the residual tidal and flood waters remaining in depressions and cracked ground.

The following District Practices were adopted in December 1977, and are made for preventing problems, and should be implemented prior to removal or breaching of any levee or water control structure.

Policies for Management of Salt Marsh Restoration of Exterior Levee Lands

1. Develop a management program for the control of mosquitoes. Such a plan should be developed in coordination with SCMAD.

2. If necessary, obtain an engineering survey to locate depressions that would retain tidal water, and to determine the location of ditches for water circulation and drainage.

3. Establish a water recirculation system by interconnecting depressions with ditches that will enhance water movement and provide access for predator fish.

4. Disk or harrow all cracked ground caused by shrinkage and subsidence.

5. Plan and fund a long-term maintenance program on the marsh. The maintenance should include:

    a. Dredging and cleaning of sloughs, spreader ditches and main ditches to provide adequate water circulation.

    b. Disking of cracked ground as needed.

    c. Maintenance and repair of water control structures.

F. Wastewater Reclamation

Background Statement

Recent changes in California water pollution regulations and current emphasis for reuse of wastewater have serious prospects for mosquito production. Proposals for reusing effluent and surface runoff or preventing these waters form flowing directly into estuaries or water

cources can create new mosquito sources. The types of proposals under consideration for the diversion and reuse of wastewater are; (1) impoundments for reclamation; (2) agriculture irrigation; (3) recharge of ground warer; (4) development of marshland and wetland habitat; and (5) industrial recycling.

The following District Practices were adopted in December 1977, and are made for preventing problems, and should be implemented prior to removal or breaching of any levee or water control structure.

Policies for Management of All Lands Which Utilize Wastewater

1. All sites designated for wastewater reclamation should either be graded or ditched as necessary for proper drainage.

2. Sites for temporary impoundments used for waterfowl feeding areas or for production of food should be flooded according to the water management schedules developed by Suisun Resource Conservation District, Soil Conservation Service, California Department of Fish and Game and Solano County Mosquito Abatement District.

3. The use of wastewater for crop irrigation requires careful land preparation and judicious water management to prevent standing water.

4. Establishment of wetland habitat using wastewater requires land grading or ditching to allow removal of all water from the shallow areas, water control structures, pumps, etc., for complete water management. Access provisions for marsh management equipment such as boats and aquatic or terrain vehicles are also required.

5. Excess wastewater at the low ends of sites used for marsh flooding or crop irrigation must be recycled, utilizing a return system or be disposed of in a drainage facility.

6. Water control devices such as pumps, weir boxes and flap gates should be of sufficient capacity to drawdown the temporary wastewater impoundments within a time designated by the Solano County Mosquito Abatement District.

Wastewater Storage Ponds

1. Ponds filled with wastewater may be any shape but should not have small coves or irregularities around their perimeters.

2. Ponds should be designed to be emptied by gravity or pumping for cleaning or drying and have graded bottoms so all water can be removed.

3. Side slopes of excavations and levees should be as steep as possible, consistent with soil characteristics and risk factors of slope failure.

4. Where steep side slopes cannot be economically achieved, the slopes should be lined with suitable material such as concrete to 3 feet below the water line or sterilized to achieve weed control.

5. The top width of embankments should be a minimum of 12 feet and should be adequately constructed to support maintenance vehicular traffic.

6. An access ramp should be provided on an inside slope for launching a small boat for mosquito control.

7. Ponds designed for long term wastewater storage should have a minimum storage depth of four feet.

8. A maintenance program for weed and erosion control along inner slopes is essential.

9. All accumulations of dead algae, vegetation and debris should be routinely removed form the impounded wastewater surface and properly disposed.

Wastewater Conveyance Facilities

1. Ditches for wastewater must be maintained free of emergent, marginal and floating vegetation.

2. Ditches should be sized and graded for adequate flow and must not be used for water storage.

3. Unpressurized and low pressure pipelines, commonly used in irrigation distribution systems, should be designed to be emptied when not in use and should not be used for wastewater storage because of the mosquito breeding potential in the partially filled pipes.

Septic Tanks

1. Septic tanks should be adequately sealed to prevent mosquito entry and production.

2. Tanks should be designed and installed as per Solano County Health Department standards to prevent ground cracks which would serve as access to mosquitoes.

G. Dredge Material Disposal

Background Statement

Land disposal of dredge material by hydraulic dredging of rivers and sloughs creates in many instances mosquito breeding sources. Due to the initial high water content and characteristice of the dredged material, shrinkage cracks occur in the drying process. These shrinkage cracks provide ideal habitat for the production of mosquitoes. Experience by mosquito abatement agencies has shown the use of chemicals to kill mosquito larvae in the cracks is very inefficient and generally not practical. Solution of the problem lies in water management and periodic manipulation of the surface of the deposited material. Disking the spoil material fills and closes the cracks. Drainage of storm water and keeping the elevation of the ground water below the shrinkage cracks also prevents mosquito problems.

The following District Practices were adopted in December 1977, and are made for preventing problems, and should be implemented prior to establishing of any dredge material disposal site.

Policies For Management of Dredge Material Disposal Sites

1. Provide ditches and/or water control structures for drainage of surface water. An engineering survey may be necessary.

2. Disking of the area may be required to close shrinkage cracks.

3. Provide access roads that are capable of supporting maintenance, inspection and mosquito control equipment.

4. Areas designated for permanent water should be constructed and managed for mosquito prevention as necessary for the specific site. Generally, dense aquatic vegetation, algae mats and shallow water cause or lead to mosquito production.

5. Areas designated for wetland development need ditches to promote and enhance tidal water circulation and/or water control structures to provide water management capabilities. The exterior levee system should be retained until sufficient drying has occurred and all necessary grading and ditching has been finished.

6. Retention of exterior levees and water control structures may be necessary or desirable for water management to prevent excessive production of mosquitoes.

7. Plan and fund a maintenence program for the area to provide for:

a. Maintenace of ditches and water control structures.

b. Disking as necessary.

c. Maintenance of levees and access roads.

d. Occasional mosquito control with pesticides and/or a biological agent such as mosquito-fish.

H. Permanent Ponds

Background Statement

The diversity of waterfowl habitat in the Suisun Marsh is increased by the occurence of permanent ponds. Permanent ponds, however, should remain a minor part of the marsh habitat because (1) they require specific conditions to provide optimum habitat and (2) other more intensive types of management can generally be carried out that provide for higher yields of waterfowl food.

Seeding of permanent ponds is not necessary since plants such as sago pondweed and widgeongrass should become established in the ponds naturally.

Policies For Management of Permanent Ponds

Establishment:

1. Permanent ponds are recommended only in areas where at least 70% of the total permanent water area will be maintained year round at a minimum depth of 3½ to 4 feet. This depth limits the occurrence of cattails and tules and stimulates the production of desirable pondweeds.

2. Levees surrounding permanent ponds must have a shelf on which cattails and tules can become established to serve as a buffer against wave action.

3. Permanent ponds should be established only in areas where the gates and ditches can provide maximum circulation of water without fluctuation in water level.

Maintenance:

1. Set gates to allow maximum circulation without change in water level. Maintain circulation year round, but especially during warmer months (April-Sept.). Poor circulation during these months could increase salinity, mosquito reproduction, and the probability of botulism.

2. Once every five years, completely drain the pond in February

and keep it dry through September. This will control carp populations, allow oxidation of the sediment in pond bottoms resulting in the release of nutrients, and allow for mowing or burning of undesirable vegetation. At this time an inspection of gates and levees will be undertaken and needed repairs will be made.

Notice:

The Solano County Mosquito Abatement District (SCMAD) has participated in the preparation of this management plan and endorses this Water Management Schedule to minimize the production of mosquitoes. This plan is suitable for use on private duck club land and all other lands owned by public agencies managed as water fowl habitat, and in normal weather cycles will limit the production of mosquitoes if water levels are managed properly. However, if adverse variations in water levels occur, SCMAD may take action to abate any production of mosquitoes pursuant to the procedures set forth in the California Health and Safety Code Sections 2274 et.seq, at the property owners expense when ever larvae and adult mosquitoes are found to be present in sufficient densities to warrant control procedures.

I. Controlled Burning

Background Statement

The SCMAD recognizes burning may be the preferential method for removing vegetation in duck clubs, agricultural lands and tidal marshes. However, in certain instances such fires become uncontrolled. Uncontrolled fires can be dangerous, costly to extinguish and detrimental to adjacent lands. Fires in peat soil, common in the marsh, are often impossible to extinguish without flooding. SCMAD is frequently asked by the Solano County Fire Warden and other local and State agencies to open water control structures to extinguish the fires. If flooded lands are not drained quickly and completely marsh properties produce billions of mosquitoes which necessitate aerial pesticide spraying to control.

Policies For Management of Controled Burning

1. Burning should be accomplished in the spring, when vegetation is dead and dry and the soil is wet.

2. Property owners should have sufficient manpower and equipment at the time of burning to prevent wild fires.

3. Backfire away from or disking around buildings, levees, etc. at the start of burning to prevent their destruction.

4. If flooding becomes necessary to put out uncontrolled fires and such flooding results in the production of mosquitoes, the SCMAD may take action to abate the mosquitoes pursuant to the proceedures set forth in the California Health and Safety Code, Sections 2274 et. seq. and Section III of this document.

J. Utility Construction Practices

Background Statement

Installation of natural gas lines and wells, electrical lines, telephone lines, petroleum pipelines and the like can alter both topography and habitat. Activities which disrupt drainage patterns, obstruct water flow or water control structures, prevent access, or leave mounded debris can cause mosquito production.

Policies For Management of Utility Construction In Marsh Areas

1. SCMAD should be notified of proposed utility construction activities in marsh areas through lead agencies or responsible parties. Such activities should be reviewed by SCMAD at both the project development phase and after the work has been completed to ensure the project is carried out in conformance with SCMAD policies.

2. Installation of utilities should not obstruct water flow or alter drainage patterns without prior notification of SCMAD.

3. Following installation of utilities the topography ahould be returned to original conditions, circulation ditches or natural drainageways should drain effectively and levees and/or access roads should be put back in good repair.

4. If mosquitoes are produced as a result of negligent utility construction practices, all costs necessary to abate mosquitoes by SCMAD will be borne by the responsible agencies or property owners, pursuant to the proceedures set forth in the California Health and Safety Code, Sections 2274 et. seq. and Section III of this document.

K. Biological Control

Background Statement

Many natural predators of mosquitoes are found within marshes. They are, however, often limited in their abundance and effectiveness

because they require permanently ponded water. Fish such as mosquitofish and three-spined stickleback are often found throughout sloughs and other permanent bodies of water in marshes. Additionally, many useful insect predators coexist within these permanent ponds and contribute to natural biological control of mosquitoes. In well-managed ponds these predators can control mosquito populations and often eliminate the need for chemical control.

Mosquitofish, the most efficient mosquito predator are well adapted to many aquatic habitats. They can withstand a wide range of conditions (mild alkali to brackish water). They eat a wide variety of aquatic micro-organisms, most notably, mosquitoes. Mosquitofish select food depending on its relative availability. They will consume living organisms in preference to dead matter. Mosquitofish are highly reproductive and bear live young. Because of these characteristics they have the potential of proliferating under favorable conditions.

Winter/spring rains cause flushing of marshes which results in the annual reduction of mosquitofish populations. When necessary SCMAD periodically re-stocks creeks, ponds and ditches with mosquitofish to expedite their re-distribution within the marshlands.

There are other biological control agents which appear promising for mosquito control. There are several fungus diseases (Lagenidium beauveria), bacterial agents (Bacillus sphericus) and nematode worms (Mermithids) which may be useful in marshes in the future.

The success of biological agents for mosquito control in the marsh habitat rests with good water management. Once chemical pesticides are required to suppress mosquito populations, the survival of other organisms (including biological agents) may be in jeopardy.

Policies For Management of Biological Control

1. After the spring flushing-leaching and circulation cycles (various Suisun Resource Conservation District Water Management Schedules) main ditches may be kept flooded during the summer months to maintain predator populations and ensure their dispersal into duck clubs with the fall flooding. Water must be confined within the main ditches, and not be allowed to overflow the ditches during the summer months, otherwise mosquitoes will be produced.

2. SCMAD will continue to investigate other potential biological control agents which may be of assistance in reducing mosquito populations.

L. Chemical Control

Background Statement

Marshes within Solano County provide several types of wetland habitat, each having unique characteristics. When not managed properly, these habitats can produce massive mosquito populations which are uncontrollable by natural control agents. SCMAD is authorized under federal, state and county regulatory agencies to use chemical agents (pesticides) as necessary to abate these nuisances. Chemical agents are used only in extreme emergency conditions when no other methods will control the nuisance. Pesticides may be applied to control immature mosquitoes to prevent the emergence of adults or in extreme cases to control emerged adults.

SCMAD has therefore entered into a cooperative agreement with the California Department of Health (Vector Biology & Control Section) to comply with U.S. Environmental Protection Agency, California Department of Agriculture, and County Agriculture Commissioner requirements to ensure the proper storage and application of registered pesticides and calibration of equipment for mosquito control. (See Section III of this document.)

Policies For Management of Chemical Control

1. When biological and/or physical control methods are ineffective or infeasible SCMAD will apply appropriate pesticides to abate mosquitoes.

2. Property owners may consult with SCMAD regarding preventive practices such as ditches and may enter a contractual agreement with the District for payment of treatment costs and estimated re-treatment costs. These treatments will depend on current water management practices.

3. Property owners may also enter a seasonal contractual agreement with SCMAD for pre-emergence pesticide application as may be judged necessary by SCMAD to prevent large outbreaks of mosquitoes. These treatments may be necessary on marshes in which preventive water management practices have not yet been undertaken.

4. Pesticide applications described in recommendations (2) and (3) above will only be conducted to provide time for completion of water management plans to be fully executed by property owners. They are not intended as preventive control measures to be applied regularly on an annual basis.

SOLANO COUNTY MOSQUITO ABATEMENT DISTRICT
P. O. BOX 304
SUISUN, CALIF. 94585

CONTRACTUAL AGREEMENT

V.

I, _____, the owner/manager of property located at _____, Solano County, agree to the following mosquito control program which will be conducted by the Solano County Mosquito Abatement District.

1. SCMAD may provide construction of new or maintenance of old lateral (18" x 18") re-circulation ditches. Such ditches are necessary for the re-circulation of trapped water in the marsh in order to prevent mosquito occurrence on the above said property.

2. If conditions are allowed to exist that may necessitate aerial spraying to control mosquitoes, I will reimburse the SCMAD for all costs of pesticide application on the above said property.

3. SCMAD will maintain adequate general liability and Workers' Compensation insurance coverage at all times while this agreement is in effect and, to the extent that it legally may, agrees to hold harmless for any injuries to employees of, or under contract to, the District while in performance of their duties on my property.

4. This agreement shall be effective for the yearly period commencing with the date of my approval of it and shall continue from year to year thereafter, subject to termination at any time either by the District or myself upon 30 days' prior written notice to the other party.

Signed, _____ (Owner/Manager)

_____ (SCMAD Manager)

Date _____

SOLANO COUNTY MOSQUITO ABATEMENT DISTRICT
P. O. BOX 304
SUISUN, CALIF. 94585

CONTRACTUAL AGREEMENT
DITCH CONSTRUCTION AND MAINTENANCE

Between Solano County Mosquito Abatement District and _____, the owner/manager of property located at _____, Solano County. I _____ enter into agreement with Solano County Mosquito Abatement District to have the District provide construction of new or maintenance of old lateral (18" x 18") re-circulation ditches at the rate of _____ per hour. Such ditches are necessary for the re-circulation of trapped water in the marsh in order to prevent mosquito occurrence on the above said property.

Signed _____ (Property Owner/Manager)

_____ (SCMAD Manager)

Date _____

SOLANO COUNTY MOSQUITO ABATEMENT DISTRICT
P. O. BOX 304
SUISUN, CALIF. 94585

CONTRACTUAL AGREEMENT
PESTICIDE APPLICATION

Between Solano County Mosquito Abatement District and _____ _____, the owner/manager of property located at _____, Solano County. I _____ enter into agreement with Solano County Mosquito Abatement District to reimburse Solano County Mosquito Abatement District for all costs of pesticide application at the rate of _____ per acre necessary to abate mosquito nuisances that may arise on the above said property.

Signed _____ (Owner/Manager)

_____ (SCMAD Manager)

Date _____

APPENDIX

Definitions of Technical Terms

Main Ditch - (also called supply or circulation ditches) are water conveyance facilities whose purpose is to deliver water from intake structures located at the exterior levees to the ponds or to remove water from the ponds to the outlet structures located at the exterior levees. They include any spurs leading to the individual ponds.

Spreader Ditches - (also called lateral or collector ditches) are water conveyance facilities whose purpose is to connect low spots within the ponds to the main ditches.

Levees

Exterior Levees - embankments which prevent uncontrolled flooding of marshland due to tidal action. The crown of these levees is normally about 9 feet above zero tide with a 12 food top width.

Interior Levees - embankments which allow for management of water inside exterior levees. They are not exposed to tidal action. The crown of these levees is normally less than 4 feet above the natural ground with a top width of 10 feet.

Water Control Structures

Culvert - a corregated steel pipe placed in a levee for the purpose of conveying water from one side of the levee to the other.

Flap Gate - a hinged wooden or metal cover installed on the end of a culvert or redwood box designed to allow free water flow in one direction and prevent back flow in the other direction. In the free flow direction the size of the opening is controlled by the water pressure against the flap.

Lift Flap Gate - similar to a flap gate but with a winch and chain or other mechanism added to permit mechanical lifting of the flap and allowing a controlled amount of backflow to occur.

Slide Gate (alos called a Screw Gate)- a wooden or metal cover which slides up and down in a frame attached to the end of a culvert or redwood box. It is raised and lowered by a screw mechanism which is usually turned by hand. Water flow is equal in either direction and volume is determined by the degree of opening.

Slide/Flap Gate (also called a Screw/Flap Gate) - similar to slide gate but with a flap gate added to prevent back flow.

Flashboard Box or Weir Box - a wooden box with grooved runs for inserting wood planks. The planks are placed, one on top of the other, to the desired water height. Any excess water about this height will overflow over the boards and out through the box. The boards can be removed for complete water drainage.

Flashboard Riser - a length of corregated metal pipe cut in half longitudinally and placed vertically on top of the inlet or outlet of a culvert. The riser is fitted with wood planks than can be placed, on top of the other, to the desired height. These function the same as that of a weir box.

Marsh Types

Managed Wetlands - leveed areas within the Primary Management Area (PMA) in which water inflow and outflow is artificially controlled, or in which waterfowl food plants are cultivated, or both, to enhance habitat conditions for water associated birds and wildlife.

Tidal Marshes - vegetated areas within the PMA subject to daily tidal action.

Tidal Waters - open water areas within the PMA subject to daily tidal action.

Management

Circulation - a system of ensuring slow, but continuous movement of water across the club or pond to reduce insect and water quality problems associated with stagnation of standing water.

Flushing Cycles - a cycle of flooding and draining a pond for the purpose of reducing soil salinities.

Pond - any area of the club that is underwater when club is flooded to normal shooting level. Ponds are not limited to open water areas or to the mowed (or otherwise more intensively managed) areas around an established blind.

Shooting Level - the depth of water found to be the most attractive to water fowl. Most of the ducks utilizing the Suisun Marsh are "dabblers" and are attracted to areas flooded with 12 - 18 inches of water.