Confined Animal Facilities Element of the Glenn County General Plan

May, 2005

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CHAPTER ONE
INTRODUCTION

1.1 NEED FOR THE ELEMENT

The purpose of the Confined Animal Facilities Element is to provide guidance for the design, construction, operation and management of animal confinement facilities in Glenn County. At the same time the Element provides for the protection of the quality of the environment, safeguards the health, safety and general welfare of the population, and provides for the continuation and growth of animal-related industries in the county. It has been determined by the County that these purposes are best accomplished through adoption of a General Plan element to address confined animal facilities. Placement of policies and standards related to confined animal facilities in the General Plan also acknowledges the importance of agriculture and animal husbandry to the economy and quality of life of Glenn County.

1.2 ELEMENT OBJECTIVES

The following project objectives have been identified as points of focus in the Confined Animal Facilities Element:

- Compliance with current and future Central Valley Regional Water Quality Control Board, Cal EPA and federal EPA standards for water quality and air quality rather than development of additional local standards.

- Development of user-friendly processes and economically feasible development standards that recognize facility size.

- Avoidance of an over concentration of the dairy industry in Glenn County, or any specific part of Glenn County.

- Avoidance of conflicts between existing residential uses and other sensitive land uses and confined animal facilities.

- Protection of established animal confinement facilities from encroachment by incompatible land uses.

- Avoidance of unnecessary regulatory burdens on existing confined animal facilities.

- Use of performance standards in future confined animal facility location decision-making, rather than maps that exclude dairies from areas of the County based on soil type, water table, etc.

- Establishment of setbacks and buffers around existing communities and residences.

- Use of buffers to protect viewsheds and other visitor/tourist amenities.

- Provision of adequate sites appropriately zoned for confined animal facility support industries and services.

- In addition to the above objectives that are drawn from public outreach, the following additional objectives are proposed in order to address potential concerns and comply with existing State and federal requirements:

    - Identification of roadway mitigation requirements to ensure that roadways are adequate to accommodate projected vehicle use.

    - Development of odor and vector control techniques for new and expanded facilities.

    - Minimization of future environmental review for individual facilities.

    - A mechanization by which the Confined Animal Facilities Element can be updated periodically to reflect changes in technology and the regulatory environment.

    - Use of applicant-generated nutrient management plans and geological-hydrological reports in the site-specific environmental review process.

    - Identification of minimum content requirements for plans submitted to the County to ensure an adequate and consistent information base.

    - Compliance with all State and federal regulations concerning special status plant and animal species, and protection of wetlands.

    - Compliance with State and federal requirements for protection of cultural and historic resources.

I.3 LEGAL REQUIREMENTS

California State law requires each county to adopt a General Plan that describes the direction the county will take concerning its future development. As described in the State of California General Plan Guidelines (Governor's Office of Planning and Research, 1998):

> The role of a community's general plan is to act as a "constitution;" a basis for rational decisions regarding a city's or county's long-term physical development. The general plan expresses the community's development goals and embodies public policy relative to the distribution of future land uses, both public and private…

The General Plan must be comprehensive in nature: geographically comprehensive (covering the entire county), and comprehensive with regard to addressing a broad range of issues. It must take a long-term perspective, typically looking 20 years into the future.

The General Plan must also be "internally consistent." This means that all of the elements of the General Plan must be consistent with one another, and there must also be consistency within each element. Diagrams must be consistent with the text of General Plan elements. Finally, plans for specific areas of the county, both existing plans and those that may be adopted in the future, must be consistent with the General Plan.

There are seven mandatory "elements," or subject areas, that must be included in the General Plan. These seven elements include land use, circulation, housing, conservation, open space, noise and safety. The Glenn County General Plan combines these subject areas into three broad "elements" identified as Natural Resources, Public Safety and Community Development. The Confined Animal Facilities Element will become a fourth "element" to the General Plan. State law permits the inclusion of "optional" elements in the General Plan, of which the confined animal facilities is Glenn County's first optional element, although the current General Plan does include an optional subject (Economic Development) as part of the Community Development Element. State law also requires local agencies to review the General Plan every five years and revise the document as necessary.

I.4 CITIZEN PARTICIPATION

Public participation is essential to the formulation of a general plan element that will be accepted and embraced by the community. The County of Glenn has engaged the community on numerous occasions in the process of developing this Element.

During an extended public outreach/public education process, meetings were held with a variety of groups and individuals in the County to provide information on the Confined Animal Facilities Element project and to gather opinions on directions the Element should reflect. Meetings were held with the following groups:

- County Water Advisory Committee and their Technical Advisory Committee
- Resource Conservation District,
- Surface Water Advisory Committee
- County Planning Commission
- Board of Supervisors
- 12th Annual North Valley Dairy Day Symposium
- Board of Realtors
- CEQA-required Scoping Meeting
- County Farm Bureau

In addition the County appointed a Livestock Operations Committee to meet with staff and consultants on a regular basis to provide guidance to the process. The Committee consists of 15 members representing the livestock industry and other interested citizens. A total of 18 meetings with the various groups were held during formulation of the Element.

I.5 CONSISTENCY WITH OTHER GENERAL PLAN ELEMENTS

The Confined Animal Facilities Element has been reviewed for consistency with other elements of the General Plan and proposes changes where necessary to ensure consistency. Policies of the Confined Animal Facilities Element support, and are supported by, policies of the other elements and the policies of Confined Animal Facilities Element are cross-referenced where necessary.

I.6 ORGANIZATION OF THE ELEMENT

The Confined Animal Facilities Element contains the following sections:

Chapter 1: Introduction to the Confined Animal Facilities Element

- 1.1 Need for the Element
- 1.2 Element Objectives
- 1.3 Legal Requirements
- 1.4 Citizen Participation
- 1.5 Consistency with Other Elements
- 1.6 Organization of the Element
- 1.7 Confined Animal Facilities in Glenn County
- 1.8 Existing Confined Animal Facilities Policies and Standards

Chapter 2: Environmental and Regulatory Setting

- 2.1 Agriculture/Soils
- 2.2 Land Use and Planning
- 2.3 Hydrology/Water Quality
- 2.4 Biological Resources
- 2.5 Air Quality
- 2.6 Aesthetics/Light and Glare
- 2.7 Solid and Hazardous Waste
- 2.8 Population and Housing
- 2.9 Traffic/Circulation
- 2.10 Cultural Resources
- 2.11 Public Services

Chapter 3: Analysis of Opportunities and Constraints

- 3.1 Potential Target Areas For New Confined Animal Facilities
- 3.2 Land Use Conflicts
- 3.3 Hydrological Constraints
- 3.4 Air Quality Constraints
- 3.5 Traffic and Circulation Constraints

3.6 Biological Constraints

Chapter 4: Goals. Policies and Development Standards

The Confined Animal Facilities Element is accompanied by a Program Environmental Impact Report that assesses any environmental impacts that may result from Confined Animal Facilities Element adoption.

I.7 CONFINED ANIMAL FACILITIES IN GLENN COUNTY

Glenn County Code Section 19.040.020 defines CAFs as "cattle, calves, horses, sheep, goats, swine, rabbits, or large fowl, corralled, penned, or otherwise caused to remain in restricted areas for agricultural-commercial purposes where feeding is other than grazing for more than 45 days during the year." The code exempts from the definition range pastures for livestock beef cattle as well as school projects, 4-H, fairs and other individual educational projects.

Dairies are by far the most common type of confined animal facilities in Glenn County (see Figure 1-1, Vicinity Map). Dairy product production was valued at $48.5 million in 2003 and ranked third among agricultural commodities in the county after rice and almonds, according to the Glenn County Farm Bureau. California Dairy Statistics reported that in 2004 Glenn County ranked 12th in the state in the number of milking cows (see Table 1-1). Glenn County remains far below the leading counties in sheer numbers of cows and dairies, with only 1 percent of the total for cows and 3 percent of total of dairies statewide. By contrast, the top ten counties contain 93 percent of the state's dairy cows and 82 percent of the dairies.

Table I-I
Top 25 California Dairy Counties in 2004

Rank	County	Number of Milking Cows	Number of Dairies	Average Milking Cows Per Dairy
1	Tulare	442,853	334	1,326
2	Merced	237,854	317	750
3	Stanislaus	178,420	311	574
4	Kings	162,656	165	986
5	San Bernardino	131,675	154	855
6	San Joaquin	103,619	148	700
7	Kern	121,147	51	2,375
8	Fresno	95,577	117	817
9	Riverside	67,573	55	1,229
10	Madera	63,934	57	1,020
11	Sonoma	30,660	82	374
12	Glenn	18,404	60	266
13	Sacramento	17,764	48	370
14	Humboldt	16,138	92	175
15	Marin	10,265	29	354
16	San Diego	5,397	8	675

Rank	County	Number of Milking Cows	Number of Dairies	Average Milking Cows Per Dairy
17	Tehama	4,514	23	196
18	Solano	4,068	5	814
19	Yuba	3,278	4	820
20	Del Norte	3,047	10	305
21	Santa Barbara	2,296	3	765
22	Yolo	2,043	3	681
23	Siskyou	1,606	5	321
24	Monterey	1,607	4	402
25	San Benito	842	3	281
Total/Avg. - All Counties		**1,737,789**	**2,107**	**824**

Source: 2004 Dairy Statistics and Trends, California Department of Food and Agriculture

Table 1-2 illustrates trends in Glenn County's dairy industry since 2000. As of 2004, the county had 18,404 dairy cows on 60 dairies. The average dairy size was 306 head, which is significantly smaller than the statewide average of 824.

Table I-2
Growth Trends in Glenn County Dairy Sector

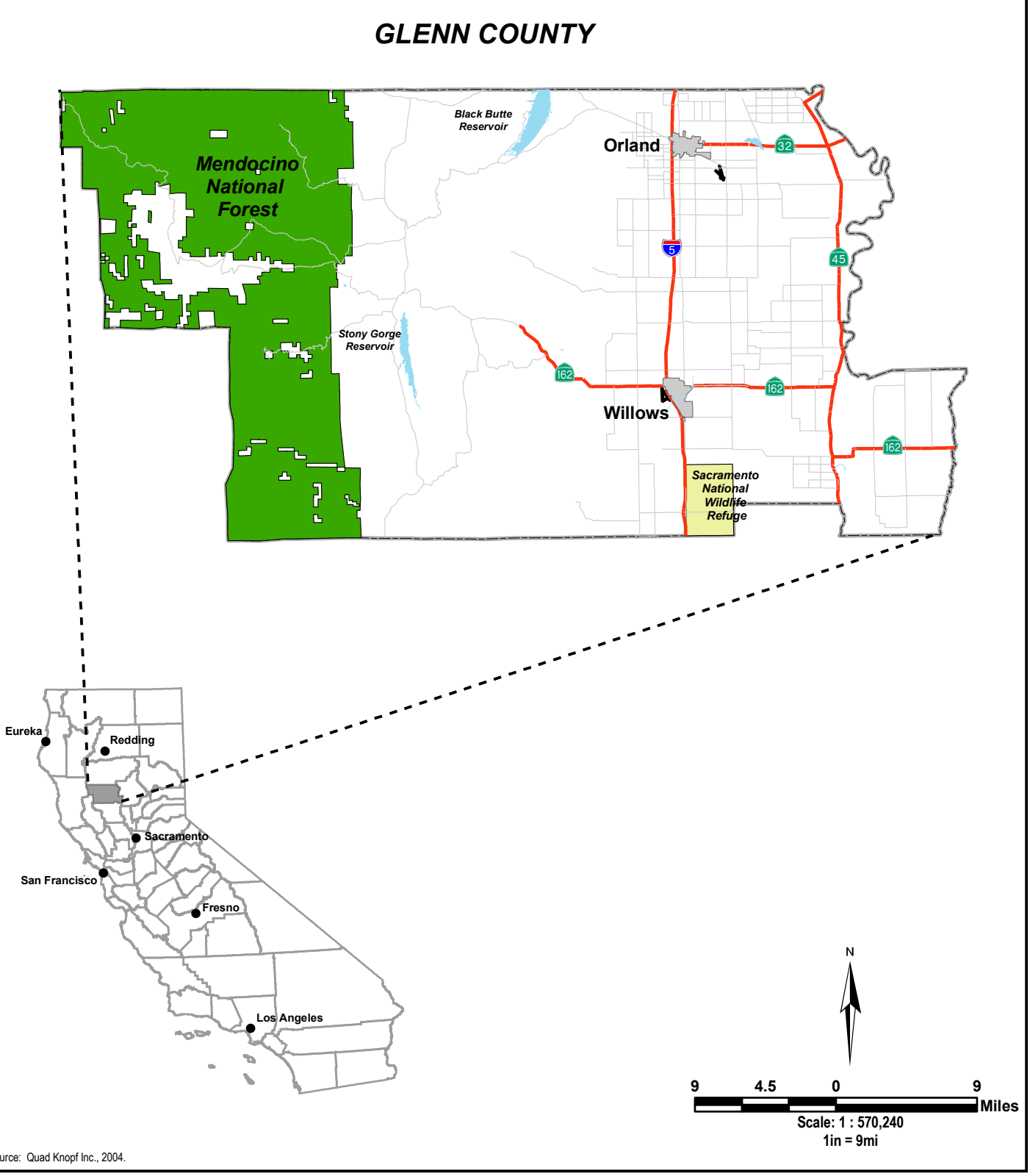
Year	Number of Cows	Number of Dairies	Average Cows Per Dairy
2000	14,676	67	219
2001	15,365	59	260
2002	17,830	66	270
2003	19,398	73	266
2004	18,404	60	306

Source: California Dairy Statistics and Trends (2001-2004), California Department of Food and Agriculture

Figure 1-2, Dairy Locations, shows the approximate locations of 50 dairies compiled using data from the California Department of Food and Agriculture (Milk and Dairy Food Control) and the Glenn County Division of the Assessor/Clerk-Recorder. Currently, the majority of dairies are located east of I-5. Most of the dairies are small by the standards of current dairy development, but six operations have more than 1,000 milking cows each. The figure also shows the location of the two manufacturing milk processing plants in the county—Land 'O Lakes, Inc. on County Road C northwest of Artois and Sierra Nevada Cheese Co. on County Road 39 north of Willows at Blue Gum—and the Rumiano Cheese Company packaging plant on County Road E northeast of Willows.

I.8 EXISTING CONFINED ANIMAL FACILITIES POLICIES AND STANDARDS

The *Glenn County General Plan*, which was adopted in 1993, established performance standards for dairies (Section 6.2). The standards were later incorporated into the Glenn County Zoning Code under "Performance Standards for Livestock Operations" under section 19.23.90:



Source: Quad Knopf Inc., 2004.

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Figure 1-1

VICINITY MAP

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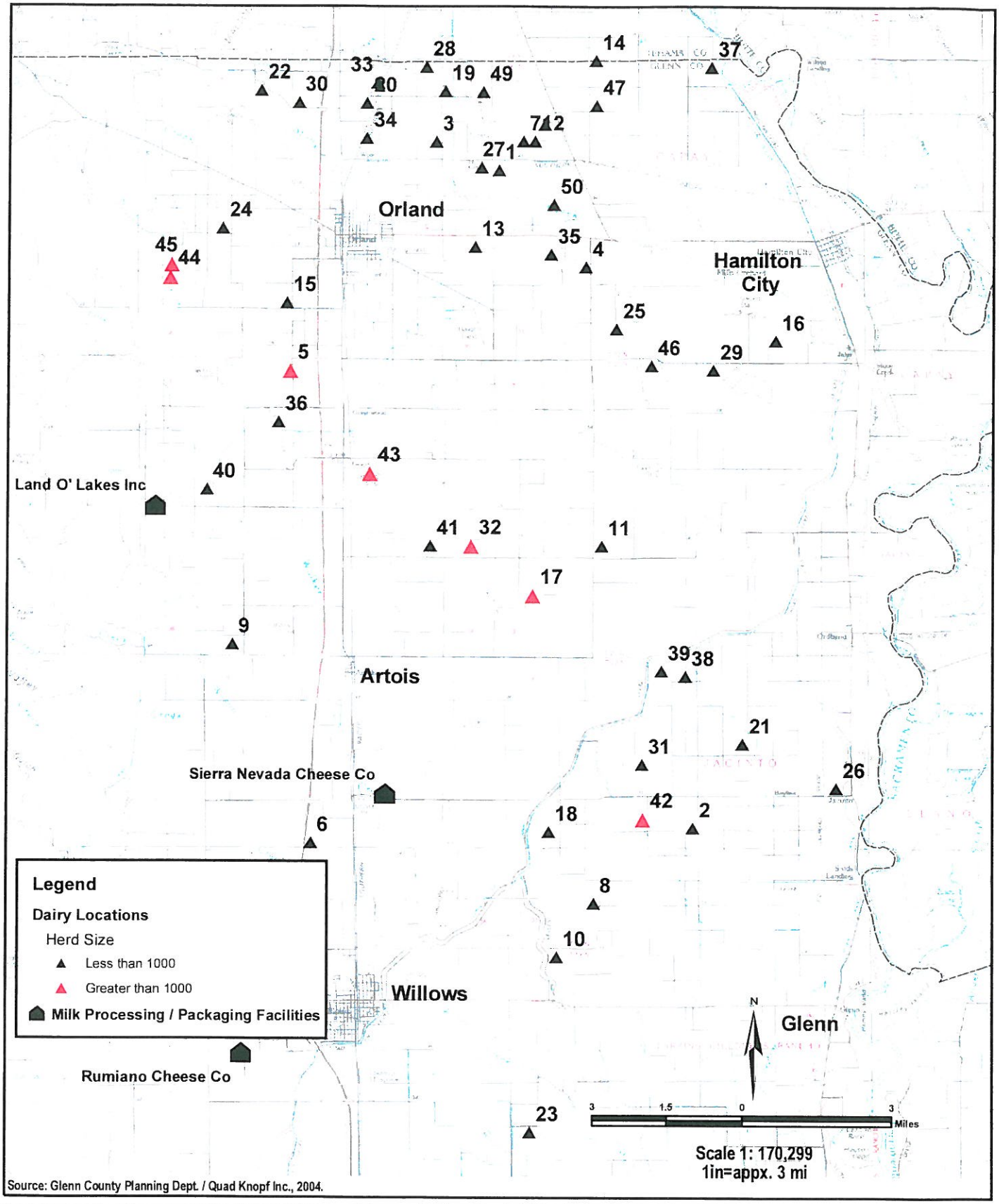

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Figure 1-2

DAIRY LOCATIONS

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A. Notwithstanding any other provision of the County Code new construction for a livestock operation shall meet the following minimum setbacks from all county road and/or state highway rights-of-way:

   1. Milk barns: 45 feet from edge of right-of-way.

   2. Holding pens, housing barns, manure ponds and animal confinement areas: one hundred feet from edge of right-of-way.

B. Confined animal and manure handling facilities for livestock operations shall be located at least five hundred feet from any residential zoning district and five hundred feet from any school or high occupancy structures on neighboring parcels in any zoning district.

C. The use, storage, and disposal of hazardous materials shall meet all county, state, and federal regulations.

D. An encroachment permit shall be required from the Glenn County Public Works Department prior to any work in a county road right-of-way. An encroachment permit shall be required from Caltrans prior to any work in a state highway right-of-way.

E. The construction and operation of a livestock operation shall conform to all applicable state and county codes including but not limited to the following:

   1. A building permit shall be secured from the Glenn County Building Department prior to any construction at the site.

   2. The Glenn County Health Department shall approve the location and design of all wells and on-site sewage disposal systems.

   3. A land leveling permit shall be applied for and received from the Glenn County Public Works Department prior to the grading of any land, where the grading exceeds five (5) acres in size and will result in cuts or fills of greater than two (2) feet, a redirection of runoff from the site onto a county road or a change in the entrance or exit of runoff from the parcel. A grading and drainage plan shall accompany all land leveling permit applications and any inquiries as to the applicability of this section to the proposed project.

F. All trash, discarded materials, animal remains shall be screened from adjacent properties and county and/or state rights-of-way and shall be disposed of according to the applicable codes.

G. Disposal of manure shall meet State of California Central Valley Regional Water Quality Control Board Standards. Verification of submission of an

application for a waste discharge permit is required; final State approval of plans will be a condition for issuance of a building permit.

H. Best management practices shall be applied to the animal confinement, manure ponds, holding and animal housing pens to prevent a nuisance caused by fly and/or mosquito breeding, dust and/or odors.

I. Farm labor quarters consisting of one mobile home or residence meeting the requirements of Section 19.66 of the Glenn County code shall be permitted upon first securing an administrative permit.

J. Farm labor camps (consisting of mobile homes and/or conventional homes) shall be permitted upon first securing a conditional use permit in the "FA" (Foothill Agriculture). "AP" (Agricultural Preserve), and "AE" (Exclusive Agricultural) zoning districts. Mobile home parks and farm labor camps consisting of mobile homes shall also meet requirements of the State Department of Housing and Community Development Division of Codes and Standards.

K. A conditional use permit shall be required for dairies that exceed one (1) cow per 20,000 square feet of area in the "RE" (Rural Residential Estate) zoning district. Dairies in the "RE" district exceeding 30 cows shall be required to obtain a conditional use permit.

L. Reactivation of existing livestock operation or dairy facilities shall be permitted in accordance with these performance standards.

M. Prior to the issuance of a building permit for a new livestock operation or dairy, the applicant shall enter into an agreement with the County of Glenn to improve the existing county maintained road from the main entrance of the livestock operation or dairy to the nearest county road having a paved surface at least 24 feet wide, in accordance with Standard Drawing No. RS-6, except that a double chip seal shall be allowed instead of asphalt concrete. The maximum length of roadway improved as a result of this paragraph shall not exceed one (1) mile. The cost of any improvements required as a result of this paragraph shall be borne equally by both the dairy and the County. The Public Works Director may grant a waiver to the requirements of this paragraph upon receiving a written request from the applicant.

N. Livestock operations or dairies shall conform to all applicable County, State and Federal codes and requirements including but not limited to Chapter 20.08 of the Glenn County Code, Water Well Drilling Permits and Standards, and the State of California Central Valley Regional Water Quality control Board. (Ord. 1150 § 3, 2002; Ord. 1142 § 1, 2001; Ord. 994 § 1, 1991.)

Conditional Use Permit

In 2002, the Glenn County Board of Supervisors adopted Ordinance No. 1150 amending Title 19 (Zoning) of the Glenn County Code to require a conditional use permit for confined animal facilities. The ordinance added the following definition to Glenn County Code Section 19.040.020 Definitions:

> "Confined animal facilities" are cattle, calves, horses, sheep, goats, swine, rabbits, or large fowl, corralled, penned, or otherwise caused to remain in restricted areas for agricultural-commercial purposes where feeding is other than grazing for more than 45 days during the year. Range pastures for livestock beef cattle are exempt from the definition of confined animal facilities. School projects, 4-H, fairs and other individual educational projects are exempt from the definition of confined animal facilities.

Section 3 of Ordinance No. 1150 also added the following performance standard to the code by amending Section 19.23.190 with the following:

> B. Confined animal and manure handling facilities for livestock operations shall be located at least five hundred feet from any residential zoning district and five hundred feet from any school or high occupancy structures on neighboring parcels in any zoning district.

Section 4 of Ordinance No. 1150 amended four agricultural zones to include confined animal facilities as "Uses Permitted with a Conditional Use Permit," including:

- Section 19.32.030 N. - "FA" (Foothill Agricultural/Forestry)
- Section 19.34.030 H. - "AP" (Agriculture Preserve)
- Section 19.35.030 E. - "FS" (Farmland Security)
- Section 19.36.040 X. - "AE" (Agricultural Exclusive)

Current conditional use permit procedures require applicants to fill out an "Environmental Information Form" that requires submittal of information on topography, soil stability, plants and animals, any cultural/historical or scenic aspects, a description of existing structures on the site and their uses, and site photographs. Other requirements include:

- A statement and tests explaining percolation rates, soil types, and suitability for any onsite sewage disposal systems which may be required.

- A description of surrounding properties including information on plants; cultural, historical, or scenic aspects, types and intensity of land use, and photographs of the vicinity.

The balance of this Confined Animal Facilities Element consists of Chapter Two, Environmental and Regulatory Setting, Chapter Three, Analysis of Opportunities and Constraints, and Chapter Four, Goals, Policies and Development Standards.

Chapter Two

Environmental & Regulatory Setting

CHAPTER TWO
ENVIRONMENTAL AND REGULATORY SETTING

The function of the Environmental and Regulatory Setting Chapter is to assist in the formulation of the Confined Animal Facilities Element of the *Glenn County General Plan.* It also serves to inform discussion of various environmental impacts discussed in the Programmatic Environmental Impact Report covering the Confined Animal Facilities Element.

The chapter focuses on the agricultural and planning context in which the location of CAFs in Glenn County is taking place. It also provides the background for the environmental issues that are most relevant in the operation of such facilities.

2.1 AGRICULTURE/SOILS

Two-thirds of Glenn County's 1,317 square miles, approximately 790,000 acres, are comprised of agricultural croplands and pasture. The prime agricultural soils, which are the most valuable to the county, are concentrated in the eastern third of the county with scattered, more isolated tracts in the central portion of the county. (See Figure 2-1, Prime Farmland).

As the most extensive land use in Glenn County, agriculture constitutes a significant component of the county's economy. Agriculture is the county's largest private industry, with gross production of agricultural commodities valued at over $303 million in 2002 (2002 Annual Crop and Livestock Report). Rice and almonds are the top two commodities in terms of production value, followed by dairy products, cattle and calves, hay and alfalfa, walnuts, corn, olives, prunes, and grapes (see Table 2.1-1). Agriculture was also the second largest employer (behind government), with 1,400 employees in 2002 (County Snapshots, Labor Market Information Division of the California Employment Development Department).

Table 2.1-1
Glenn County's Ten Leading Agricultural Commodities

Commodity	2002 Value
Rice	$97,829,000
Almonds	$46,728,000
Dairy Products	$38,477,000
Cattle and Calves	$15,099,000
Hay and Alfalfa	$13,309,000
Walnuts	$12,607,000
Corn	$11,517,000
Olives	$11,339,000
Prunes	$10,040,000
Grapes	$5,488,000

Source: 2002 Annual Crop and Livestock Report

Agricultural Land Preservation

Glenn County's farm economy requires prime agricultural land, an important soil resource, the conversion of which constitutes an irreversible loss. The conversion of prime agricultural lands typically leads to the conversion of less productive soils to farmland in an attempt to compensate for the loss of more productive soils. In addition, the conversion of agricultural land to other uses can lead to the loss of resources such as wetlands and other special habitat. Agricultural land also provides open space, which has both psychological and aesthetic benefits, and provides important wildlife habitat. (See Table 2.1-2)

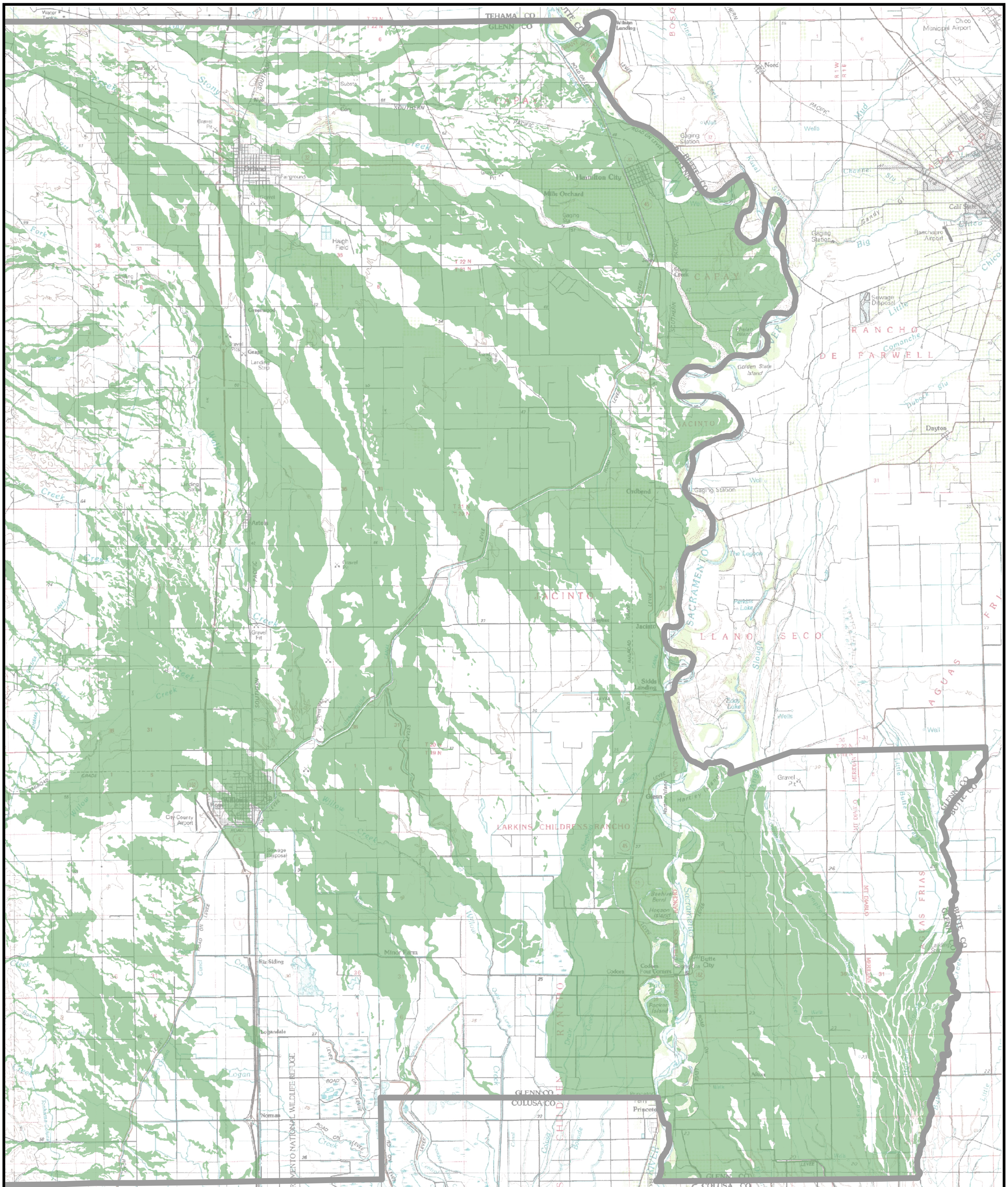
Table 2.I-2
Agricultural Lands in Glenn County – 2000

Land Use Category	Acres
Prime Farmland	166,549
Farmland of Statewide Importance	87,784
Unique Farmland	11,605
Farmland of Local Importance	141,965
Grazing Land	176,071
Urban Built-Up Land	5,609
Other Lands	253,785
Water Area	5,759
Total	849,127

Source: California Department of Conservation, Farmland Mapping and Monitoring Program

Prime farmland has the best combination of physical and chemical characteristics for crop production. Farmland of statewide importance is not as productive as prime soil, though it still has supported crop production for at least the three preceding years. Unique farmland ranks below prime and statewide important farmlands, though it is still capable of producing "high economic value crops" such as olives, avocados, or grapes. Finally, farmland of local importance ranks below the other three, yet "may be important to the local economy due to its productivity" (Department of Conservation, Important Farmland Map Categories).

The U.S. Department of Agriculture, National Resources Conservation Service (NRCS) conducts soil surveys for each county. The last NRCS survey for Glenn County was in 1968. The survey listed soil candidates by soil type for both Prime Farmland and Farmland of Statewide Importance. Table 2.1-3 lists the general soil types in each category.



Source: Glenn County Planning Dept. / Quad Knopf Inc., 2004.

Table 2.I-3
General Soil Types in Glenn County Listed as Candidates for Prime Farmland and Farmland of Statewide Importance

Prime Farmland Soils	Farmland of Statewide Importance Soils
Arbuckle gravelly loams	Altamont clays
Capay clays	Artoi loams
Clear Lake clay	Ayar clay
Columbia sandy loams	Burris clay
Columbia loamy sands	Castro clays
Columbia silt loams	Columbia loams
Jacinto sandy loams	Cortina loam
Landlow clay loam	Hillgate loams
Marvin silty clays	Kimball laoms
Marvin silty clay loams	Landlow clay
Myers clays	Marvin silty clay and clay loams
Myers clay loams	Maywood loam
Orland loams	Nacimiento clay
Perkins gravelly loam	Nacimiento-Contra Cost association
Plaza silt loams	Orland loams
Pleasanton gravelly loams	Orland-Cortina complex
Porterville clays	Perkins gravelly loam
Sacramento clay	Plaza silt loams
Stockton clay	Riz loams
Tehama loams	Sehorn soils
Wyo loams	Stockton clay
Yolo clay loams	Sunnyvale clays
Zamora silty clay and clay loams	Tehama loam and clay loam
	Willows clays
	Wyo loams
	Yolo clay loams
	Zamora silty clay and clay loams

Source: U.S. Department of Agriculture, Natural Resources Conservation Service, Soil Survey of Glenn County, 1968

Approximately 400,000 acres or slightly more than half of Glenn County's farmland is governed by either of two types of contracts, Williamson Act or Farmland Security Zone, that are designed to be an incentive to farmers to keep highly productive cropland in production and slow the conversion of such land to urban uses. Table 2.1-4 shows the acreage under each contract. Figure 2-2, Agricultural and Farmland Security Zones shows the location of farmland under contract.

Table 2.I-4
County of Glenn Farmland Under Williamson or FMZ Contracts – Fiscal Year 2002-2003

Contract	Type	Acreage Under Contract
Williamson Act	Prime	58,914
	Non-Prime	266,233
Farmland Security Zone	Urban Prime	9,573
	Urban Non-Prime	1,260
	Non-Urban Prime	62,268
	Non-Urban Non-Prime	2,268

Source: Glenn County Assessor's Office

Williamson Act. The California Land Conservation Act of 1965, or Williamson Act, authorizes the county to establish agricultural preserves. The objectives of the Glenn County Agricultural Preserve Program (Zoning Code 19.34.010) are to:

- Preserve the maximum amount of the limited supply of agricultural land which is necessary in the conservation of the county's economic resources and vital for a healthy agricultural economy of the county

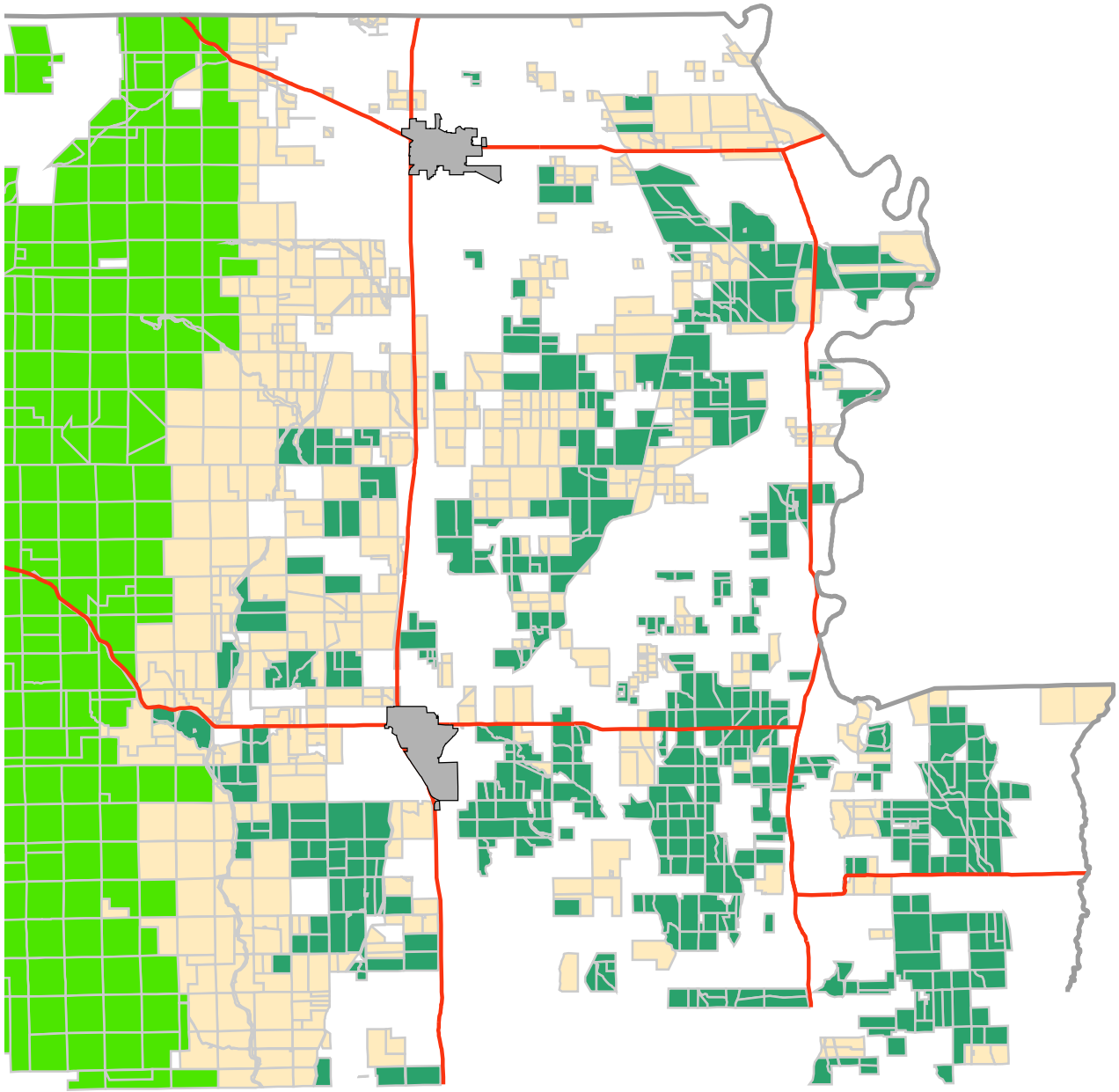
- Protect the general welfare of the agricultural community for encroachments of unrelated agricultural uses which, by their nature, would be injurious to the physical and economic well-being of the agricultural community.

To nonrenew the Williamson Act Contract the applicant must file a Notice of Nonrenewal with the Planning Department. This Notice will be recorded. After ten years the land will be out of the Williamson Act Contract. The taxes will be gradually increased during the ten year period.

To Cancel a Williamson Act Contract the applicant must pay a fee to the State and have the Cancellation approved by the Board of Supervisors with the findings required by the State Law. This would require a proposed plan for alternative use of the land and an Environmental Impact Report.

Uses and structures permitted in the Agricultural Preserve (AP) zones are listed in Appendix A. Uses in allowed AP zones with a conditional use permit are also listed in Appendix A.

Farmland Security Zones. California's Williamson Act program was significantly strengthened by the enactment of Farmland Security Zone (FSZ) legislation during the 1998 legislative session. A farmland security zone is an area created within an agricultural preserve by a board of supervisors upon request by a landowner or group of landowners. Agricultural preserves must generally be at least 100 acres in size. Farmland security zones offer landowners greater property tax reduction than Williamson Act contracts. Land restricted by a farmland security zone contract is valued for property assessment purposes at 65% of its Williamson Act valuation, or 65% of its Proposition 13 valuation, whichever is lower. However, the minimal initial term for farmland security zone contracts is 20 years. Like a Williamson Act contract, farmland



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security zone contracts self-renew annually, thus unless either party files a "notice of nonrenewal" the contract is automatically renewed each year for an additional year.

Only parcels designated on the Important Farmland Series Maps as prime farmland; farmland of statewide significance; unique farmland, or, farmland of local importance are eligible for FSZ designation. If the land is not designated on the Important Farmland Series maps, it will qualify if it is predominantly prime farmland as defined in the Williamson Act.

Glenn County administers farmland security zone contracts under zoning code 19.35.010 for the following purposes:

- To preserve the maximum amount of the limited supply of agricultural land which is vital for the healthy agricultural economy of the County;

- To protect the general welfare of the agricultural community from encroachments of unrelated agricultural uses which, by their nature, would be injurious to the physical and economic well-being of the agricultural community; and

- To provide a unique zoning district for the Farmland Security (FS) Zone to meet the requirements of the State Law and the landowners under Farmland Security Zone Contracts.

To nonrenew the Farmland Security Zone Contract the applicant must file a Notice of Nonrenewal with the Planning Department. This Notice will be recorded. After twenty years the land will be out of the Farmland Security Zone Contract. The taxes will be gradually increased during the twenty year period.

To Cancel a Farmland Security Zone Contract the applicant must pay a fee to the State and have the Cancellation approved by the Board of Supervisors with the findings required by the State Law. This would require a proposed plan for alternative use of the land and an Environmental Impact Report.

General Plan Policies

The *Glenn County General Plan* also addresses the issue of agriculture and soils preservation. The Natural Resources Element designates the distribution, location and extent of the uses of land for open space, which includes agriculture and natural resources. Appendix B lists the General Plan policies that address agriculture and natural resource lands. Appendix B also lists the implementation strategies, programs and priorities pertaining to these policies.

2.2 LAND USE AND PLANNING

Glenn County is typified by steeper terrain in the western portion of the county trending down to relatively flat features along its eastern boundary. Two major geologic provinces exist within the county and have a major influence on the county's topography. They are the Sacramento Valley, which generally characterizes the eastern third of the county and the Coast Range, which dominates the western two-thirds (Figure 2-3, Topographic Map).

The predominant land uses in Glenn County are agriculture, forests, and open space/grazing lands. Land used for farming and grazing purposes totals nearly 500,000 acres, of which approximately half is grazing land in the foothill areas, and half is farming, mostly on the Valley floor. The mountainous area is primarily forested land, including approximately 200,000 acres within the Mendocino National Forest.

Generalized land use for Glenn County is depicted in Figure 2-4. Detailed land use maps for northern and southern Glenn County are depicted in Figures 2-5 and 2-6.

The two incorporated cities in Glenn County, Willows and Orland, are located on the Valley floor along Interstate 5 (I-5). These cities represent the two largest urbanized areas in the county. Unincorporated communities include Bayliss, Glenn, Ord Bend, Capay, Codora Four Corners, Artois, Hamilton City, Butte City, North Willows, and West Orland.

According to the adopted *Glenn County General Plan*, new development may also occur in six development nodes that have been identified along I-5 at the following interchanges: Road 7, Road 39, Road 27, Road 57, Road 33, Road 68. Specific land use designations have not been assigned to these interchanges; rather, they are shown in the General Plan as generalized areas for development. Before actual development may occur, development proposals are to be evaluated on their merit in compliance with policies and standards established in the General Plan.

Other areas where urban development may take place are local service centers—small rural communities that have developed with residential and commercial uses, and function as service centers to surrounding farms and rural areas. Local service centers provide a limited range of goods and services locally and provide housing for persons who are employed on local farms and in agriculturally-related activities. Community sewer and water services do not exist in these communities, and no plans exist to develop these services. Under the current General Plan, no peripheral expansion is permitted to occur in these areas; only infill development is to be allowed after case-by-case evaluation. These local service centers include the unincorporated communities of:

- Bayliss
- Blue Gum
- Codora Four Corners
- Glenn Ord Bend
- Elk Creek

Orland

Willows

4 2 0 4 Miles

Scale 1:253,440
1in = 4mi

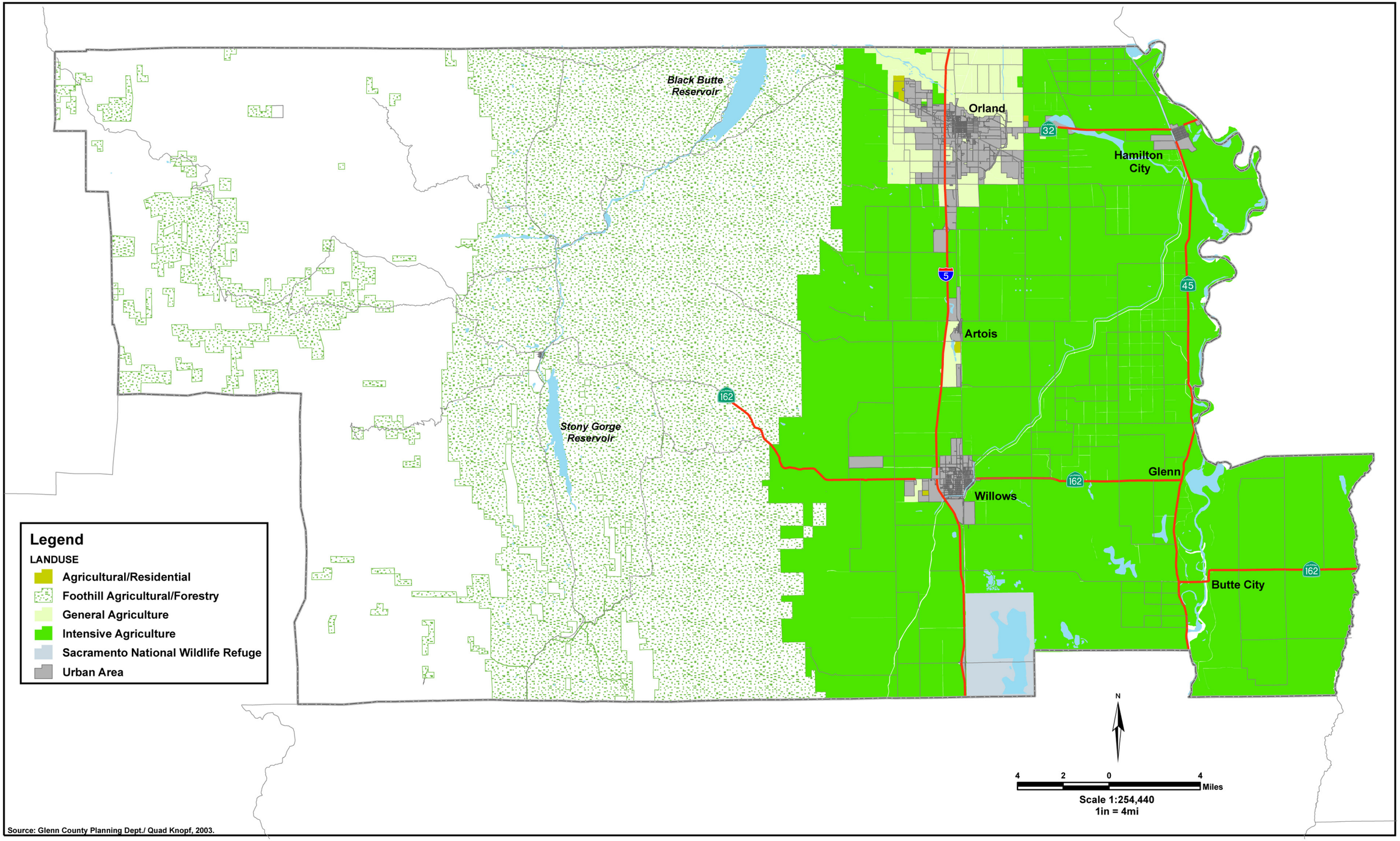
Source: MSN TerraServer, 16m DRG/ Quad Knopf Inc., 2004

Quad Knopf

Figure 2-3

TOPOGRAPHIC MAP

Job No.: 03157



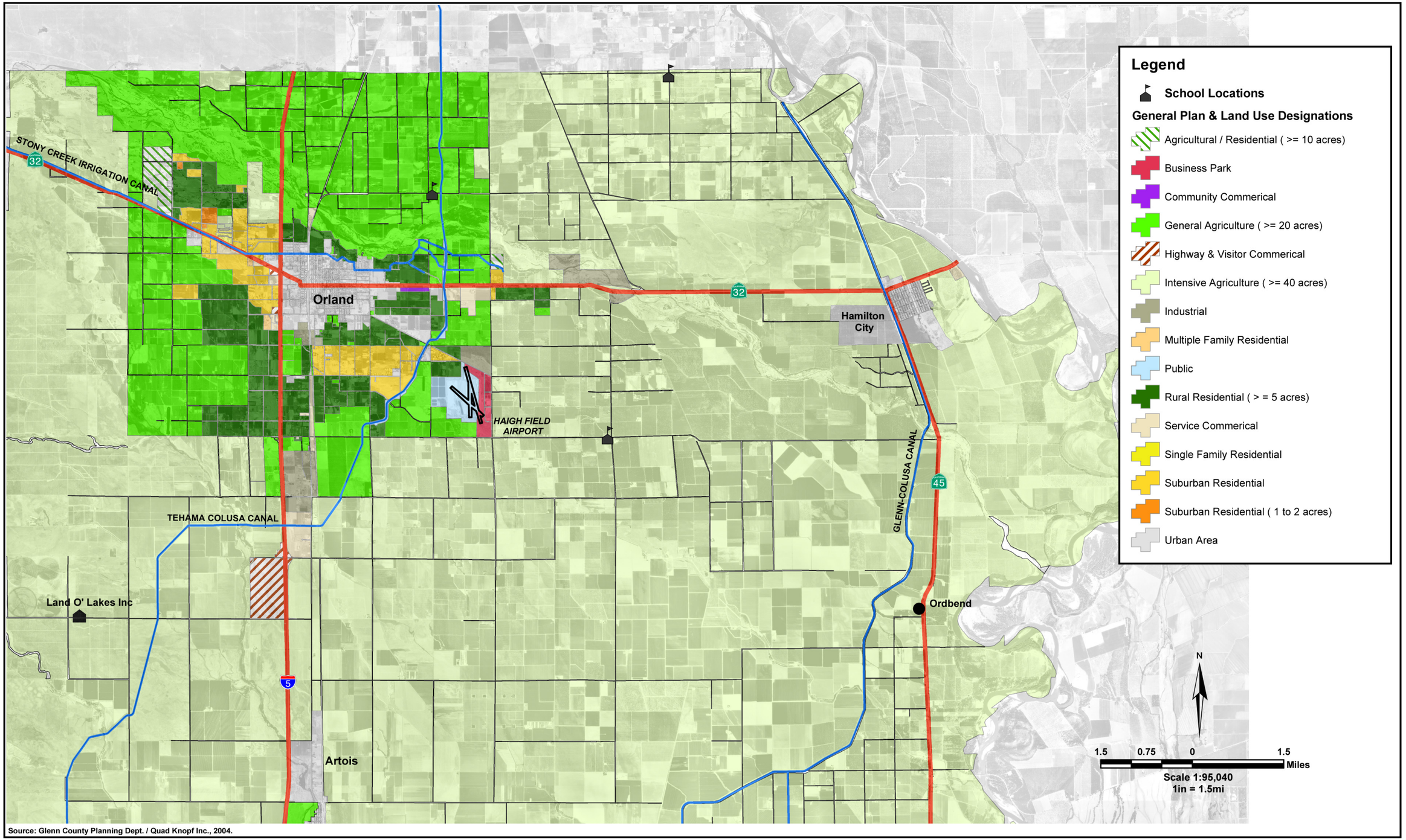
Source: Glenn County Planning Dept./ Quad Knopf, 2003.

Quad Knopf

Figure 2-4

GENERALIZED LAND USE MAP

Job No.: 03157



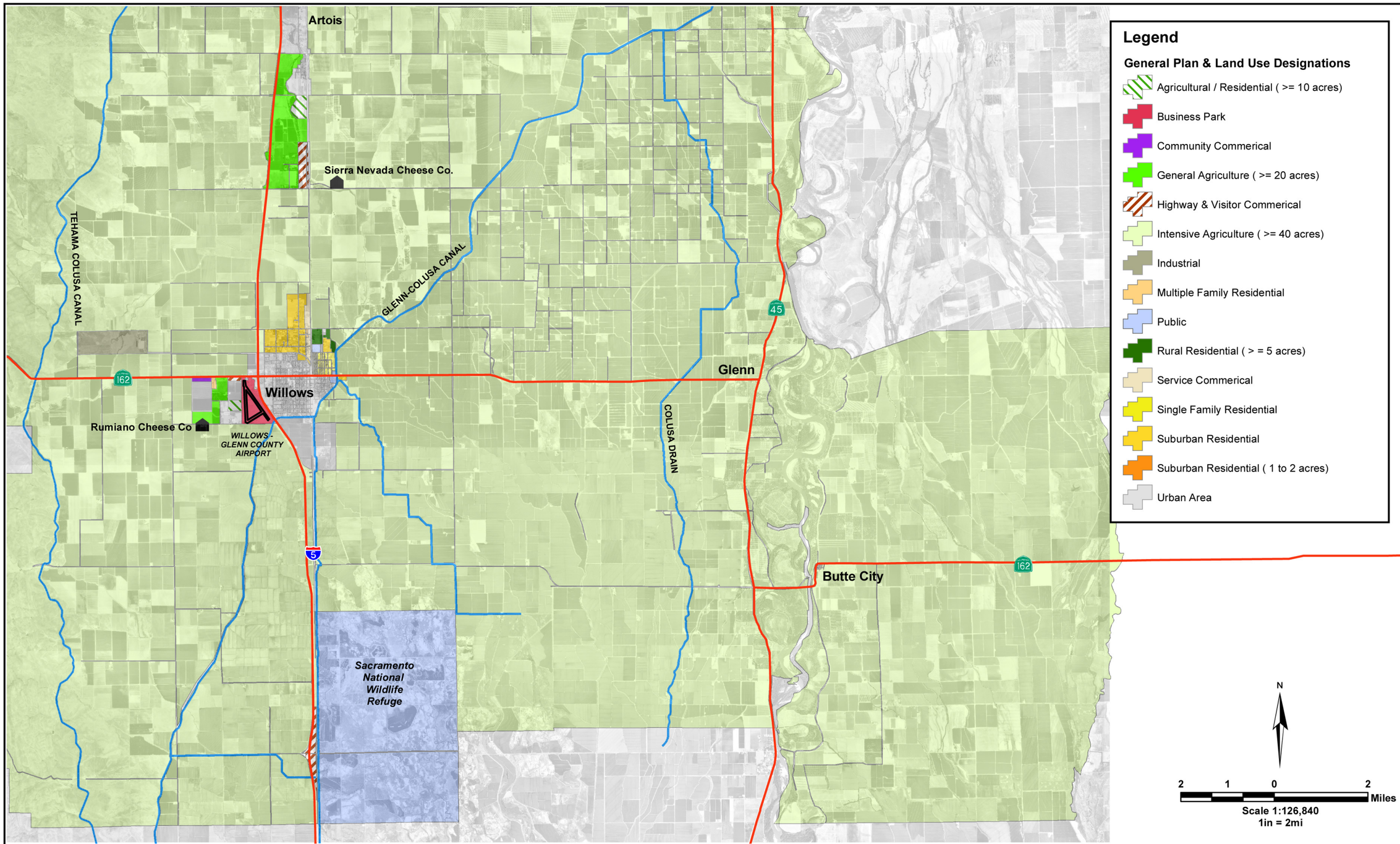
Source: Glenn County Planning Dept. / Quad Knopf Inc., 2004.

Quad Knopf

Figure 2-5

LAND USE DESIGNATIONS (NORTH)

Job No.: 03157



Source: Glenn County Planning Dept. / Quad Knopf Inc., 2004.

Quad Knopf

Figure 2-6

LAND USE DESIGNATIONS (SOUTH)

Job No.: 03157

Finally, the possibility exists that Glenn County could see development in so-called antiquated subdivisions, which are defined in the General Plan as subdivisions of more than four parcels that meet the following conditions (see Figure 2-7):

- located in an unincorporated area of the county (outside any urban limit line);
- created prior to the enactment of a local subdivision ordinance and the 1970 California Environmental Quality Act (CEQA);
- currently undeveloped (used for agriculture or open space purposes);
- zoned "FA' (Foothill Agricultural/Forestry), "AP" (Agricultural Preserve), or "AE" (Exclusive Agricultural); and
- contains less than the minimum acreage specified in the applicable zone.

Right-to-Farm Ordinance

Glenn County has adopted an ordinance (Ord. 943 § 1 (part), 1989) designed to reduce conflicts between property owners in agricultural zones who choose to exercise their rights to build residential structures and owners who are primarily engaged in agricultural operations. The ordinance was integrated into the Zoning Code under Section 21.060. The ordinance requires disclosure to buyers of property adjacent to property being used for agricultural operations that such operations will not be considered by the County to be a nuisance if they had not been determined to be a nuisance when those operations began. Details of Section 21.060 can be found in Appendix A.

General Plan Policies

The intent of the county is to direct development away from valuable agricultural lands into urban areas which can accommodate growth and provide adequate public services, including community sewer and water, police and fire protection. To accomplish this, urban limit lines were adopted as part of the General Plan around the cities of Orland and Willows, the unincorporated communities of Hamilton City, Artois, Elk Creek and Butte City. These lines represent those areas where growth can be accommodated because full urban services and infrastructure sufficient to serve development is either available now or can be made available. However, the County has not adopted an ordinance implementing urban limit lines.

It is the intent of the county to promote orderly growth by directing new growth into areas where it can be accommodated and served adequately, and to avoid potential land use conflicts through the appropriate distribution and regulation of land uses. Only compatible uses will be encouraged in agricultural areas; compatible uses are defined as those uses capable of existing together without conflict or ill effect. The General Plan contains a number of policies designed to help preserve agricultural land by preventing urban-rural conflicts. Appendix B lists these policies along with the implementation strategies, programs and priorities that address them.

2.3 HYDROLOGY AND WATER QUALITY

SETTING

Introduction

The hydrology setting of the Valley portions of Glenn County (the easterly third) is relatively complex. The soils on which confined animal facilities (mostly dairies) are located vary widely, as do groundwater levels. There is also potential for impact on surface waters in some areas. It will be critical in implementation of the Confined Animal Facilities Element of the General Plan that design criteria for individual projects reflect the limitations and opportunities of project locations with respect to that hydrologic complexity.

In order to provide relevance to hydrology data the approximate locations of existing dairies (see Figure 1-2) are shown as overlays on figures in this subsection.

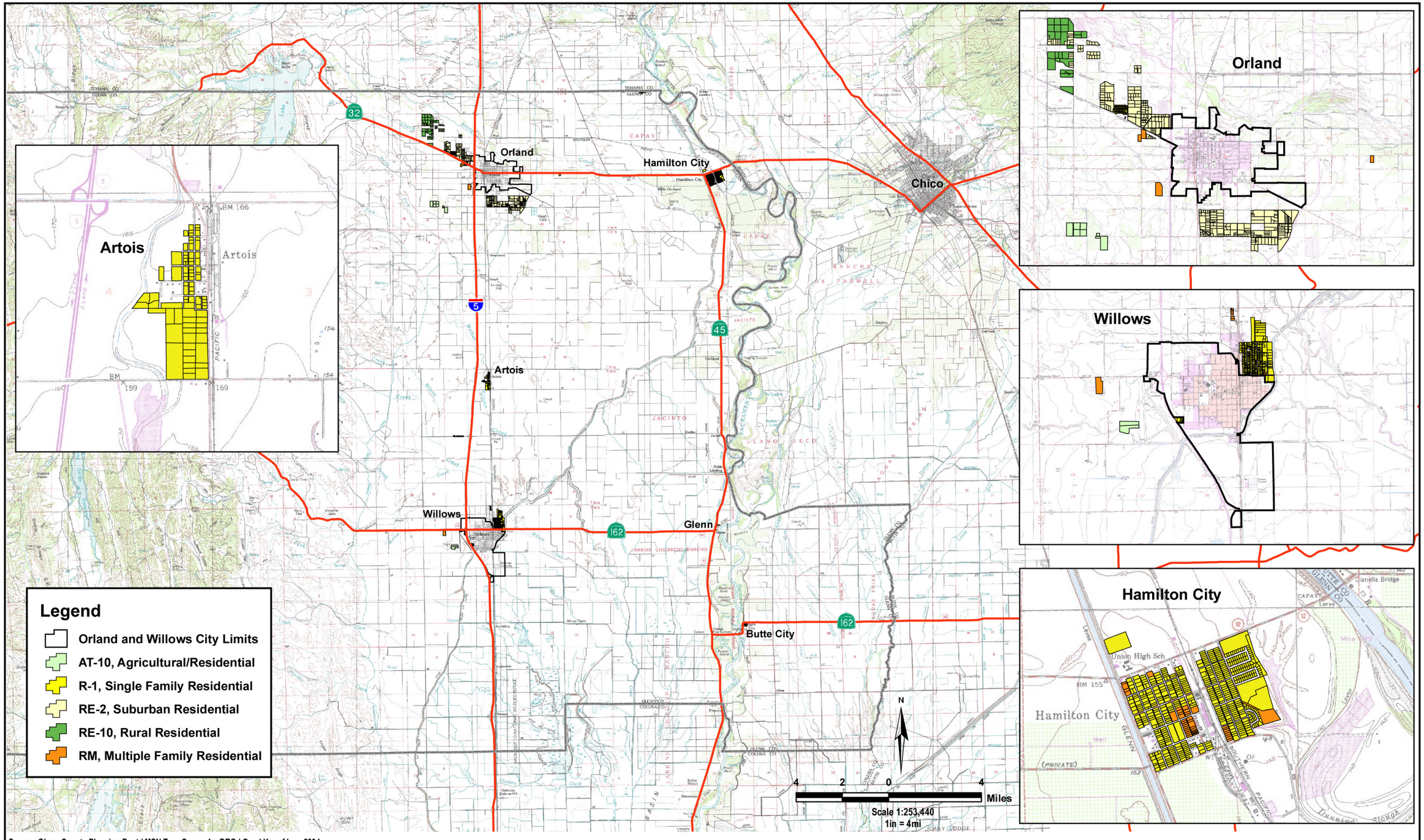
Regulatory

The primary regulatory agency with jurisdiction over confined animal facility construction and operation with respect to water quality issues in the Sacramento Valley is the California Regional Water Quality Control Board, Central Valley Region. This Board, and its staff, regulate confined animal impacts on groundwater and surface waters based on a number of policy documents and regulatory criteria: *the Water Quality Control Plan* (Basin Plan) for the Sacramento River and San Joaquin River Basins, the Statewide Water Quality Regulations for Confined Animal Facilities (from Title 27, Division 2 Subdivision 1, California Code of Regulations), the National Pollutant Discharge Elimination System (NPDES) permitting criteria and the Concentrated Animal Feeding Operation (CAFO) rules recently adopted by USEPA. Each new dairy must obtain from the Regional Board a waiver, waste discharge requirements or an NPDES permit.

The Regional Board has adopted the position that it cannot issue confined animal facility permits without the prior certification of a site-specific Environmental Impact Report, which it may then, as a 'responsible agency', utilize as a basis for the required permitting action. Previously, confined animal facility construction in Glenn County was authorized on a by-right basis as a permitted use within the appropriate zones conditioned only upon compliance with zoning ordinance provisions.

It is the intent of the Confined Animal Facilities Element, and of its implementing zoning ordinance, to provide additional guarantees against groundwater or surface water degradation. The program EIR will, in evaluation of the hydrologic/water quality impacts of the Element, provide an environmental analysis base which will reduce the necessary scope and cost of Regional Board required site-specific impact analyses for individual confined animal facilities.

The County of Glenn, although not a water quality regulatory agency, has adopted a Groundwater Management Ordinance (Section 20.03 of the County Code) and has initiated with its Water Advisory Committee basin management objectives for groundwater surface elevations.



Source: Glenn County Planning Dept./ MSN TerraServer 4m DRG / Quad Knopf Inc., 2004

Quad Knopf

Figure 2-7

ANTIQUATED SUBDIVISIONS

Job No.: 03157

The Valley-area water districts, which are participants in this program, are shown on Figure 2-8, Irrigation Districts within Eastern Glenn County. These districts, while not directly involved in the regulation of confined animal facility construction and operation, have a significant trustee role under the California Environmental Quality Act (CEQA) in commenting upon, and making water quality recommendations regarding site-specific dairy environmental analysis.

Atmospheric Factors

Rainfall in the eastern third, Valley, portion of the county averages approximately 18 to 21 inches per year with evaporation occurring at approximately 40 inches per year. The anticipated rainfall from a twenty-five year, 24-hour, storm which is customarily utilized as a basis for dairy lagoon size (runoff-capacity) calculations is approximately four inches of rainfall.

Soils

Figure 2-9 illustrates the locations of the soil series in the eastern one-third (the Valley portion of the county): Willows-Zamorra-Marvin, Columbia-Vina-Reiff, Columbia-Shanghai-Nueva, Tehama-Hillgate-Arbuckle, Los Robles-Cortina-Riverwash, Ayar-Cibo-Altament, Clear Lake-Capay-Stockton, Clear Lake-Landlow-Stockton, Newville-Dibble-Corning.

The soil types on which dairies and other confined animal facilities are and will be located in the county are critical in the analysis of potential groundwater impacts resulting from confined animal facility operations. Pond lining, soils availability, dry corral infiltration effects, and groundwater impacts from cropping fertilized with manure water and dry manure are affected by soil type dairy locations.

Table 2.3-1 lists those soil series appropriate for confined animal facilities operations in terms of their suitability. Willows-Zamorra-Marvin, Columbia-Vina-Reiff, Tehama-Hillgate-Arbuckle are generally suitable, depending on local water table and drainage conditions. Los Robles-Cortina-Riverwash soil series, which lie along the Sacramento River, require greater care in siting and facilities design to avoid impacts on groundwater and surface water.

Table 2.3-I
Suitability of Glenn County Soils for Confined Animal Facilities Operations

Soil Suitability Conditions for Confined Animal Facilities	Soil Series
Soil(s) that may be suitable, depending upon water tables and drainage	Willows-Zamorra-Marvin, Columbia-Vina-Reiff, Tehama-Hillgate-Arbuckle
Soil(s) that may require site-specific facilities and siting care	Los Robles-Cortina-Riverwash

Source: Quad-Knopf, Inc.

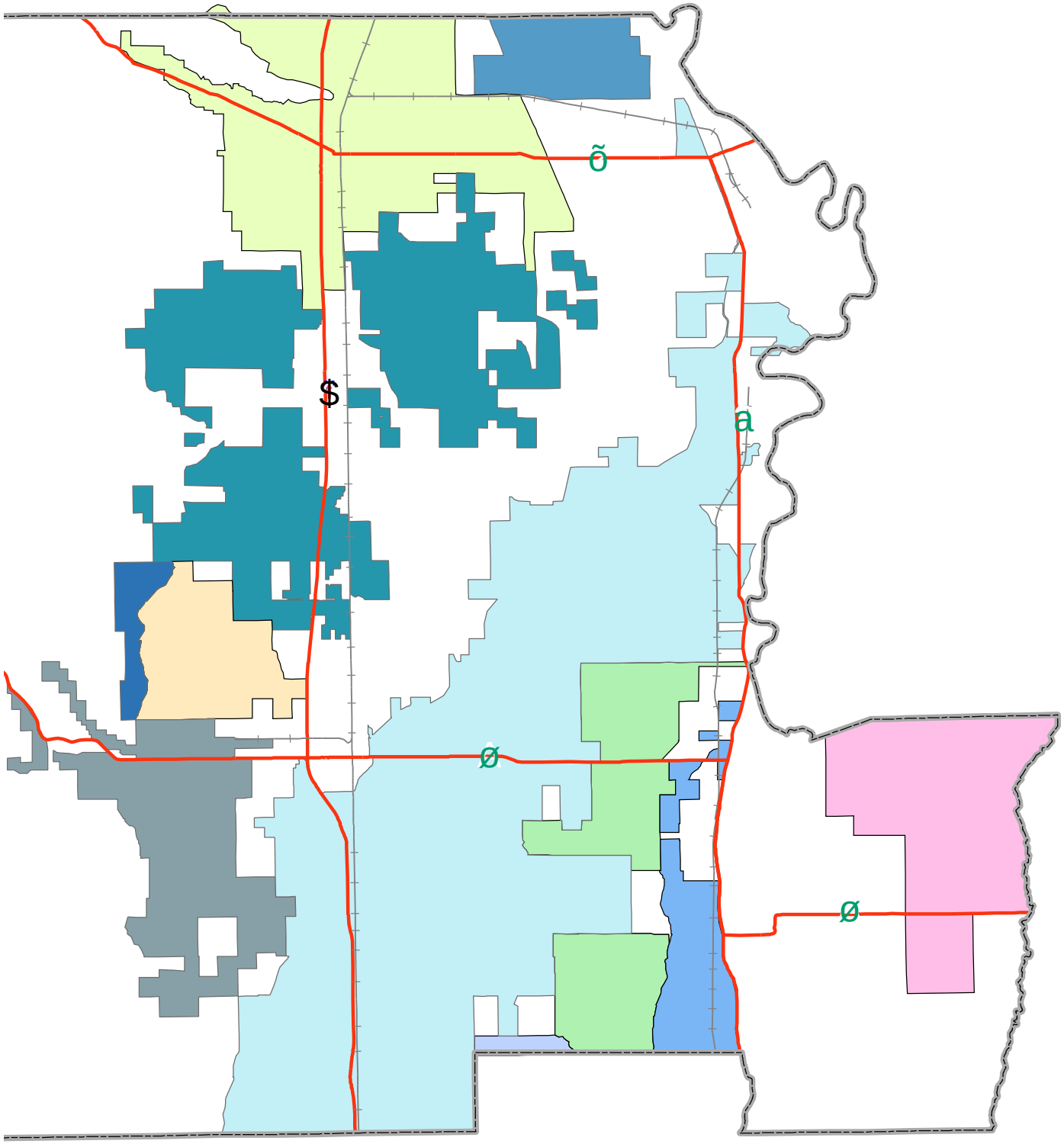
Groundwater

From a hydrologic standpoint, data on the county's groundwater is, although vital for environmental analysis, somewhat limited both as to groundwater elevations and groundwater quality. The eastern portion of Glenn County overlies the 5,000 square mile Sacramento Valley Groundwater Basin, which extends from Red Bluff south to the Sacramento-San Joaquin Delta, to the North Coast Range on the west, and east to the Sierra Nevada and Cascade Ranges. Figure 2-10 shows the groundwater basins for eastern Glenn County. A thick sequence of sedimentary materials underlying the valley floor contains fresh groundwater to a depth of about 400 feet near Orland in the northern portion of the county, and 800 to 1,200 feet in the Colusa Basin south of Willows (DWR, *Bulletin 118-6, Evaluation Of Ground Water Resources: Sacramento Valley*, August, 1978, Figure 18). An average well yields about 800 gallons per minute. Groundwater pumping for irrigation occurs primarily in the area south and east of Orland and north of Willows. The greatest amount of natural recharge in the valley occurs in the Stony Creek area. Groundwater levels lowered as a result of low rainfall during the late 1980s, but have since rebounded. The State Department of Water Resources monitors groundwater levels, including semi-annual measurements of in excess of 80 wells in Glenn County.

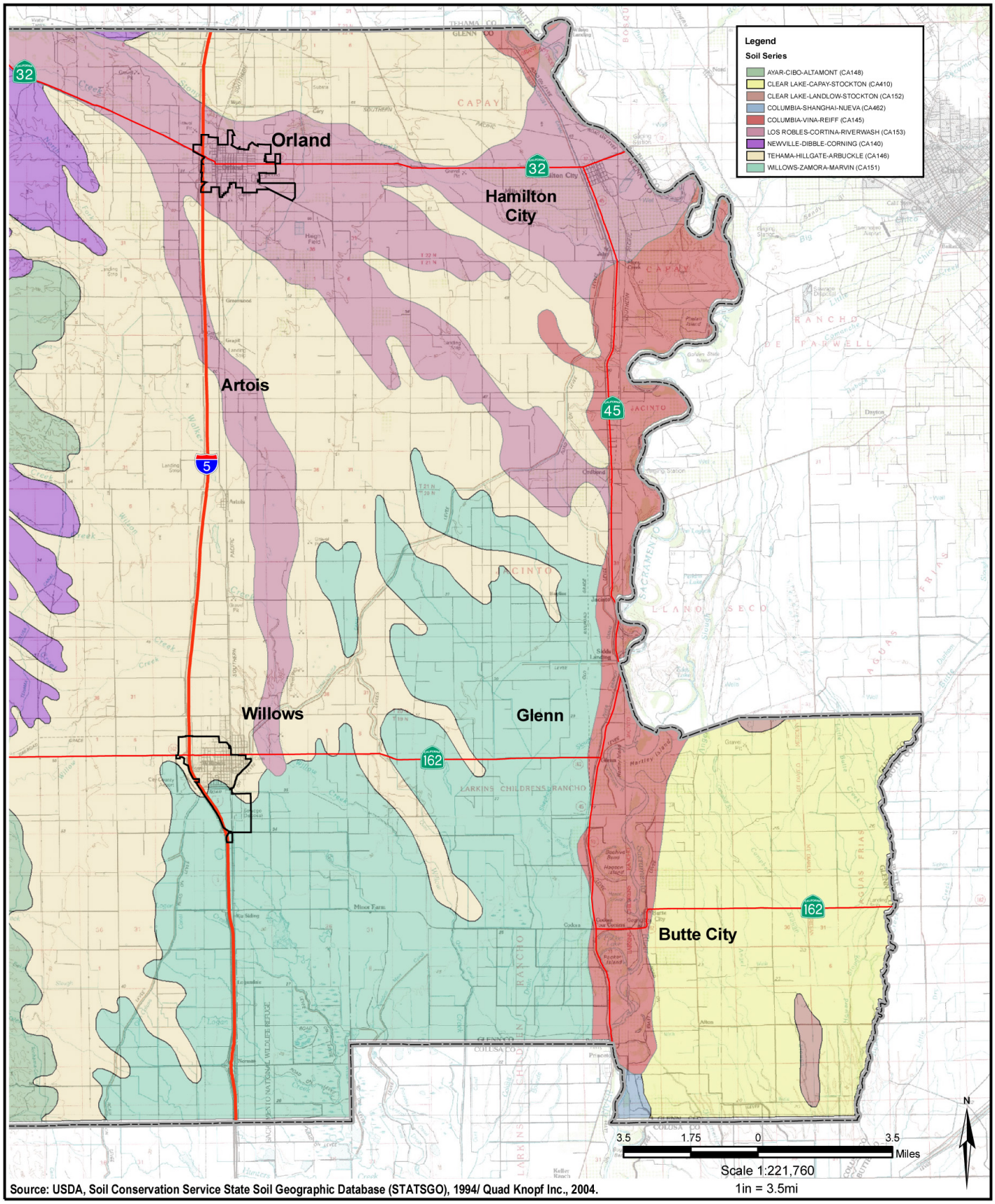
Glenn County is drained chiefly by Stony Creek, Willow Creek, Walker Creek and the Sacramento River. Stony Creek flows from the mountainous uplands through the foothills and enters the Sacramento Valley just west of the Orland Buttes. It runs southwesterly into the Sacramento River about five miles southeast of Hamilton City. Draining foothill areas west of Stony Creek are Willow and Walker Creeks. Most northerly is Walker Creek which flows southeasterly, joining Willow Creek east of Willows. Willow Creek continues into Colusa County, eventually entering the Colusa Basin Drain. The Sacramento River, which is the chief source of surface irrigation water in the county, flows southward through the center of the Sacramento Valley, joins the San Joaquin River in the Delta, and then flows into the San Francisco Bay and the Pacific Ocean. Figure 2-11 illustrates the location of the major surface waters in the eastern portion of the county. Total surface water usage in Glenn County is approximately ¾ million acre feet per year, three times the amount of groundwater usage. A substantial majority of this usage is for agricultural irrigation, with limited amounts utilized for wildlife refuges and municipal water supply.

Two major canals also traverse the county. The Glenn-Colusa Canal crosses the county starting at the Sacramento River north of Hamilton City and running southwest, passing just east of Willows before heading south into western Colusa County. The other primary irrigation canal in the county, the Tehama-Colusa Canal, begins at the Red Bluff diversion dam on the Sacramento River and trends southward through the county, eventually terminating near Dunnigan in Yolo County.

State Department of Water Resources Bulletin 118-6 *Evaluation of Groundwater Resources: Sacramento Valley* reports that 20 percent of the natural recharge in the Sacramento Valley occurs in the Stony Creek area. Such recharge comes from both stream percolation and deep percolation of precipitation. Clearly, the Stony Creek area is critical to groundwater recharge. Other groundwater recharge areas in the county include the area along the Sacramento River and other locations as shown on Figure 2-12.



Source: California State Spatial Library-Water District Boundaries/ Quad Knopf Inc., 2004.



Source: USDA, Soil Conservation Service State Soil Geographic Database (STATSGO), 1994/ Quad Knopf Inc., 2004.

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Figure 2-9

EASTERN GLENN COUNTY- SOIL SERIES

Job No. 03157

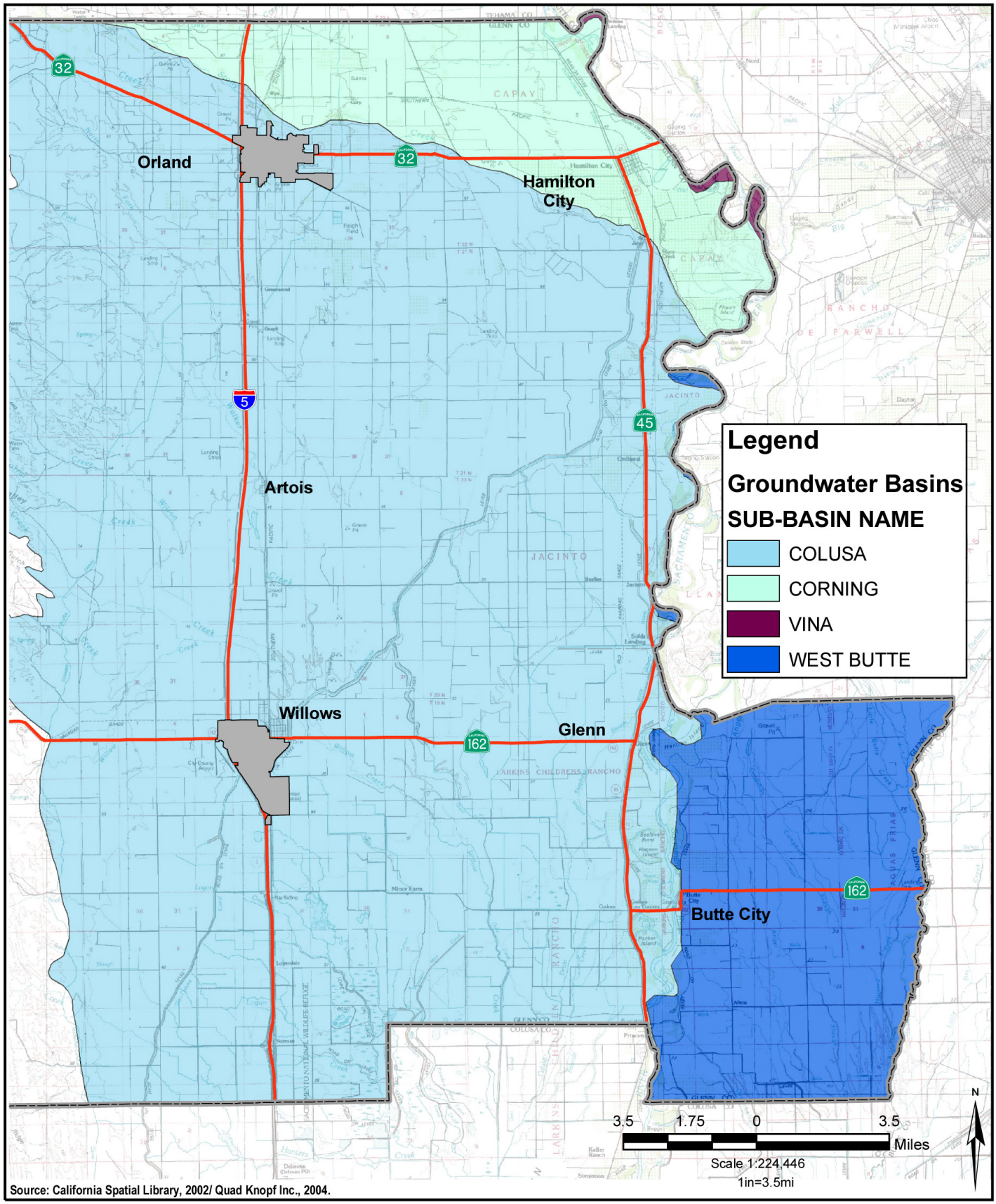

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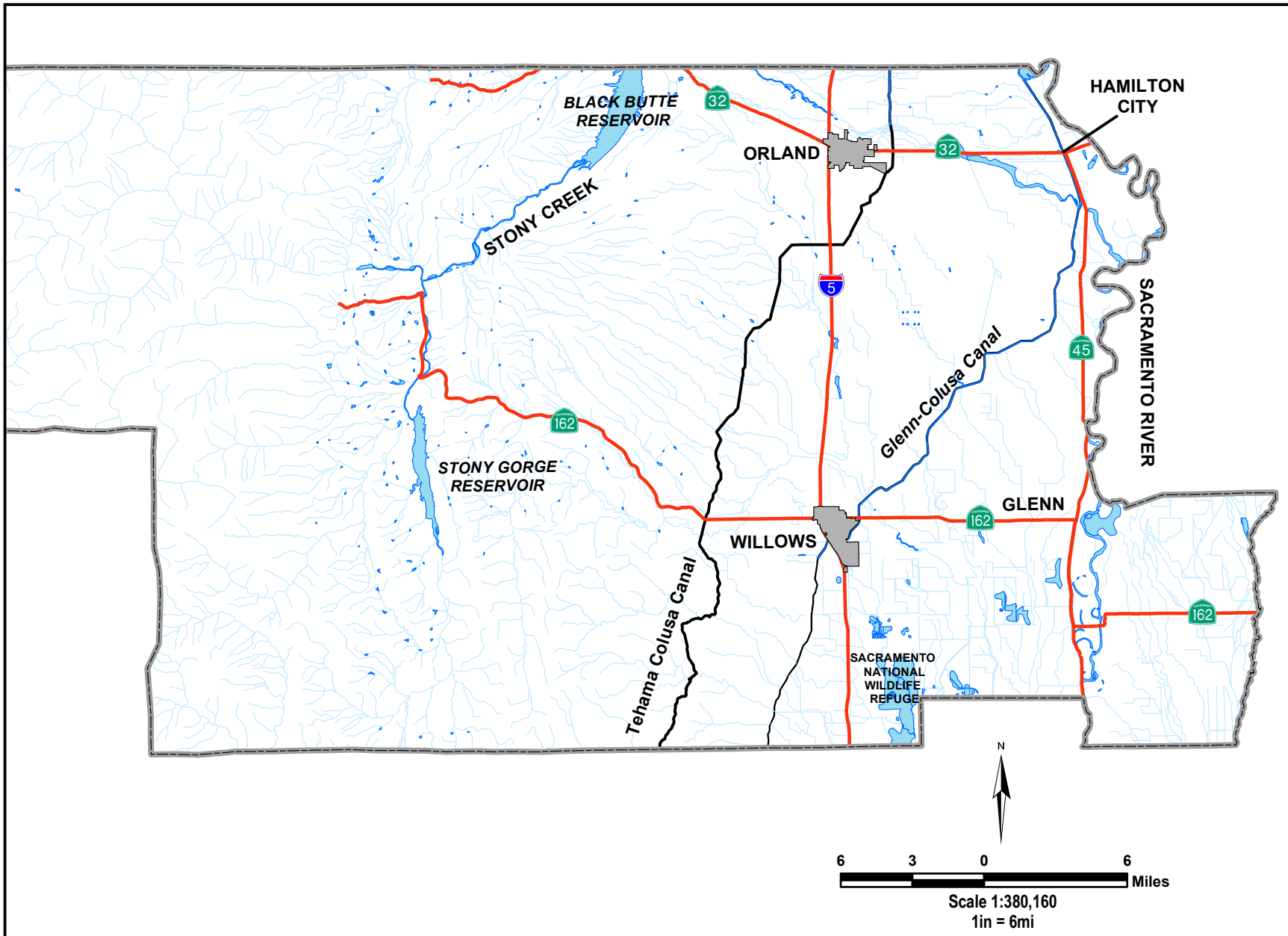
Figure 2-10

GROUNDWATER BASINS

Job No. 03157



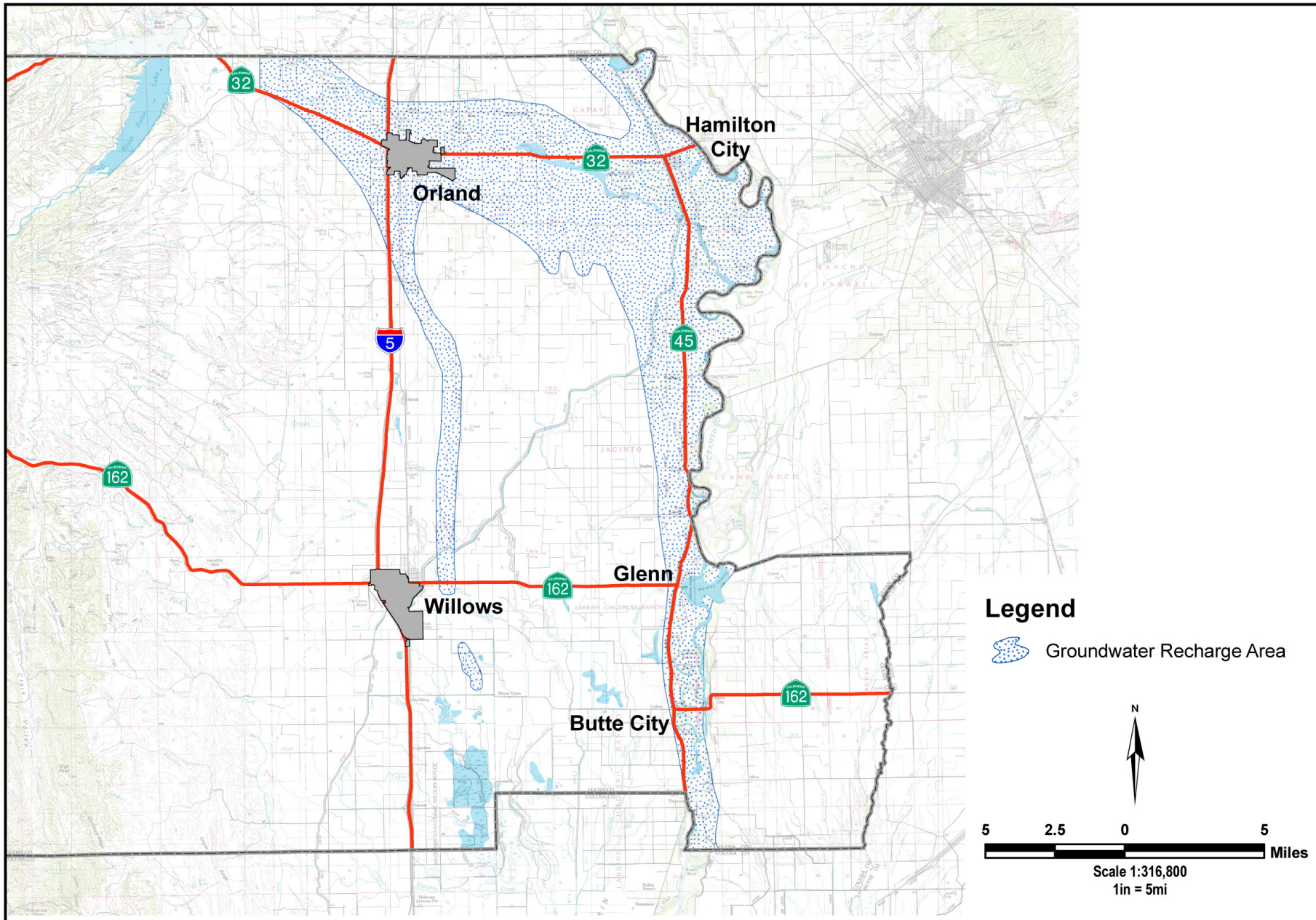
Source: Glenn County Planning Dept./ Quad Knopf, Inc, 2004.

Quad Knopf

Figure 2-11

MAJOR WATERWAYS IN GLENN COUNTY

Job No. 03157



Source: Glenn County Planning Dept. / Quad Knopf Inc., 2004.

Quad Knopf

Figure 2-12

GROUNDWATER RECHARGE

Job No. 03157

Available data from monitoring wells in the Orland-Artois Irrigation District, the Provident Irrigation District, the Princeton-Codora-Glenn Irrigation District, and the Glenn-Colusa Irrigation District, supplemented by data from the State Department of Water Resources, indicates widely varying but generally shallow groundwater depths below ground surface (bgs) in the Valley area of the county – typically 0 to 50 feet bgs in the spring of recent years. The existence of shallow groundwater in some areas in which dairies have historically been located is cause for concern with respect to new or expanded dairy operational impacts on groundwater quality.

Existing groundwater quality is, in general, excellent for agricultural irrigation purposes, with electrical conductivities well below levels at which adverse crop impacts would occur. It is reported that excess nitrates are found in some groundwaters in the Willows area (Central Valley RWQCB Watershed Management Initiative Plan, page III-1c, December 2002). Excess nitrates are also reported in portions of the Stony Creek fan (California Ecological Restoration Projects Inventory, USDA – National Resources Conservation Service).

Depth to groundwater varies throughout eastern Glenn County. Figure 2-13 shows shallow depth to groundwater concentrated in the southeastern portion of the county and along the Sacramento River.

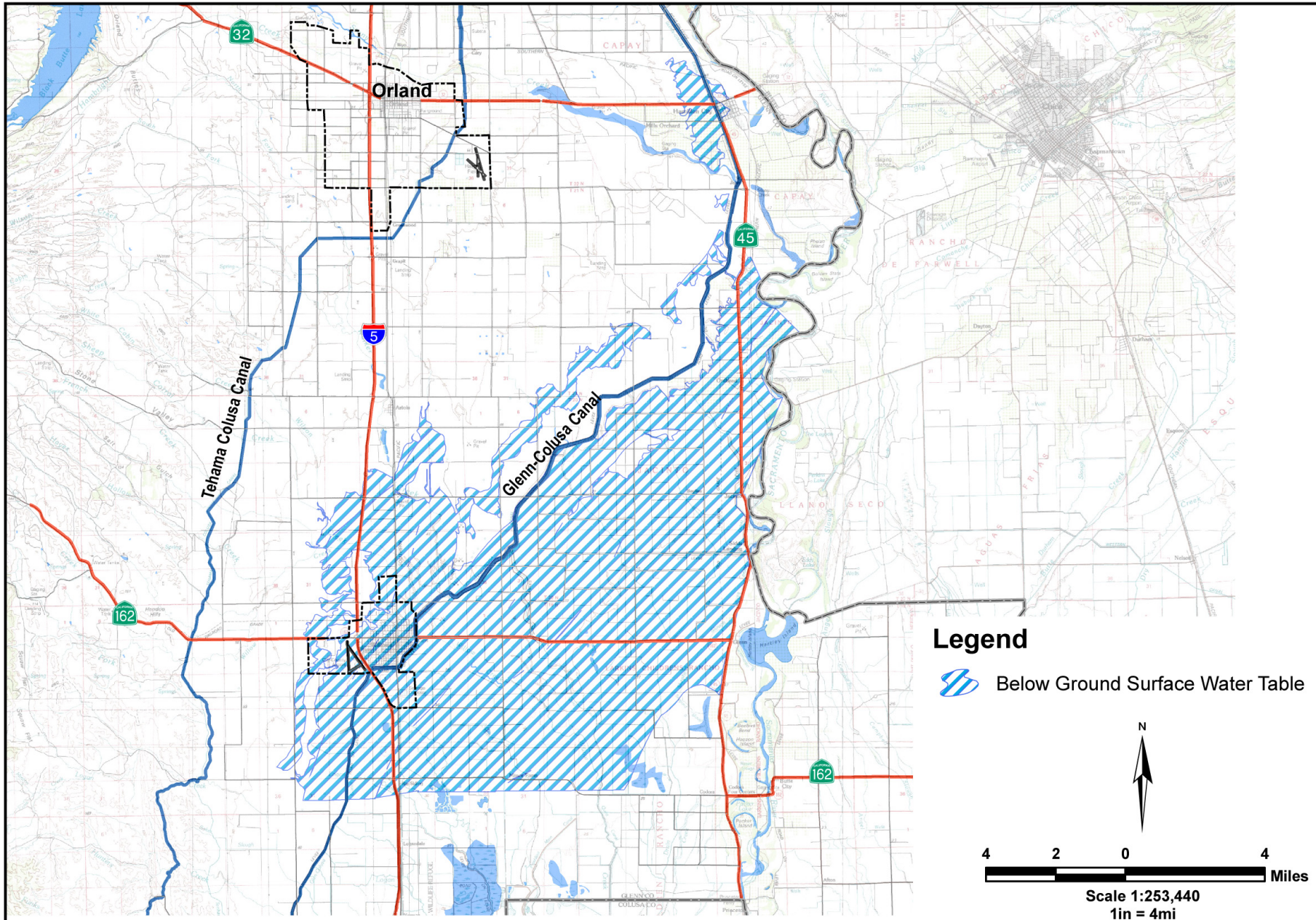
Figure 2-14, Flood Hazard Zone Areas shows the approximate location of 100-year flood boundaries (as mapped by the Federal Emergency Management Agency, FEMA). Some areas of the county adjacent to streams are subject to flooding and deposition of new soil material during heavy rainfall. The largest floodplain consists of a narrow area parallel to the Sacramento River. Dams control the flow to Stony Creek, and a levee system borders the river. Hamilton City is only protected from the Sacramento River by a poorly maintained private levee. Many old meander scars and some oxbow lakes are found in the area (Glenn County Environmental Setting, Technical Paper - Glenn County General Plan, 1993).

There are two main basin areas in the county, the Colusa Basin and the Butte Sink which lies east of the river. Both areas occasionally flood in winter because their terrain is nearly level and their soils are poorly drained. In many places they contain excess salts and alkali and have an intermittent high water table. In other areas, drainage ditches have been constructed and the soils partly reclaimed.

Beneficial uses in the Sacramento River watershed are adversely impacted by the presence of pollutants and sediments entering the watershed from a variety of sources. In 1990, the State Water Resources Control Board released the final project report for the *Sacramento River Toxic Chemical Risk Assessment Project*. In this report, the four major sources of chemical pollutants entering the Sacramento River were identified and characterized. These sources are agricultural drainage, mine drainage (primarily acid mine drainage), urban runoff, and NPDES discharges. Animal production facilities, rangelands and forest activities (including fires) were not included in that assessment, but should be considered to be potential sources of pollution. Nevertheless, the surface waters available to Glenn County for agricultural production are excellent for that purpose, with low electrical conductivity levels and an absence of constituents harmful to crops.

General Plan Goals and Policies

Glenn County's General Plan contains a goal of "protection and enhancement of water quality." Relevant policies and accompanying implementation strategies, programs and priorities are listed in Appendix B.



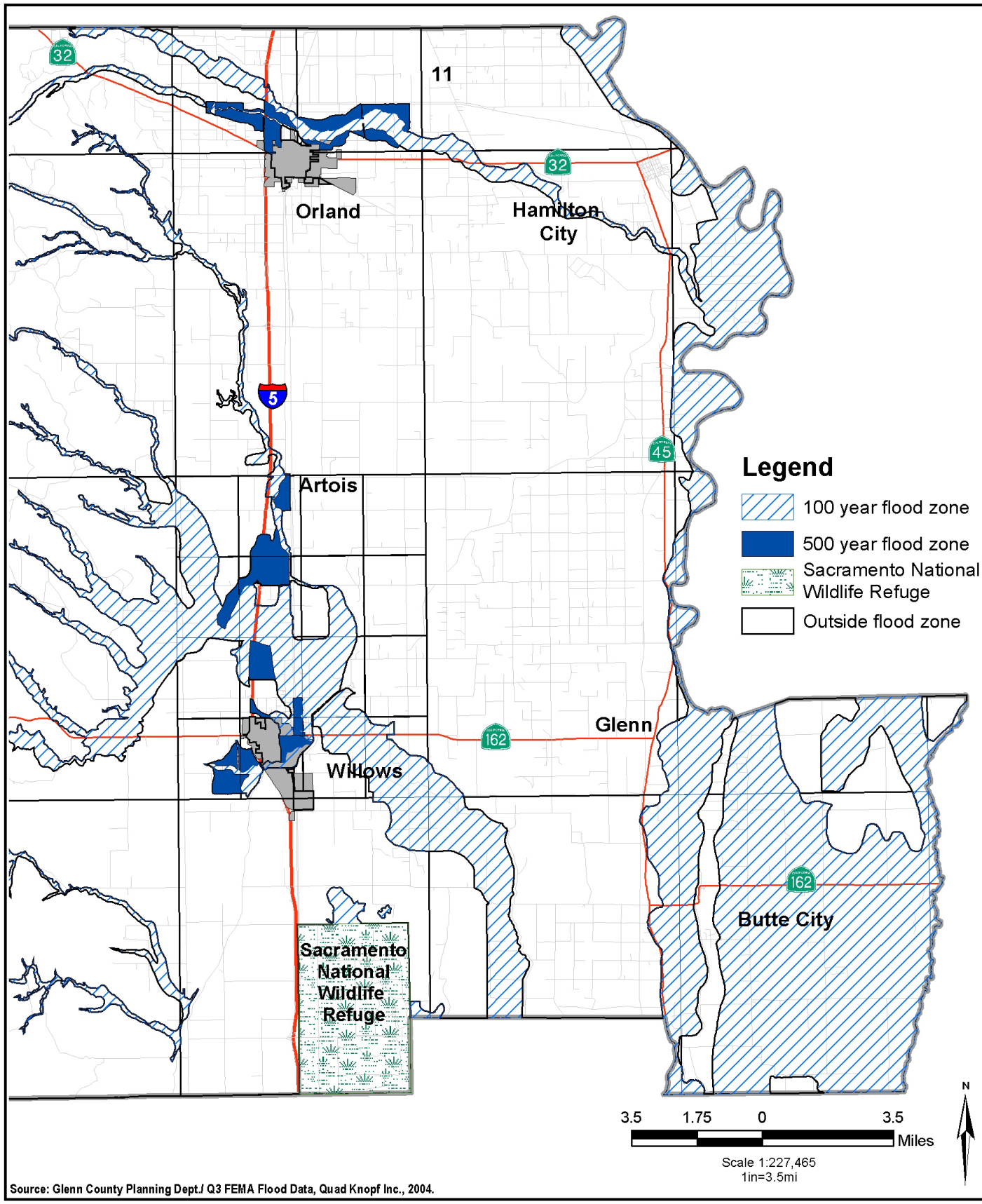
Source: Glenn County Planning Dept./ Quad Knopf Inc., 2004.

Quad Knopf

Figure 2-13

HIGH GROUNDWATER AREAS

Job No. 03157



Source: Glenn County Planning Dept./ Q3 FEMA Flood Data, Quad Knopf Inc., 2004.

Quad Knopf

Figure 2-14

FLOOD HAZARD ZONE AREAS
EASTERN GLENN COUNTY

Job No. 03157

2.4 BIOLOGICAL RESOURCES

Glenn County extends from high elevations (+7,000 feet) on the east slope of the North Coast Range to the low elevations in the broad flat alluvial plain of the Sacramento Valley. As a result of such major changes in elevation, Glenn County includes a great variety of climatic, soils and geographic conditions that, in turn, influence the distribution, variety, and abundance of the plant and animal species within the county.

Described in this section are the vegetative communities of Glenn County. In addition, sensitive plant and animal species occurring in those communities are described, with a focus on species with the highest level of protection.

It should be noted that no confined animal facility will occupy either state or federal lands; therefore, neither the Mendocino National Forest nor those lands owned by the Bureau of Land Management will be discussed in any detail.

Definition of Special-Status Species

State and federal "endangered species" legislation has provided the California Department of Fish and Game (CDFG) and the U.S. Fish and Wildlife Service (USFWS) with a mechanism for conserving and protecting plant and animal species of limited distribution and/or low or declining populations. Species listed as threatened or endangered under provisions of the state and federal endangered species acts, candidate species for such listing, state species of special concern, and some plants listed as endangered by the California Native Plant Society are collectively referred to as "species of special-status". Permits may be required from both the CDFG and USFWS if activities associated with a proposed project will result in the "take" of a listed species. "Take" is defined by the state of California as "to hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture or kill" (California Fish and Game Code, Section 86). "Take" is more broadly defined by the federal Endangered Species Act to include "harm" (16 USC, Section 1532(19), 50 CFR, Section 17.3). Furthermore, the CDFG and the USFWS are responding agencies under the California Environmental Quality Act (CEQA). Both agencies review CEQA documents in order to determine the adequacy of their treatment of endangered species issues and to make project-specific recommendations for their conservation.

Special-status animals include the following:

- Federal threatened or endangered and candidate species (FESA);
- California threatened or endangered (California ESA -CESA);
- California fully protected (Section 3511 of the California Fish and Game Code); and
- California species of special concern (CDFG's Special Animals List).

Special-status plants include the following:

- Federal threatened or endangered and candidate species (FESA);
- California threatened or endangered species (CESA);
- Species listed on Lists 1, 2, 3, or 4 of the California Native Plant Society (CNPS); and,

- Species identified as California rare (California Native Plant Protection Act).

Most birds are also protected by state and federal law. The Migratory Bird Treaty Act (MBTA: 16 U.S.C., sec. 703, Supp. I, 1989) prohibits killing, possessing, or trading in migratory birds, except in accordance with regulations prescribed by the Secretary of the Interior. This act encompasses whole birds, parts of birds, and bird nests and eggs.

Birds of prey are also protected in California under provisions of the State Fish and Game Code, Section 3503.5, 1992), which states that it is "unlawful to take, possess, or destroy any birds in the order Falconiformes or Strigiformes (birds of prey) or to take, possess, or destroy the nest or eggs of any such bird except as otherwise provided by this code or any regulation adopted pursuant thereto." Construction disturbance during the breeding season could result in the incidental loss of fertile eggs or nestlings, or otherwise lead to nest abandonment. Disturbance that causes nest abandonment and/or loss of reproductive effort is considered "taking" by the CDFG.

Wetland Criteria

The extent of wetlands is determined by examining the presence of hydrophytic vegetation, hydric soils, and wetland hydrology. Under normal circumstances, all three of these parameters must be satisfied for an area to be considered a jurisdictional wetland under Section 404 of the CWA. Only one parameter must be present to qualify as a wetland as defined by the CDFG (Cowardin Classification System).

Determination of Hydrophytic Vegetation. Hydrophytic vegetation is defined as the sum total of macrophytic plant life that occurs in areas where the frequency and duration of inundation or soil saturation produce permanently or periodically saturated soils of sufficient duration to exert a controlling influence on the plant species present. The vegetation occurring in a wetland may consist of more than one plant community (wetland plant communities may contain plant species that are Obligate (OBL), Facultative Wetland (FACW), Facultative (FAC), Facultative Upland (FACU), Upland (UPL), No Indicator (NI), and/or Not Listed (NL).

Determination of Hydric Soils. Hydric soils are defined as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, July 13, 1994).

Determination of Wetland Hydrology. Wetland hydrology is defined as all hydrologic characteristics of areas that are periodically inundated or have soils saturated to the surface at some time during the growing season. Areas with evident characteristics of wetland hydrology are those where the presence of water has an overriding influence on characteristics of vegetation and soils due to anaerobic and reducing conditions, respectively.

Wetland hydrology is determined to be present if a site supports one or more of the following characteristics:

- Landscape position and surface topography (i.e., site position relative to an upslope water source, location within a distinct wetland drainage pattern, concave surface topography);

- Inundation or saturation for a long duration (based on field indicators or survey observations); or

- Residual ponding/flooding evidence (i.e. scour marks, sediment deposits, algal matting, drift lines).

Natural Communities

Natural communities present within Glenn County (excluding Mendocino National Forest) are primarily annual non-native grasslands, vernal pools and other wetlands, foothill oak woodlands, and valley foothill riparian. Scrub and alkali seep habitats are interspersed through some areas.

Vegetation

Glenn County contains seven major vegetation associations, which support a diverse array of plant and animal species. Figure 2-15 shows the major vegetation associations in the county. The following descriptions of the vegetation associations and predominant species within each association are based on findings reported by Kuchler (1988), and Holland (1986). The acreage of the cover types is based on previous county estimates (County of Glenn 1985, 1987).

Blue Oak-Gray Pine Woodlands. The Blue Oak-Gray Pine community occupies about 174,700 acres (21.7 percent) of the county. This plant community is located in the central portion of the county in the lowest foothill elevations, immediately between the chaparral on the higher slopes and the grasslands/agricultural lands on the valley floor. The plant community is characterized by medium tall, dense-to-open broad-leaved deciduous forest mixed with needle-leaved evergreens. The community typically transitions from relatively dense canopy cover to a savanna situation where grasslands dominate the groundcover. The dominant species are blue oak and digger pine intermixed with California buckeye, toyon, buckbrush, common manzanita, whiteleaf manzanita, Valley oaks, interior live oak, coffeeberry, and poison oak.

Chamise Chaparral and Northern Mixed Chaparral. Chamise Chaparral and Northern Mixed Chaparral occupy approximately 84,447 acres or 10.5 percent of the land in Glenn County. The Chamise Chaparral dominates in the lower elevations, while the Northern Mixed Chaparral dominates at higher elevations. The chaparral communities typically intergrade with the Coast Range Montane Forest in the higher elevations and the Blue Oak-Digger Pine Woodlands in lower elevations of the east slope. These communities form dense stands of needle-leaved and broad-leaved evergreen sclerophyll shrubs ranging in height from 3 to 10 feet. Typical species include chamise, several manzanita species, including eastwood, bigberry and whiteleaf manzanita, buckbrush, chaparral whitethorn, redbud, toyon, California buckeye, interior live oak and mountain-mahogany.

Grasslands. Grassland communities cover approximately 63,103 acres (7.5 percent) of the county, typically in the lowest valley elevations. Formerly, these lands were dominated by

perennial native grasses, but have largely been replaced with non-native annual species since European settlement. Two major grassland communities are the non-native grassland and the valley needlegrass community described below:

- **Non-Native Grassland Community.** Composed principally of introduced perennial and annual grasses, including wild oats, soft chess, red brome, ripgut brome, fescue, cheat grass, ryegrass, and other herbaceous vegetation, such as storksbill, filaree, California poppy, and lupine.

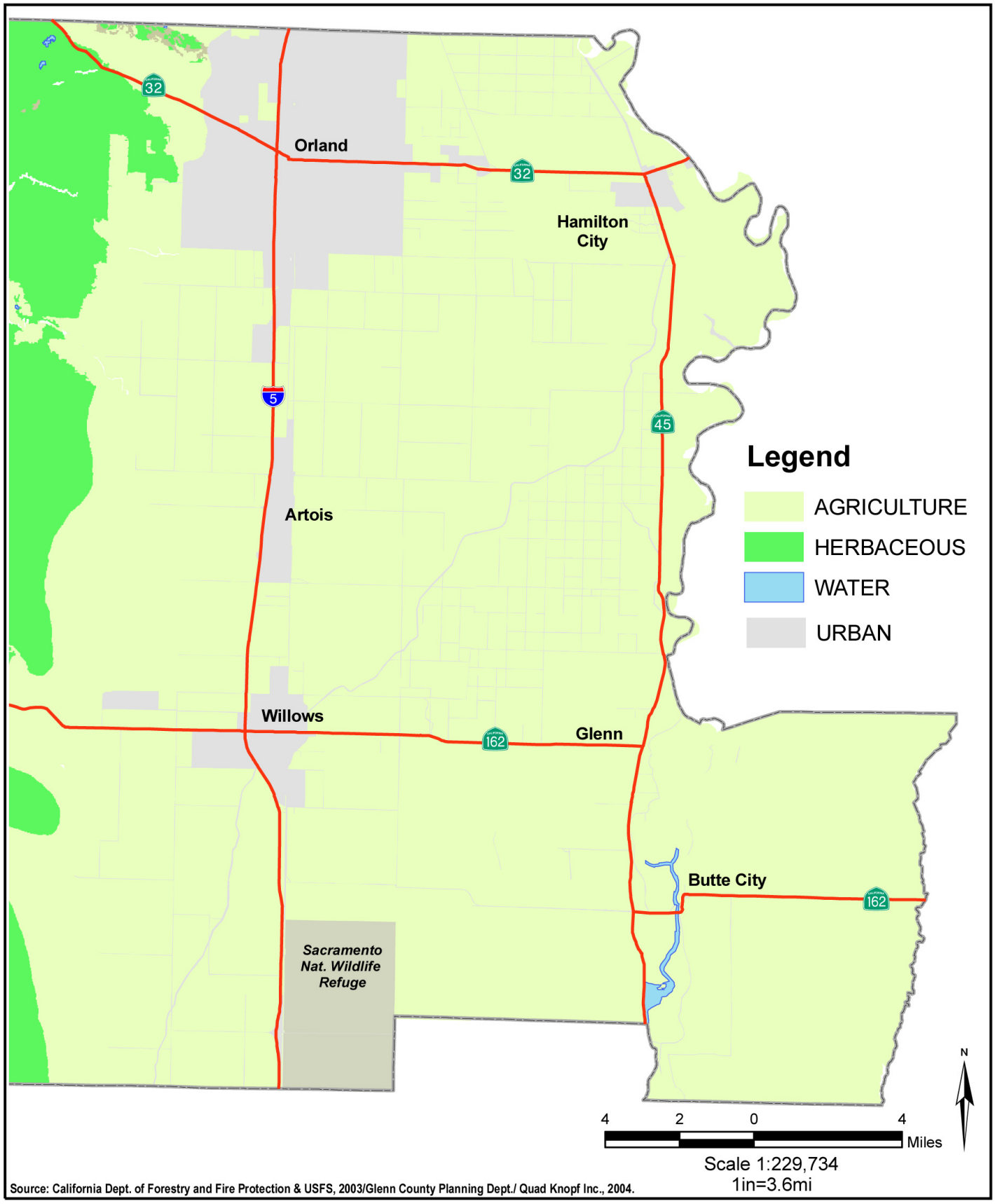
- **Valley Needlegrass Grassland Community.** A relict community (i.e., left over from a previous ecological system) dominated by the perennial, tussock-forming speargrass found on fine-textured soils that are moist or waterlogged in winter, but very dry in summer (Holland 1986). Native species commonly associated with this community include needlegrass, yarrow, blow-wives, mountain dandelion, golden brodiaea, soap plant, melic grass, plantain, bluegrass, nodding stipa grass, as well as a number of introduced species, such as wild oats and brome grasses.

Riparian Communities. Riparian communities formerly occupied extensive stands within the county; however, current acreage estimates are about 2,280 acres, principally along the Sacramento River, Willow Creek, and Walker Creek. Four particularly important riparian communities in Glenn County include:

- **Great Valley Willow Scrub.** An open to dense, broadleafed, winter deciduous streamside thicket community. Dense stands have little understory and are dominated by Pacific willow, arroyo willow, sandbar willow, black willow, wild grape, and shrub-sized Fremont cottonwood. In open thickets, grass understories can develop. This community is generally situated in the lowest flood plain elevations and is subjected to considerable scour during flood stages that impairs the succession to woodland.

- **Great Valley Cottonwood Riparian Forest.** This dense, broadleafed, winter deciduous forest community is dominated by Fremont cottonwood and Goodding's willow. Associated canopy and understory vegetation include California box elder, Oregon ash, buttonbush, wild grape, and several willow species (Pacific, arroyo, black, and sandbar). This community is typically a transitional community between the Great Valley Willow Scrub community at lower elevations and the Great Valley Mixed Riparian Forest community at higher elevations. A tall, broadleafed riparian forest community with a closed canopy composed of winter-deciduous species. Typical canopy species include California box elder, Fremont cottonwood, western sycamore, Hind's walnut, Goodding's willow, and Pacific willow. These forests are generally very dense, resulting in a shade-tolerant understory typically composed of buttonbush, shrub Oregon ash, wild grape, and poison oak.

- **Great Valley Valley Oak Riparian Forest.** The highest elevational element of the riparian complex, this community intergrades with typically upland communities at the margins of the floodplain. This community is composed of medium-to-tall broadleafed, winter deciduous species and is dominated by the Valley oak. Associated understory vegetation



Source: California Dept. of Forestry and Fire Protection & USFS, 2003/Glenn County Planning Dept./ Quad Knopf Inc., 2004.

Quad Knopf

Figure 2-15

VEGETATION MAP

Job No. 03157

includes sycamore, Oregon ash, Hind's walnut, California rose, wild grape, poison oak, blackberry, and greenbriar.

Wetlands. Wetlands comprise approximately 4,278 acres of Glenn County, and include marshes, ponds, fringes of small lakes, sloughs, and swamps. The largest wetland assemblages occur within the Sacramento River floodplain, including the managed wetlands of the Sacramento National Wildlife Refuge. Wetlands may also be found in areas with suitable soil and hydrologic conditions not illustrated on these maps.

The U.S. Soil Conservation Service (SCS) has identified 25 soil series, involving 93 specific soil mapping units, in Glenn County that display hydric characteristics. These soils are typically found in soil associations of the drainage basins (Willows-Capay, Willows-Plaza-Castro and Landlow-Stockton) found primarily in the southeast portion of the county; soils of older alluvial fans and low terraces (Arbuckle-Kimball-Hillgate, Hillgate-Arbuckle-Artois, Tehama-Plaza, Myers-Hillgate and Zamora-Marvin Associates) found throughout the eastern two-thirds of the county along creek drainages; and soils of the more recent alluvial fans and floodplain (Wyo-Jacinto, Cortina-Orland and Columbus Associates) also found throughout the eastern two-thirds of the county (USDA 1968).

Hydric soils are saturated over long periods and support hydrophytic (wetland) vegetation under saturated conditions. Many of the lands underlain with hydric soils have been drained or managed for rice production. A typical wetland community in Glenn County is the "Coastal and Valley Freshwater Marsh," which is typically found in floodplain areas and dominated by cattails, tules, sedges, umbrella sedges, scour rushes, and smartweed.

In addition to wetlands, vernal pools are found in various portions of the county. Vernal pools are herbaceous communities that develop in ground depressions that fill with water from winter rains. The depressions have restricted soil percolation due to impervious materials (clay) underlying them. Because runoff and percolation are impaired, water is retained for prolonged periods until evaporated in the spring. As evaporation proceeds, concentric rings of vegetation, corresponding to residual soil moisture, remain. Typically, vernal pool communities in Glenn County would include the following:

- **Northern Hardpan Vernal Pool.** These vernal pools are found on old, acidic, iron-silica cemented soils. Typical vegetation includes brook spike-primrose, annual hairgrass, double-horn downingia, cuspidate downingia, flat-face downingia, inch-high rush, Fremont's goldfield, white meadowfoam, northern mudwort, white-head navarretia, paintbrush owl's-clover, Sacramento mesamint, dwarf wholly-heads, corn speedwell, slender popcorn flower, and coast popcorn flower.

- **Northern Claypan Vernal Pool.** These vernal pools are underlain with old, circum-neutral, silica-cemented hardpan soils. Typical species associated with this community include fine-branch popcorn flower, smooth spike-primrose, spreading alkali-weed, Hoover's downingia, California coyote-thistle, smooth goldfields, coast goldfields, tiny mouse-tail, Douglas' mesamint, and purslane speedwell.

Sensitive Species

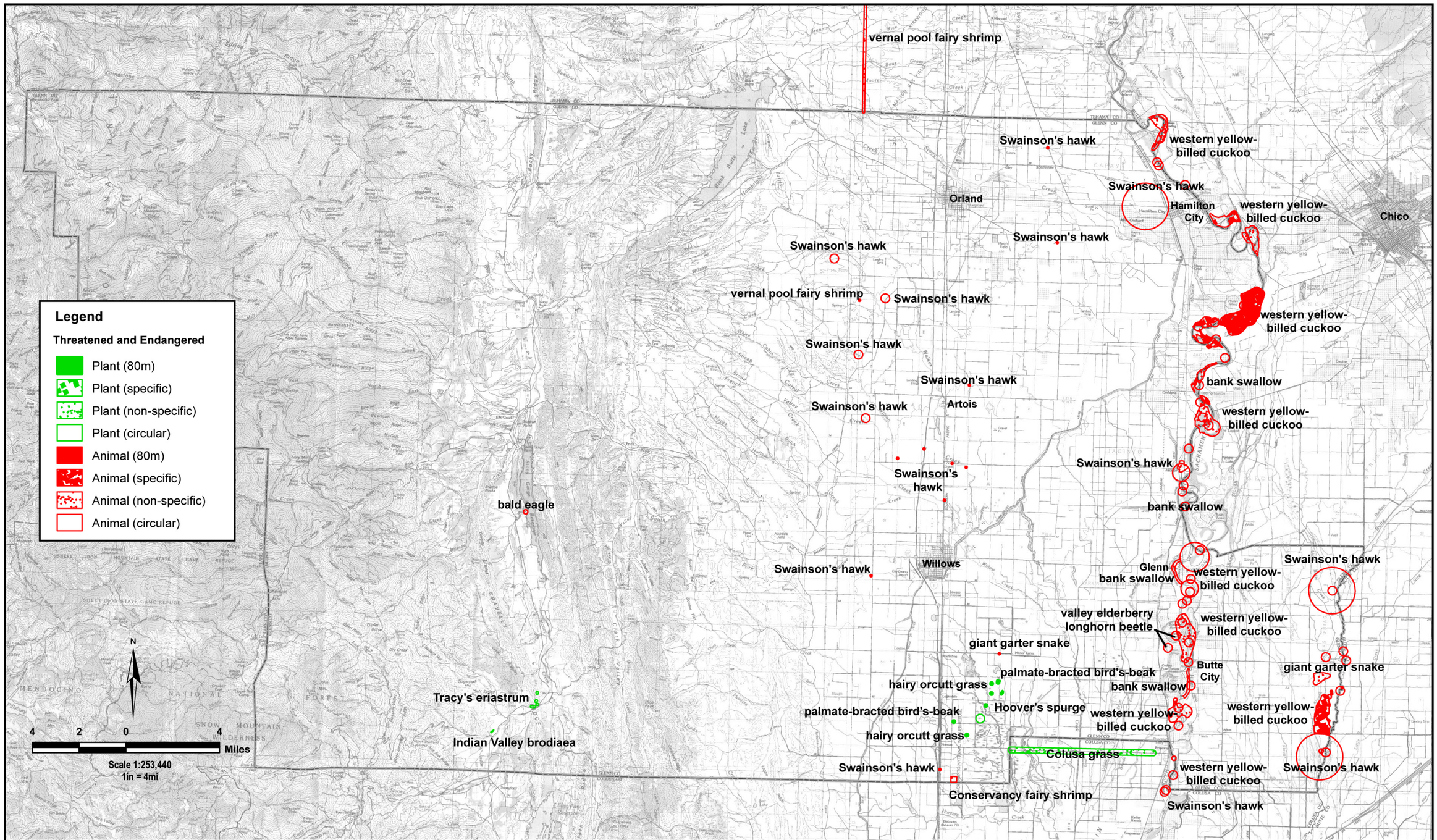
Grasslands, vernal pools, and riparian woodlands are home to most of the county's special-status plant and animal species, according to *California Natural Diversity Data Base* (CNDDB) (CDFG 2003), *Special Vascular Plants, Bryophytes, and Lichens List* (CDFG 2003), *Special Animals List* (CDFG 2003), and *The California Native Plant Society's Inventory of Rare and Endangered Vascular Plants of California* (Online version) (CNPS 2003). Sixty-three special-status plant species and twenty-seven special-status animal species were recorded within the county. All special-status plant and animal species occurrences reported to the CNDDB within Glenn County are listed in Appendix C. A brief description of the species given the highest levels of protection follows. Figures 2-16 and 2-17 depict generalized locations of CNDDB special-status plants, animals, and natural community occurrences reported within the county.

The CNDDB identified six threatened, endangered, or rare plant species, and 30 plants with CNPS listings (one List 1A species, 26 List 1B species, and three List 2 species), in addition to seven natural vegetation communities of concern. The CNPS Online Inventory of Rare and Endangered Plants of California identified four additional List 1B plant species and one additional List 2 species.

The unofficial USFWS list for Glenn County, California (online version) identified one additional listed invertebrate species, four listed fish, one listed amphibian, and one additional listed bird species that may be affected by projects in Glenn County. Several other candidate and special-status species were included on the unofficial list; however, only the listed species are addressed below.

Listed Amphibian Species

California red-legged frog (*Rana aurora draytonii*) is the largest native frog in the western United States. It ranges from about 1.5 to 5 inches (4-13 centimeters) in length, measured from the tip of the snout to the vent (Stebbins 1985). Adult frogs are somewhat variable in color, and when viewed from above, this species may appear olive, gray, brown, orange, or red in color with dark spots or flecks usually present on its back. Individuals typically appear rather smooth-skinned and prominent dorsolateral folds of skin are present from behind each eye to the hip. The underside is whitish and patches or a hue of orange, salmon-pink, or red are usually present on the abdomen and hind legs. A well-defined whitish or cream-colored stripe is usually present along the upper lip from beneath the eye to the rear of the jaw. The California red-legged frog occurs in aquatic habitats such as streams, ponds, marshes, and stock ponds. Adult frogs may move through upland habitats during periods of wet weather, but considerable time is spent resting or feeding in riparian habitat. The majority of their diet consists of a wide variety of invertebrates. The historic range of this species included at least 46 counties in California from Marin County, inland to Shasta County in the northern portion of the state, to northwestern Baja California, Mexico. Today, the frog is known from only 23 counties, many of which are along the California coast (66 FR 14627). Habitat loss and modification, overexploitation, and introduction of exotic species are major reasons for the decline of the California red-legged frog (CDFG 2003). Note: Need more information on habitat restoration plan for red-legged frog.



Source: CA Dept. of Fish and Game, CNDDB 2004 / Quad Knopf Inc., 2004

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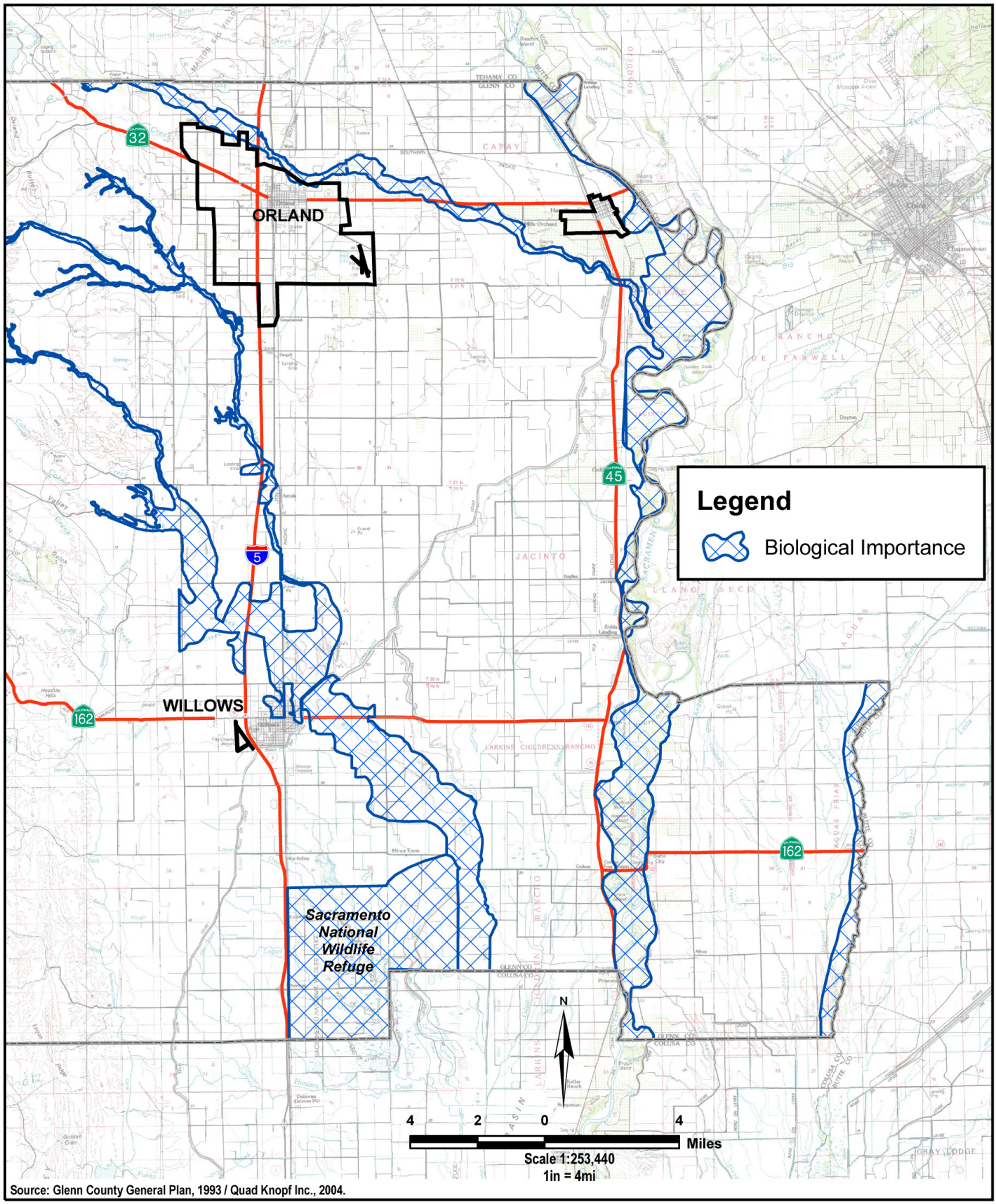
Figure 2-16

CNDDB MAP

Job No.: 03157



Source: Glenn County General Plan, 1993 / Quad Knopf Inc., 2004.

Quad Knopf

Figure 2-17

GLENN COUNTY GENERAL PLAN SPECIAL OVERLAY DESIGNATION: BIOLOGICAL IMPORTANCE

Job No. 03157

Listed Bird Species

Bald eagle (*Haliaeetus leucocephalus*) is a large brown raptor, which can be distinguished from other broad winged raptors by its greater size and proportionately longer wings (Peterson 1990). Adult birds have a white head and tail, and a massive yellow bill that is nearly as long as the head. The species is a permanent resident and uncommon winter migrant in northern California, with breeding restricted to mostly Butte, Lake, Lassen, Modoc, Plumas, Shasta, Siskiyou, and Trinity counties (Zeiner et. al 1990). It is fairly common as a local winter migrant at a few preferred inland waters in southern California. Bald eagles nest and winter along the margins of lakes and rivers, and along the ocean shore, with most nest sites occurring within one mile of water. The species requires large bodies of water or free-flowing rivers with an abundant supply of fish, and adjacent snags or other perches. Large, old-growth or live trees with open branches are required for nesting, and the species may prefer ponderosa pines. Threats to the species include encroaching development and disturbance, including off-road vehicle use (CDFG 2003).

Bank swallow (*Riparia riparia*) is a small, brown-backed bird with a distinctive dark breastband. This species is found primarily in riparian and other lowland habitats in California west of the deserts. Bank swallows require vertical banks and cliffs with fine textured or sandy soils near streams, rivers, ponds, lakes, and the ocean for nesting. They forage by hawking insects during long gliding flights and feed predominantly over open riparian areas, but also over brushland, grassland, and cropland (Zeiner et al. 1990). Bank swallows are usually colonial breeders and breed from early May through July, with peak activity from mid-May to mid-June. Eggs and adults are preyed upon by rats, skunks, house cats, snakes, and some raptors. Channelization and stabilization of banks of nesting rivers, and other destruction and disturbance of nesting areas, are major factors causing decline in the species (Zeiner et al. 1990).

Great gray owl (*Strix nebulosa*) is the largest owl, characterized by its size, a round head lacking ear tufts, a large, strongly lined facial disk surrounding its small yellow eyes, and a black chin spot bordered by two broad white mustache-like patches (Peterson 1990). The body is dusky gray and heavily striped lengthwise on its underparts, and the species has a relatively long tail for an owl. The great gray owl is known to hunt by day, occupying dense conifer forests with adjacent meadows or bogs.

Northern spotted owl (*Strix occidentalis caurina*) is a large, dark brown forest owl with a puffy round head. This owl has large dark eyes, a heavily spotted chest, and a barred belly (Peterson 1990). This species is an uncommon permanent resident in heavily forested areas, from San Luis Obispo County to San Diego County, along the coast of northern California from Marin County north, and in the Sierra Nevada, from Plumas County to extreme northern Kern County (Gould 1974). In northern California this subspecies occurs in dense, old growth, multi-layered mixed conifer, redwood and Douglas-fir habitats from sea level up to approximately 7,600 feet (2,320 meters). In the fall, adults may migrate down slope and then return to higher elevations in the spring. In the Sierra Nevada, these movements average 2,474 feet (754 meters) change in elevation. California spotted owls nest on broken treetops, cliff ledges, in natural tree cavities, or in trees on stick platforms. This subspecies roosts during the day and hunts at dusk and at night from a perch. Prey items consist of small mammals, particularly nocturnal or semi-arboreal species. The species requires mature forests stands with large trees and snags, while California

spotted owl habitat continues to be lost or degraded by logging and/or forest fragmentation (Zeiner *et al*. 1993).

Swainson's hawk (*Buteo swainsoni*) is distinguished from most other hawks by its long, narrow-pointed wings. The plumage is extremely variable and this raptor can be mistaken for a red-tailed hawk (*Buteo jamaicensis*). A large portion of its diet consists of insects. Preferred habitats include riparian woodlands and oak woodlands with adjacent grassland or agricultural land (Anderson and England 1987). The reasons for the decline of this species are not fully understood, but the conversion of grasslands to incompatible agricultural uses and pesticide contamination have been cited as causative factors in this species' decline, as Swainson's hawks are known to forage in agricultural fields.

Western yellow-billed cuckoo (*Coccyzus americanus occidentalis*) is a long, slender bird distinguished by a long, curved bill with a yellow lower mandible. Wings are olive-brown above, white on the underside with bright rufous primary feathers and the outer tail feathers have large white spots. The preferred habitat is lowland riparian associations and scrub lands. Destruction of riparian habitat resulting from urban and agricultural development, and flood control and stream stabilization projects have been major factors leading to the decline of the species (Anderson and England 1987). Most of the habitat for this species has been extirpated and the lack of extensive stands of riparian vegetation is a severely limiting factor.

Listed Invertebrate Species

Conservancy fairy shrimp (*Branchinecta conservatio)* is a small crustacean in the Branchinectidae family, ranging in size from ½ inch to one inch in length. This family is characterized by elongate bodies, no carapace, large stalked compound eyes, and eleven pairs of swimming legs, and the species inhabits rather large, cool-water vernal pools with moderately turbid water (Eriksen and Belk 1999). Although the historical distribution of this species is unknown, it is likely that this species once occupied suitable vernal pool habitats throughout the Central Valley and southern coastal regions of California. The Conservancy fairy shrimp is a Federal Endangered listed species, and is currently known from several distinct populations, including the Sacramento National Wildlife Refuge in Glenn County.

Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) is one of three species of *Desmocerus* known from North America. The subspecies *dimorphus* is known from riparian areas in the Central Valley (USFWS 1984). Coloration of the beetle is variable; the first pair of wings may vary from dark metallic green, with a bright red-orange border to a pattern of four oblong metallic green spots. Females are larger than males, while males possess longer, more robust antennae than females (USFWS 1984). The antennae are nearly as long as the body, extending forward from the head, thus the "longhorn" designation. The life of the beetle is restricted to elderberry (*Sambucus* spp.). Eggs are deposited in cracks and crevasses of the bark of living elderberry trees. Presumably, the eggs hatch shortly after they are laid. The larvae bore into the pith of larger stems and roots. When the larvae are ready to pupate, they work their way up from the roots, through the pith of the elderberry, and open an emergence hole through the bark. The larvae then return to the pith to pupate. Adults emerge at about the same time the

elderberry flowers (USFWS 1984). The entire life cycle encompasses two years. The loss of up to 90 percent of riparian habitat in California has severely decreased this species' range.

Vernal pool fairy shrimp (*Branchinecta lynchi*) is a small crustacean in the Branchinectidae family, also ranging in size from ½ inch to one inch in length (*http://sacramento.fws.gov/es.animal_spp_acct/vp_fairy.htm*). Elongate bodies, large stalked compound eyes, no carapace, and eleven pairs of swimming legs characterize the species. The vernal pool fairy shrimp occurs in a variety of vernal pool habitats, from small, clear sandstone rock pools to large, turbid, alkaline, grassland valley floor pools. It is most frequently found in pools in grass or mud bottomed swales, or basalt flow depression pools in unplowed grasslands, measuring less than 0.05 acre. The vernal pool fairy shrimp is widespread but not abundant, with known populations extending from Stillwater Plain in Shasta County through most of the Central Valley to Pixley in Tulare County, and four additional distinct populations exist in San Luis Obispo, Santa Barbara, and Riverside Counties. Threats to this species include the continued loss of vernal pool habitat through conversion to agricultural and urban uses.

Vernal pool tadpole shrimp (*Lepidurus packardi*) is a small crustacean in the Triopsidae family, which has compound eyes, a large shield-like carapace, and a pair of cercopods (appendages) at the end of the last abdominal segment (http://sacramento.fws.gov/es.animal_spp_acct/vp_tadpole .htm). Adults reach a length of 2 inches and have 35 pairs of legs and two long cercopods. This species climbs or scrambles over objects, in addition to plowing along bottom sediments in search of organic debris and invertebrates, including fairy shrimp. Vernal pool tadpole shrimp occur in vernal pools with clear to highly turbid water and their life history is linked to the seasonal cycle of the vernal pool. This species is known from 18 populations in the Central Valley, ranging from east of Redding in Shasta County south to the San Luis Wildlife Refuge in Merced County, and from a single vernal pool complex on the San Francisco Bay National Wildlife Refuge in The City of Fremont, Alameda County.

Listed Fish Species

Central Valley spring-run chinook salmon (*Oncorhynchus tshawytscha*) is most widely referred to as king salmon in California, but Chinook salmon has been adopted as its official common name by the American Fisheries Society (Moyle 1976). By far the largest salmon weighing 30 or more pounds, it is identified by the conspicuous large black spots on its back, both caudal fin lobes, dorsal, and adipose fins and by its black gums on the lower jaw. Spawning adults are olive brown to dark maroon or purple in color. Spawning males usually develop a hooked jaw and a raised hump, and appear darker than the females. Spawning runs once occurred as far south as the Ventura River, but at present the southernmost run occurs in the Sacramento-San Joaquin River system. Spawning age varies from one to seven years. Spawning usually occurs in large streams with coarse gravelly riffles but may also occur in small tributaries to the larger streams (Moyle 1976). Most California Chinook salmon are fall spawners, and begin to initiate their spawning migration in late September, with the majority occurring in October and November, and an occasional run as late as December and January. Before the damming of many California rivers there were also winter and spring runs, but today these exist only in special habitat situations. Chinook that make the spring-run move upriver from December through February, and then they wait until May or June to spawn, producing eggs that hatch in late summer

(McGinnis 1984). Central Valley Evolutionarily Significant Unit (ESU) includes populations spawning in the Sacramento River and its tributaries. Fish and Wildlife Service has designated critical habitat for 19 Evolutionarily Significant Units of Salmon and Steelhead in Washington, Oregon, Idaho, and California effective on March 17, 2000, which included the ESU in Central Valley (FR 50 7764). However, the critical habitat designation has been rescinded for this ESU on April 30, 2002.

Central Valley steelhead (*Onchorhynchus mykiss*) is the anadromous form of the rainbow trout. Most steelhead will spawn for the first time after spending two to three years in fresh water and then one to two years in salt water. When in fresh water they occur in cool, clear, fast-flowing permanent streams and rivers where riffles predominate over pools. This fish will survive temperatures from 0 to 28°C. Spawning usually occurs from February to June but may occur in July or August if temperatures are low in the high mountain areas. Most steelhead will migrate upstream in the fall months before spawning and will spawn in the same stream, which they had lived as fry. Riffles with gravel are the preferred locations for redd sites (Moyle 1976). Central Valley Steelhead has been listed as threatened by the federal government. The Steelhead in the Central Valley ESU has populations in the Sacramento and San Joaquin Rivers and their tributaries. Fish and Wildlife Service has designated critical habitat for 19 Evolutionarily Significant Units of Salmon and Steelhead in Washington, Oregon, Idaho, and California effective on March 17, 2000, which included the ESU in Central Valley (FR 50 7764). However, the critical habitat designation has been rescinded for this ESU on April 30, 2002.

Coho salmon–So. Oregon/No. California (*Onchorhynchus kisutch*) live for approximately 2 to 5 years. The first year and potentially the second year of their life is spent in fresh water and the next one to three years at sea. During the fall and winter months, adults return to their home stream to spawn. Spawning that occurs in California can take place anytime from early September through March. Spawning streams are typically moderate sized coastal stream, or stream tributaries to large river with summer temperatures that seldom exceed 21°C. The head of a riffle in small to medium sized gravel is the preferred locations for redd sites (Moyle 1976). Coho salmon have been listed as threatened by the federal government. The Coho salmon in the Southern Oregon and Northern California ESU occur in river basins between Cape Blanco in Curry County, OR and Punta Gorda in Humboldt Co., CA. The Coho salmon Central California Coast ESU has naturally spawning populations in streams between Punta Gorda, Humboldt Co., CA and the San Lorenzo River, Santa Cruz, Co., CA. The U. S. Fish and Wildlife Service has designated critical habitat for 19 Evolutionarily Significant Units of Salmon and Steelhead in Washington, Oregon, Idaho, and California effective on March 17, 2000, which included the ESU in Southern Oregon and Northern California (FR 50 7764).

Delta smelt (*Hypomesus transpacificus*) is native to the lower and middle reaches of the Sacramento and San Joaquin Delta. This species of fish is quite small reaching a standard length of approximately 120 mm and lives 1 year rarely 2 years (McGinnis 1984). Delta smelt are tolerant of a wide salinity range with most of the populations living at salinities less than 2 ppt for the majority of the year. They are seldom found at salinities greater than 10 ppt. During the fall, most of the population is concentrated in the lower reaches of the Delta and upper Suisun Bay. Spawning season varies from year to year and may occur form late winter (December) to early summer (July and August) with ripe smelt collected from December to April. Spawning

occurs in side channels and sloughs of the Delta. It is believed that the smelt's adhesive eggs attach to substrates such as cattails and tules, tree roots, and submerged branches (Moyle 1976). The main food source for this smelt is a variety of zooplankton but they will also eat small aquatic insect larvae when present (McGinnis 1984). The USFWS designated critical habitat for the threatened delta smelt on December 19, 1994. This final rule designates critical habitat for the delta smelt in the following geographic areas: areas of all water and all submerged lands below ordinary high water and the entire waster column bounded by and contained in Suisun Bay; the length of Goodyear, Suisun, Cutoff, First Mallard, and Montezuma sloughs; and the existing contiguous water contained within the Delta as defined in Section 12220 of the California Water Code (FR 50 65256).

Listed Reptile Species

Giant garter snake (*Thamnophis gigas*) is the most aquatic snake in California. It has well separated spots on its back, in a checkered arrangement and is brown below. The dorsal stripe is dull yellow, often with irregular edges (Stebbins 1985). The giant garter snake prefers freshwater marsh and low gradient streams. It has adapted to drainage canals and irrigation ditches. Giant garter snake is listed as threatened by both the state and federal governments. Generally, these snakes forage in and along streams eating fishes, amphibian, amphibian larvae and occasionally, small mammals and invertebrates (Zeiner *et al*. 1988). Giant garter snakes are active during the day and may bask on streamside rocks or on densely vegetated stream banks. At night, the snake seeks refuge in mammal burrows, crevices, and surface objects.

Listed Plant Species

Colusa grass (*Neostapfia colusana*) is an annual herb in Poaceae that becomes brown-sticky-glandular with age. Ascending stems grow 4 to 12 inches (1-3 decimeters) tall and bear spike-like inflorescences that resemble miniature ears of corn (Hickman 1993), which bloom between May and August. It occurs on adobe bottomed vernal pools, up to 700-foot elevations, ranging from 5-200 meters (CNPS 2001). Threats to this species include agriculture, development, overgrazing, flood control, and non-native plants.

Greene's tuctoria (*Tuctoria greenei*) is an annual grass in Poaceae that grows from 2 to 12 inches (5-30 centimeters) in height. This species is a small, delicate, annual grass with fragile stems that are often purplish. The flowering spikes are typically about 3 inches (8 cm) in length and are somewhat crowded at the stem tips (Hickman 1993). The blooming period occurs from May through September. It grows in claypan or hardpan soils in vernal pools within valley and foothill grassland habitats at elevations between 100-3,510 feet (30-1,070 meters). Greene's tuctoria is threatened by agriculture, urbanization, and overgrazing (CNPS 2001).

Hairy Orcutt grass (*Orcuttia pilosa*) is an annual herb in the grass family (Poaceae). Densely hairy plants grow in a clumped manner, and stems branch only at lower nodes (Hickman 1993). Hairy Orcutt grass occurs in vernal pools in Butte, Glenn, Madera, Merced, Stanislaus, and Tehama counties (CNPS 2001). Agriculture, urbanization, overgrazing, non-native plants, and trampling seriously threaten the species. Hairy Orcutt grass blooms from May through September and occurs at elevations ranging from 180-655 feet (55-200 meters).

Hoover's spurge (*Chamaesyce hooveri*) is an annual herb of the prostrate spurge family (Euphorbiaceae). Glabrous stems grow low to the ground and produce a milky sap. Plants bear flower-like, bell-shaped inflorescences (Hickman 1993). Hoover's spurge occurs in vernal pools in northern California and in Tulare County in the San Joaquin Valley (CNPS 2001). The species is known from approximately twenty occurrences and is threatened by grazing, agriculture and non-native plant species. Hoover's spurge generally blooms in July and August and occurs at elevations ranging from 82-820 feet (25-250 meters).

Indian Valley brodiaea (*Brodiaea coronaria* ssp. *rosea*) is a bulbiferous, perennial herb in the lily family. This subspecies is characterized by a thin corm coat, and a rose to pink-purple colored perianth that occurs on a 1 to 3 inch (4-7 centimeter) axis (Hickman 1993). Blooming occurs from May through June (CNPS 2001). Although the species occurs on serpentinite soils in closed-cone coniferous forest, chaparral, cismontane woodland, valley and foothill grassland habitats, Indian Valley brodiaea generally occurs in grassland habitats, and is known from fewer than twenty occurrences in Colusa, Glenn, Lake, and Tehama Counties, of California (CNPS 2001). Vehicles, dumping, and horticultural collecting threaten this species.

Palmate-bracted bird's-beak (*Cordylanthus palmatus*) is a hemiparasitic annual herb of the figwort family (Scrophulariaceae). This species is gray-green in color, and appears soft-hairy, reaching heights of 4 to 12 inches (Hickman 1993). The leaves may be up to 5-lobed and are more or less oblong, measuring 0.28 to 0.79 inches. Flower petals are 0.59 to 0.79 inches, whitish, with sides often pale lavender. Palmate-bracted bird's-beak occurs on alkaline soils in valley and foothill grasslands, and in chenopod scrub. This species occurs at 15-510 feet elevations in Alameda, Colusa, Fresno, Madera and Yolo Counties. It has been extirpated from San Joaquin County. The blooming period is from May through October. This species is known from only nine occurrences and is threatened by agriculture, urbanization, vehicles, grazing, industrial development, and altered hydrology (CNPS 2001).

Tracy's eriastrum (*Eriastrum tracyi*) is an annual herb in the phlox family, Polemoniaceae. Tracy's Eriastrum blooms during June and July, and this species occurs in chaparral, cismontane woodland, between 1,000-2,500 feet (315-760 meters) (CNPS 2001). Threats to this species include grazing and vehicles.

Mitigation Banks, National Wildlife Refuges, Wildlife Management Areas, Wildlife And Botanical Preserves

Glenn County contains two major portions of the Sacramento National Wildlife Refuge Complex: The Sacramento National Wildlife Refuge and the Sacramento River National Wildlife Refuge. Over 200 species of birds have been recorded in the Sacramento National Wildlife Refuge, including 26 species of waterfowl and 20 species of shorebirds.

The complex as a whole provides resting and feed areas for nearly half of the migratory birds on the Pacific flyway.

Conservation easements in Glenn County include private lands operated by Ducks Unlimited (DU). DU was contacted and a request was made to obtain GIS information regarding preserve locations in Glenn County, but at the time of this draft no information had been obtained.

Habitat Conservation Areas (HCAs) exist within the Mendocino National Forest, but are not relevant to the Confined Animal Facilities Element.

California Department of Fish and Game also manages 3,770 acres of riparian habitat along a seventy-mile reach of the Sacramento River. Called the Sacramento River Wildlife Area, it contains 8 management units. They are as follows: Wilson Landing Unit (285.5 acres), Pine Creek Unit (combined 1,061.4 acres), Shannon Slough Unit (150 acres), Ord Bend (112.2 acres), Jacinto Unit (283 acres), Oxbow Unit (94.1 acres), Beehive Unit (197.9 acres), and Princeton Unit (combined 450.2 acres). These units often abut those managed by the USFWS providing a contiguous stretch of habitat available to wildlife. A public review draft of the *Comprehensive Management Plan for the Sacramento River Wildlife Area* and the accompanying Initial Study and Negative Declaration are available at (http://www.dfg.ca.gov/srwa/).

General Plan Goals and Policies

Glenn County's goal under biological resources is "preservation and enhancement of the county's biological resources in a manner compatible with a sound local economy" (NRG-3). To support this goal, the county's General Plan contains policies and implementation measures, which are listed in Appendix B.

Areas Required for the Preservation of Plant and Animal Life. When reviewing development related proposals, NRP-47 of the *Glenn County General Plan* calls for the County to recognize and protect areas of unique biological importance. These areas have been identified in a Special Overlay Designation: Areas of Biological Importance (see Figure 2-17).

> **Biological Importance.** This overlay designation reflects areas of biological importance in Glenn County which are critical to the preservation of plant and animal life. The purpose of the designation is to identify areas where certain types of development may have an adverse impact on biological resources. In some instances, development should not occur; in others, development should occur only when it can be shown that proper protection of resources will be achieved either through mitigation or compensation. Areas identified include the Sacramento River corridor, the Sacramento National Wildlife Refuge, migratory deer herd range, naturally occurring wetlands, and stream courses such as Butte and Stony Creeks.

In addition to the general areas mentioned above, twelve specific sites were identified in the Environmental Setting Technical Paper as part of the preparation of the 1993 General Plan update:

- Llano Seco Area
- Oxbow Waterfowl Area

- Oxbow Heron Rookery
- Sacramento NWR
- Princeton Riparian Woodland
- Sacramento River Wildlife Area
- Sacramento River Oxbow Preserve
- St. John's Mountain
- Sheetiron Mountain
- Black Butte Reservoir
- Stony Gorge Reservoir
- Orland Buttes

Restorable Wetlands. In addition to Areas of Biological Importance, the General Plan also contains an overlay designation for restorable wetlands. It reflects those areas approved by the Glenn County Board of Supervisors, by Resolution No. 92-56, for waterfowl or wetland habitat easement acquisition by the U.S. Fish and Wildlife Service. The U.S. Fish and Wildlife Service proposes to acquire easements, upon a willing seller basis, using Migratory Bird Conservation Funds in accordance with the North American Waterfowl Management Plan and Central Valley Habitat Joint Venture Implementation Plan.

2.5 AIR QUALITY

Air Basin Characteristics

Glenn County is located in the western portion of the Sacramento Valley, a broad, flat valley bounded by the coastal ranges to the west and the Sierra Nevada to the east. The entire air basin is about 200 miles long in a north-south direction, and has a maximum width of about 150 miles, although the valley floor averages only about 50 miles in width.

The climate of the project area is characterized by hot, dry summers and cool, wet winters. During the summer months from mid-April to mid-October, significant precipitation is unlikely and temperatures range from daily maxima exceeding 100 degrees F to evening lows in high 50s and low 60s. During the winter highs are typically in the 60s with lows in the 30s. Wind direction is primarily up- and down-valley due to the channeling effect of the mountains to either side of the valley. During the summer months surface air movement is from the south, particularly during the afternoon hours. During the winter months wind direction is more variable.

The vertical dispersion of air pollutants in the Sacramento Valley is limited by the presence of persistent temperature inversions. Because of expansional cooling of the atmosphere, air temperature usually decreases with altitude. A reversal of this atmospheric state, where the air temperature increases with height, is termed an inversion. Inversions can exist at the surface, or at any height above the ground. The height of the base of the inversion is known as the “mixing height.” Pollutants can mix vertically to this level. Semi-permanent systems of high barometric pressure fronts frequently establish themselves over the Sacramento Valley, deflecting low-pressure systems that might otherwise bring cleansing rain and winds. Air above and below the inversion base does not mix because of differences in air density. Warm air above the inversion is less dense than below the base. The inversion base represents an abrupt density change where little exchange of air occurs. Inversion layers are significant in determining ozone formation and PM_{10} concentrations.

Glenn County experiences two types of inversions that affect the vertical depth of the atmosphere through which pollutants can be mixed. In summer, sinking air forms a "lid" over the region. These subsidence inversions contribute to summer photochemical smog problems by confining pollution to a shallow layer near the ground. Ozone and its precursors will mix and react to produce higher concentrations under an inversion. Since PM_{10} is both created in the atmosphere as a chemical reaction and directly emitted, inversions will also trap and hold directly emitted PM_{10}. Concentration levels are directly related to inversion layers due to the limitation of mixing space.

Radiative inversions are formed when the ground surface becomes cooler than the air above it during the night. The earth's surface goes through a radiative process on clear nights, where heat energy is transferred from the ground to a cooler night sky. As the earth's surface cools during the evening hours, the air directly above it also cools, while air higher up remains relatively warm. The inversion is destroyed when heat from the sun warms the ground, which in turn heats the lower layers of air: this heating stimulates the ground-level air to float up through the

inversion layer. Daytime temperature inversions during the summer are usually encountered 2,000 to 2,500 feet above the valley floor and in the winter, the inversion usually occurs 500 to 1000 feet above the valley floor. Winter inversions are usually more persistent (stable). These inversions typically occur during winter nights and can cause localized air pollution concerns near emission sources because of poor dispersion.

REGULATORY SETTING

Federal

The Federal Clean Air Act (FCAA) required the states to classify basins (or portions thereof as either "attainment@ or "non-attainment" with respect to the criteria air pollutants, based on whether or not the NAAQS had been achieved, and to prepare air quality plans containing emission reduction strategies for those areas designated as "non-attainment." Glenn County classified as attainment or unclassified for all national standards.

State

The California Air Resources (CARB) is the state air quality management agency. It regulates mobile emissions sources and oversees the activities of County Air Pollution Control Districts (APCDs) and regional Air Quality Management Districts (AQMDs). The CARB regulates local air quality indirectly by state standards and vehicle emission standards, by conducting research activities, and through its planning and coordinating activities.

California has adopted ambient standards that are in some cases more stringent than the federal standards for the criteria air pollutants (see Table 2.5-1). Under the California Clean Air Act (CCAA), patterned after the federal CAA, areas have been designated as attainment or non-attainment with respect to state standards. Glenn County region is considered to be in attainment or unclassified for all state standards except those for ozone and PM_{10}.

Table 2.5-I
Federal and State Ambient Air Quality Standards

Pollutant	Averaging Time	Federal Primary Standard	State Standard
Ozone	1-Hour 8-Hour	0.12 ppm 0.08 ppm	0.09 ppm --
Carbon Monoxide	8-Hour 1-Hour	9.0 ppm 35.0 ppm	9.0 ppm 20.0 ppm
Nitrogen Dioxide	Annual 1-Hour	0.05 ppm --	-- 0.25 ppm
Sulfur Dioxide	Annual 24-Hour 1-Hour	0.03 ppm 0.14 ppm --	-- 0.05 ppm 0.5 ppm
PM_{10}	Annual 24-Hour	50 ug/m^3 150 ug/m^3	20 ug/m^3 50 ug/m^3

Pollutant	Averaging Time	Federal Primary Standard	State Standard
$PM_{2.5}$	Annual 24-Hour	15 ug/m^3 65 ug/m^3	12 ug/m^3 --
Lead	30-Day Avg. 3-Month Avg.	-- 1.5 ug/m^3	1.5 ug/m^3 --

ppm = parts per million
ug/m^3 = Micrograms per Cubic Meter

Local

The local air district is the Glenn County Air Pollution Control District (GCAPCD), which is part of the Sacramento Valley Air Basin. The Sacramento Valley Air Basin has been further divided into two planning areas called the Northern Sacramento Valley Air Basin (NSVAB) and the Greater Sacramento Air region. Glenn County is located in the NSVAB.

The District adopts and enforces controls on stationary sources of air pollutants through its permit and inspection programs and regulates agricultural burning. Other District responsibilities include monitoring air quality, preparation of clean air plans and responding to citizen air quality complaints.

The District participates with other air districts in the Northern Sacramento Valley Air Basin in formulating open burning plans and attainment plans for achieving and maintaining state ambient air quality standards. Control measures and mitigation of indirect source emissions are developed with as much uniformity as possible, considering unique differences among the various rural and urban areas.

General Plan Goals and Policies

Glenn County's General Plan goal is "protection and enhancement of air quality." The *Glenn County General Plan* contains the following air quality policies within the Public Safety Element:

PSP-34: Support State programs to reduce backyard and agricultural burning, including development of alternatives to rice straw burning and creating markets for rice straw.

PSP-35: Review development requests to determine the impact such development will have on the existing air quality and for compliance with the air pollution reduction measures specified in the Glenn County Air Quality Attainment Plan.

PSP-36: Promote jobs/housing balance when evaluating development projects.

PSP-37: Encourage design of new development which minimizes automobile trips and maximizes other modes of transportation.

Air Quality Standards

Both the U. S. Environmental Protection Agency and the California Air Resources Board have established ambient air quality standards for common pollutants. These ambient air quality standards are levels of contaminants which represent safe levels that avoid specific adverse health effects associated with each pollutant. The ambient air quality standards cover what are called "criteria" pollutants because the health and other effects of each pollutant are described in criteria documents.

The federal and California state ambient air quality standards are summarized in Table 2.5-1 for important pollutants. The federal and state ambient standards were developed independently with differing purposes and methods, although both processes attempted to avoid health-related effects. As a result, the federal and state standards differ in some cases. In general, the California state standards are more stringent. This is particularly true for ozone and PM_{10}.

The U.S. Environmental Protection Agency established new national air quality standards for ground-level ozone and for fine particulate matter in 1997. The existing 1-hour ozone standard of 0.12 PPM microns or less) is to be phased out and replaced by an 8-hour standard of 0.08 PPM. Implementation of the 8-hour standard was delayed by litigation, but was determined to be valid and enforceable by the U. S. Supreme Court in a decision issued in February of 2001.

In 1997 new national standards for fine Particulate Matter (diameter 2.5 microns or less) were adopted for 24-hour and annual averaging periods. The current PM_{10} standards were to be retained, but the method and form for determining compliance with the standards were revised.

The State of California regularly reviews scientific literature regarding the health effects and exposure to PM and other pollutants. On May 3, 2002, the California Air Resources Board (CARB) staff recommended lowering the level of the annual standard for PM_{10} and establishing a new annual standard for $PM_{2.5}$ (particulate matter 2.5 micrometers in diameter and smaller). The new standards became effective on July 5, 2003.

In addition to the criteria pollutants discussed above, Toxic Air Contaminants (TACs) are another group of pollutants of concern. There are many different types of TACs, with varying degrees of toxicity. Sources of TACs include industrial processes such as petroleum refining and chrome plating operations, commercial operations such as gasoline stations and dry cleaners, and motor vehicle exhaust. Cars and trucks release at least forty different toxic air contaminants.

Public exposure to TACs can result from emissions from normal operations, as well as accidental releases. Health effects of TACs include cancer, birth defects, neurological damage and death.

Air Pollutant Properties, Effects and Sources

The primary air quality problems in the Sacramento Valley Air Basin are ozone and particulate matter. The following is a discussion of the properties, health effects and sources of these important pollutants.

Ozone. Ozone is produced by chemical reactions, involving nitrogen oxides (NOx) and reactive organic gases (ROG), that are triggered by sunlight. Nitrogen oxides are created during combustion of fuels, while reactive organic gases are emitted during combustion and evaporation of organic solvents. Since ozone is not directly emitted to the atmosphere, but is formed as a result of photochemical reactions, it is considered a secondary pollutant. In the Sacramento Valley Air Basin ozone is a seasonal problem, occurring roughly from April through October.

Ozone is a strong irritant that attacks the respiratory system, leading to the damage of lung tissue. Asthma, bronchitis and other respiratory ailments as well as cardiovascular diseases are aggravated by exposure to ozone. A healthy person exposed to high concentrations may become nauseated or dizzy, may develop headache or cough, or may experience a burning sensation in the chest.

Research has shown that exposure to ozone damages the alveoli (the individual air sacs in the lung where the exchange of oxygen and carbon dioxide between the air and blood takes place). Research has shown that ozone also damages vegetation.

Major sources of the ozone precursor ROG in Glenn County are on- and off-road vehicles, waste burning, and the evaporation of solvents and petroleum products. Major sources of the ozone precursor NOx in Glenn County are on- and off-road vehicles and fuel combustion.

Suspended Particulate. Suspended particulate matter (PM) is a complex mixture of tiny particles that consists of dry solid fragments, solid cores with liquid coatings, and small droplets of liquid. These particles vary greatly in shape, size and chemical composition, and can be made up of many different materials such as metals, soot, soil, and dust. "Inhalable" PM consists of particles less than 10 microns in diameter, and is defined as "suspended particulate matter" or PM_{10}. Fine particles are less than 2.5 microns in diameter ($PM_{2.5}$). $PM_{2.5}$, by definition, is included in PM_{10}.

Particles greater than 10 microns in diameter can cause irritation in the nose, throat, and bronchial tubes. Natural mechanisms remove much of these particles, but smaller particles are able to pass through the body's natural defenses and the mucous membranes of the upper respiratory tract and enter into the lungs. The particles can damage the alveoli, tiny air sacs responsible for gas exchange in the lungs. The particles may also carry carcinogens and other toxic compounds, which adhere to the particle surfaces and can enter the lungs.

The major components of suspended particulate are dust particles, nitrates, and sulfates. The majority of suspended particulate in Glenn County is directly emitted to the atmosphere as a by-product of combustion (waste burning), wind erosion of soil from farming activity, fugitive windblown dust and unpaved road travel. Small particles are also created in the atmosphere through chemical reactions.

Reactive Organic Gases (ROG). Organic gases are photochemically reactive hydrocarbons that are important for ozone formation. This definition excludes methane, carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, ammonium carbonates, methylene chloride, methyl chloroform and various chlorofluorocarbons (CFCs).

There are no health standards for ROG separately. The main concern with ROG is its role in photochemical ozone formation. In addition, some compounds that make up ROG are also toxic. An example is benzene, which is a carcinogen.

Over 23 percent of the 9.83 tons per day of ROG emissions in Glenn County in the year 2004 come from motor vehicles. Another 22 percent comes from waste burning and disposal. Another 23 percent is split between petroleum production and pesticide/fertilizer evaporation. (All emission data from ARB website: www.arb.ca.gov/emisinv/emsmain/esmain.htm)

Oxides of Nitrogen (NOx). NOx is a family of gaseous nitrogen compounds and are precursors to ozone formation. The major component of NOx, nitrogen dioxide (NO_2), is a reddish-brown gas that is toxic at high concentrations. NOx results primarily from the combustion of fossil fuels under high temperature and pressure.

Health effects associated with NOx are an increase in the incidence of chronic bronchitis and lung irritation. Chronic exposure to NO_2 may lead to eye and mucus membrane aggravation, along with pulmonary dysfunction. NOx can cause fading of textile dyes and additives, deterioration of cotton and nylon, and corrosion of metals due to production of particulate nitrates. Airborne NOx can also impair visibility. NOx is a major component of acid disposition in California.

Over 35 percent of the 8.86 tons per day of NOx emissions in Glenn County in the year 2004 came from mobile sources. Another 21 percent came from oil and gas production. Within the mobile sources category, nearly 49 percent of the NOx is from farm equipment.

Hydrogen Sulfide. Hydrogen sulfide, a potential emission from confined animal facilities, is generated by the anaerobic decomposition of manure. It has a distinct odor and can cause dizziness, nausea, and headaches at low concentrations, and more serious effects at higher concentrations. It is naturally emitted in geothermal areas and is also associated with certain industrial processes. There is a state ambient air quality standard for hydrogen sulfide but no corresponding national standard.

Ammonia and $PM_{2.5}$. Although not a criteria pollutant, ammonia is considered a precursor to the newest criteria pollutant, $PM_{2.5}$. Ammonia is considered an air toxic under the *Air Toxics "Hot Spots" Information and Assessment Act California Health and Safety Code sections 44300, et seq., 1987, Connelly* program (AB 2588). The Office of Environmental Health Hazard Assessment has established acute and chronic reference exposure levels (REL's) for ammonia. Ammonia is generated during anaerobic decomposition of manure; in high concentrations it can severely irritate the eye, ear and throat. It is a strong alkali that can react in the atmosphere to produce fine particulate in the form of ammonium nitrate or ammonium sulfate. Ammonia concentrations are not monitored in California, but the California Air Resources Board is currently developing inventories for ammonia as part of the state $PM_{2.5}$ planning process (Gaffney and Shimp, 1999).

Ammonia gas (a base) is known to react with acids in the atmosphere (typically nitric or sulfuric acid) to form ammonium nitrates or sulfates, which are particles. In the eastern portions of the country sulfates predominate because of the burning of sulfur-containing fuels, while in California the nitric acid predominates. Nitric acid is a product of photochemical reactions in the atmosphere. Ammonia is thus a potential secondary source of particulate, since the particulate results from a chemical reaction in the atmosphere.

While it is known that the release of ammonia gas is a participant in the formation of ammonium nitrate, there is currently no capability to forecast how much ammonium nitrate would be created by a release of a certain amount of ammonia. The reaction that forms ammonium nitrate is dependent on the presence of other chemicals which are in turn part of a complex photochemical process occurring in the atmosphere. At the same time, both ammonia and ammonium nitrate are subject to removal processes that constantly remove the pollutants from the atmosphere (e.g., deposition, removal by rain, participation as nuclei, etc.).

Ammonia is generated during anaerobic decomposition of manure; in high concentrations it can severely irritate the eye, ear and throat. The health effects of $PM_{2.5}$ are similar to those of PM_{10}; they can impair proper lung function and may contribute to the development of chronic bronchitis. They are a health concern because they easily reach the deepest recesses of the lungs. Scientific studies have linked particulate matter (alone or in combination with other air pollutants) with a series of health problems, including premature death, respiratory related hospital admissions or emergency room visits, aggravated asthma, chronic bronchitis, decrease in lung functions, and work and school absences. Those who are most at risk are the elderly, individuals with preexisting heart and lung disease, children, and asthmatics and asthmatic children.

Methane. Methane is an odorless greenhouse gas that absorbs and reflects terrestrial radiation back to the earth. The recent phenomenon of rising temperatures reported from greenhouse gases is known popularly as global warming. Methane is emitted into the environment from various sources including ruminant livestock and manure decomposition. Methane released from domesticated ruminant livestock accounts for about 30 percent (about 80 million metric tons per year) of the anthropogenic methane generated in the United States; (U.S. *EPA, Final Report on U.S. Methane Emissions 1990-2020: Inventories, Projections, and Opportunities for Reduction,* EPA 430-R-99-013, September 1999).

Methane generation from ruminant animals is influenced by feed quality, essential nutrients in the feed, feeding level and schedule, and animal health. Methane is released through the animal's mouth and nostrils and from anaerobic decomposition of livestock manure. Of the major greenhouse gases, methane has a relatively short lifespan in the atmosphere. Removal from the atmosphere occurs due to chemical reactions in the atmosphere, as well as from microbial uptake by soils.

There are no state or national ambient air quality standards for methane, and it is not considered a precursor of any other pollutant. Regulatory requirements for the reduction of control of methane emissions have not been established on the Federal, State, or local levels. However, EPA prepares methane emission source inventories as required by the CAA amendments. The

five major anthropogenic sources of methane in the United States have been identified to be (in order of contribution): solid waste disposal, domesticated livestock, natural gas and oil production, coal mining, and livestock manure (U.S. EPA, 1999). Methane has been determined to be the second most significant greenhouse gas that reportedly contributes to global warming.

Ambient Air Quality

The GCAPCD currently operates an air quality monitoring station in Willows Red Bluff measuring ozone and inhalable particulate matter (PM_{10}). Exceedances of the state/national standards during the period 2002-2004 are shown in Table 2.5-2. No violations of the state/federal ozone standards were recorded during this time. While the federal standard for PM_{10} was met during this period, the more stringent state standard was exceeded between 1 and 7 days each year.

Table 2.5-2
Air Quality Data Summary for Willows, 2001-2003

Pollutant	Standard	Days Standard Was Exceeded During:		
		2002	2003	2004
Ozone	Federal 1-Hour	0	0	0
Ozone	State 1-Hour	0	0	0
Ozone	Federal 8-Hour	0	0	0
PM_{10}	Federal 24-Hour	0	0	0
PM_{10}	State 24-Hour	7	3	1

Source: Air Resources Board, Aerometric Data Analysis and Management (ADAM), 2005.

Regional Air Quality Planning

Both the federal and state governments have enacted laws mandating the identification of areas not meeting the ambient air quality standards and development of regional air quality plans to eventually attain the standards. Under the federal Clean Air Act, Glenn County is currently considered attainment or unclassified for all national ambient air quality standards. It is a nonattainment area[1] for the more stringent state ambient air quality standards for ozone and PM_{10}. The air districts of the Northern Sacramento Air Basin have jointly prepared and adopted a uniform air quality attainment plan addressing ozone and PM_{10} (NSVAB, 2003).

The U.S. Environmental Protection Agency has are both recommending that Glenn County as unclassifiable/attainment for the two new federal standards for 8-hour ozone and $PM_{2.5}$. (see Table 2.5-3).

[1] Glenn County is designated Nonattainment/Transitional for the state ozone standard. An area is designated nonattainment/transitional to signify that the area is close to attaining the standard for that pollutant.

Table 2.5-3
Glenn County Air Quality Status

Pollutant	Designation	
	Federal	California
Carbon Monoxide	Unclassified/Attainment	Unclassified
Sulfur Dioxide	Unclassified/Attainment	Attainment
Nitrogen Dioxide	Unclassified/Attainment	Attainment
PM_{10}	Unclassified/Attainment	Nonattainment
$PM_{2.5}$	Unclassified/Attainment	Unclassified
Ozone	Unclassified/Attainment	Transitional

Source: Quad Knopf, Inc.

SB700

California State Senate Bill 700 (SB700), which became effective January 1, 2004 removes agriculture's exemption from all air quality permitting activities, including Title V provisions of the FCAA and places much stricter controls on agricultural sources. Where non-attainment of federal standards occurs, SB700 requires all "large confined animal facilities" to apply for permits and reduce their emissions. SB700 defines two terms: "Agricultural source of air pollution" and "fugitive emissions".

SB700 requires an air district that is nonattainment for a federal particulate standard to establish Best Available Control Measures (BACM) and Best Available Retrofit Control Technology (BARCT) for discing, tilling, cultivation, and the raising of animals. The BACM and BARCT standards are to be done by regulation and included in a State Implementation Plan (SIP), according to a specified schedule. SB700 reiterates language from other parts of the Health and Safety Code about findings the districts must make before adopting the regulation, especially findings about cost-effectiveness. SB700 also contains a new requirement to compare cost-effectiveness of measures to be adopted under this section, and to adopt the most cost effective first.

SB700 requires the Air Resources Board (ARB) to review all relevant scientific and technical data regarding confined animal facilities, their emissions, and the effect of those emissions on an air basin's attainment of any ambient air quality standard. Based on this data, ARB is tasked with defining "large confined animal facility" which will then be regulated by regional/local air districts.

SB700 requires districts that are non-attainment for the federal ozone standard to develop a regulation (included in the SIP) to issue permits and mitigate emissions from "large confined animal facilities" as defined by ARB. If the ARB definition includes sources that emit less than 50% of the major source threshold, the district must make certain findings before requiring them to obtain permits (i.e., that the permit is necessary and not disproportionately burdensome). The degree of mitigation called for under this section is "to the extent feasible." There is a schedule

for rule adoption (7/1/06) and implementation (7/1/07). SB700 reiterates the findings from other places in the Health and Safety Code that a district must make prior to adopting the regulation.

Sensitive Receptors

Table 2.5-4 outlines the properties and effects of gases emitted from confined animal facility production.

Table 2.5-4
Properties and Effects of Gases Emitted from Dairy Production

Gas	Source	Properties	Heath Effects		Environmental Effects
			Concentration	Symptom	
Ammonia (NH3)	Manure decomposition, composting, manure handling, storage application	Sharp, pungent odor (like glass cleaner) Lighter than air	2-6 ppm 20-30 ppm 40-200 ppm 3,000 ppm 5,000 ppm	Detectable but not a risk to public health Burning eyes Headaches, nausea, respiratory irritation Asphyxiating Could be fatal	Contributes to the formation of airborne particulates May react with other compounds, potential leading to acid rain and ozone depletion Soil and water acidification Contributes to odor
Hydrogen sulfide (H2S)	Bacterial decomposition in manure without oxygen (anaerobic)	Heavier than air Accumulates near the floor in enclosed buildings Initially a rotten egg smell, but lethal concentrations paralyze sense of smell	2 ppm 20 ppm 50 ppm >500 ppm	Detectable Paralyzes sense of smell Dizziness, nausea, headache, respiratory irritation Death from respiratory paralyzes in seconds	May react with other compounds, potentially leading to acid rain
Methane (CH4)	Decomposition of manure without oxygen (anaerobic)	No smell Lighter than air	50,000 ppm 500,000 ppm	Explosive when mixed with air Can cause headaches and eventually asphyxiation when oxygen is displaced	A greenhouse gas that may contribute to global warming

Gas	Source	Properties	Heath Effects		Environmental Effects
			Concentration	Symptom	
Carbon dioxide (CO2)	Anaerobic and aerobic decomposition of organic materials Plant and animal respiration Combustion of fossil fuels	No smell Heavier than air	30,000 ppm 40,000 ppm 100,000 ppm 300,000 ppm	Increased rate of breathing Drowsiness headache Dizziness, unconsciousness Could be fatal in 30 minutes	A greenhouse gas that may contribute to global warming Removed from the air by photosynthesis Stored in soils and oceans
Nitrogen oxides (NOx)	NOx naturally generated by bacterial processes, decomposition and fires Humans contribute primarily by burning fossil fuels	NO and N2O are colorless, NO2 is reddish brown NO2 is the most common of NOx and is one of the main components of smog		NOx not very soluble so symptoms may be delayed. Effects include respiratory irritation, coughing, fever, and in extreme conditions respiratory failure.	Potentially toxic to plants, leading to reduce growth. NOx are the most potent greenhouse gases emitted by agriculture May deplete ozone
Trace gases associated with odor	Anaerobic decomposition of manure	Often have distinct smells	In low quantities, these compounds are not considered a serious threat to human health		Contributes to odor May form airborne particulates

A sensitive receptor is generally defined as a location where human populations, especially children, seniors, and sick persons are present and where there is a reasonable expectation of continuous human exposure to pollutants.

Sensitive receptors normally refer to land uses with heightened sensitivity to localized, rather than regional, pollutants. Examples include emissions of criteria or toxic air pollutants that have health effects (PM_{10}, ammonia, H_2S), and to a lesser extent odors or odorous compounds such as ammonia and H_2S. Sensitive receptors would not be directly affected by emissions of regional pollutants such as ozone precursors (ROG and NO_x).

The term "sensitive receptor" does not have a distance associated with it; its "sensitivity" is a function of the land use and not necessarily the presence or lack of nearby sources. Guidance from other air districts does offer some "screening" distances between various sources and sensitive receptors. For example, the San Joaquin Unified Air Pollution Control District "screening" (analysis - no analysis) distance for a dairy is given as one mile.

Odors Associated with Confined Animal Facilities

Odor is generally considered more of a nuisance than a health risk to neighbors, because of the degree of dilution and dispersion that occurs within short distances from the odor source, odor's

impact on health is uncertain due to the high number of compounds that may be present at extremely low concentrations. Because it is regarded as a nuisance by many people, odor is considered as a land-use issue and may be handled by local jurisdictions.

There is a difference between the psychological and physiological health effects related to odor exposure. Psychological effects such as irritation can result from exposure to odor and often occur at levels well below those that can harm human health. Physiological effects can occur from exposure to specific compounds that make up odor, for example, asphyxiation from exposure to hydrogen sulphide (H_2S) in a confined space. It is difficult to evaluate odor and its health effects for the following reasons:

- Psychological and physical health effects are not necessarily independent.

- Odor from livestock is made up of about 160 compounds. Humans have many and varied responses to these compounds.

- The proportion and characteristics of odor contributed by each of the primary sources (barns, storages and land application) are not well understood. Research is underway to characterize odors released from each of these sources.

- Odor intensity and offensiveness vary between individuals.

- Combining different odor compounds can have positive and negative effects on odor's intensity and offensiveness. These effects are not easily predicted. Eliminating all odor from livestock operations is not feasible. However, there are management practices that can control odor within reasonable limits. Odor mitigation practices should strive to reduce the nuisance to neighbors, by minimizing the frequency, intensity, duration and offensiveness of odors.

2.6 AESTHETICS/LIGHT AND GLARE

Although tourism currently is not a large industry in Glenn County, it is regarded as having the potential to help diversify the county's economy in the long run. In part to safeguard that potential, the General Plan includes a goal (NRG-7) to preserve aesthetic resources and values, including scenic vistas, natural areas, and historical and cultural resources (see Cultural Resources).

There are no eligible or State-designated scenic highways within Glenn County under guidelines established by Caltrans. Moreover, in supporting the development of tourism, the county considers its highways, particularly I-5, as "gateways" that play an important role in fostering the impressions that visitors or passing travelers have of the area. As a consequence siting of confined animal facilities visible from I-5 should be given careful consideration. General Plan policies relating to highway scenery are listed in Appendix B.

Light And Glare

There are no unusual sources of light and glare in Glenn County. Noteworthy sources of ambient light include traffic on I-5, high school stadiums when in use, and outdoor lighting of industrial and commercial developments. CAFs can contribute to night sky degradation due to use of unshielded security and corral lighting. General Plan policies light and glare are listed in Appendix B.

2.7 SOLID AND HAZARDOUS WASTE

Solid waste in Glenn County is collected by franchised haulers, with rates set by the Board of Supervisors for the unincorporated area. There is one sanitary landfill in the county, located on Road 33, west of the community Artois.

The landfill is operated by Glenn County under a Joint Powers Agreement with the cities of Orland and Willows. The site has sufficient capacity until 2020 (Tom Varga, Glenn County Public Works, pers. comm., March 26, 2004). No new facilities are planned in the county, and it is anticipated that additional land will be utilized in the immediate vicinity of the existing site for expansion purposes.

According to the COSWMP, opportunities for resource recovery are limited in Glenn County because most materials must be hauled to locations outside the county. Hazardous waste has been described, quantified and projected in the Glenn County Hazardous Waste Management Plan (CHWMP). There are currently no industries in the county authorized to provide onsite treatment of hazardous wastes, and there are no hazardous waste treatment, storage or disposal facilities located in Glenn County.

Most animal solid wastes are handled on-site or transported to off-site locations for use as fertilizer. Household wastes should not increase significantly as a result of confined animal facility construction.

General Plan Goals and Policies

Glenn County's overall goals in this area are to reduce the County's reliance on landfilling, reduce the volume of the solid waste stream, increase recovery of materials, and dispose of remaining waste in the most environmentally and fiscally responsible manner available. Relevant solid waste and hazardous materials policies and implementation strategies are listed in Appendix B.

2.8 POPULATION AND HOUSING

Between 1990 and 2004, the population of Glenn County increased by just over 2,900 residents, from 24,798 to 27,750 residents (California Department of Finance). This growth represents a 12 percent increase 14 years, or an average annualized growth rate of slightly less than 1 percent per year. The number of residents added during this same period in Orland and Willows was 1,473 and 387, respectively. Together these two cities absorbed approximately 65% of the new residents to the county, while growth in unincorporated areas totals 1,044 new residents or 36 percent of the total. Table 2.8-1 shows the population for Glenn County, Orland, and Willows for the years 1990, 2000, and 2004. Current population projections for Glenn County have not yet been released by the Center for Economic Development, Cal State University, Chico.

Table 2.8-I
Historical Population Trends for Glenn County and Major Cities

Area	1990	2000	2004
Glenn County	24,798	26,453	27,750
City of Orland	5,052	6,281	6,525
City of Willows	5,988	6,220	6,375

Source: California Department of Finance

Glenn County had a total of 7,268 single family homes as of 2002, according to the Construction Industry Board. Median value for all owner-occupied housing units was $97,800. Table 2.8-2 shows other housing statistics for the county.

Table 2.8-2
Housing Statistics for Glenn County

Description	Number
Total Single Family Homes in County	7,268
Median value for all owner-occupied housing units	$97,800
Average housing cost – new house	$140,000
Average housing cost – resale	$115,000
Average housing cost – average listing	$129,000
Average housing cost – 2-bedroom condominium	Not available
Average monthly rental cost – 2-bedroom apartment	$365/month
Vacancy rate – average annual apartment vacancies	1-2%

1. Source: Construction Industry Research Board
2. Source: U.S. Dept. of Commerce, Bureau of Census, Census 2000
3. Source: Pamela Roundy, Broker/Property Manager
4. Assumptions: Single-family home, 3 bedroom, 2,000 sq. ft.

It is anticipated that new confined animal facilities will bring additional employment and economic opportunity to Glenn County, which will increase demand for housing. Although employee housing is often provided on-site, competition for housing resources in existing communities will also increase.

General Plan Goals and Policies

As of the end of 2003, Glenn County had not completed its update of the Housing Element for its General Plan. The County's goal is "development, through public and private resources, of sufficient new housing to ensure the availability of safe, affordable housing for all households in the Glenn County unincorporated area. Related General Plan policies are listed in Appendix B.

2.9 TRAFFIC/CIRCULATION

Figure 2-18 shows roads of regional significance serving Glenn County and the adjacent region. The major north-south road is Interstate 5 (I-5), which provides major connection between Glenn County and major cities to the north, such as Red Bluff and Redding, and to the south to cities such as Sacramento. East of I-5, Routes 32 and 162 are the major east-west roads. Route 32 provides a connection through Orland to Chico, the closest of the major urban areas of California to Glenn County residents. To the south, approximately 16 miles, Highway 162 provides a similar connection to Oroville. The next major east-west road to the south is Highway 20 (approximately 23 miles south of Highway 162), which provides a connection to the Yuba City-Marysville area. Highway 45 is the only major north-south road east of I-5. It serves adjoining land uses as well as providing a connection between State Routes 32, 162, and 20.

State Route 162 is the only State Route west of I-5. The Route originally began at Highway 101 in Mendocino County and continued into Glenn County, but a 70-mile break currently exists (34 miles of which is in Mendocino County and 36 miles in Glenn County). The intermediate mileage is a seasonal road owned and maintained by Mendocino and Glenn Counties. This travel corridor, as shown in Figure 2-18, is the only east-west route between I-5 and Highway 101 between State Routes 20 and 36, a distance of approximately 75 miles.

The jurisdictions responsible for public roads within Glenn County include the County, incorporated cities (Orland, Willows), the State of California, and the U.S. Forest Service. The road system can also be broken down by functional classification and funding category. Table 2.9-1 shows the breakdown of mileage by these categories. Functional classifications include Principal Arterial, Minor Arterial, Major Collectors, Minor Collectors, Primary Roads (FAP), Federal-Aid to Secondary Roads (FAS). There are no Federal-Aid to Urban roads (FAU) within the county.

Table 2.9-I
Classification of Roads in Glenn County

Road Category	Mileage	
	Category Breakdown	Totals
Principal Arterials (Interstate)		
Interstate 5		29
Minor Arterials (Federal-Aid Primary)		52
State Route 32	10	
State Route 45	24	
State Route 62 (east of I-5)	18	
Major Collectors (Federal-Aid Secondary)		194
State Route 162 (west of I-5)	28	
Road 307 (Forest Highway)	36	
Other County Roads	130	
Minor Collectors (County)		141
Local Roads (County)		791
Paved	628	

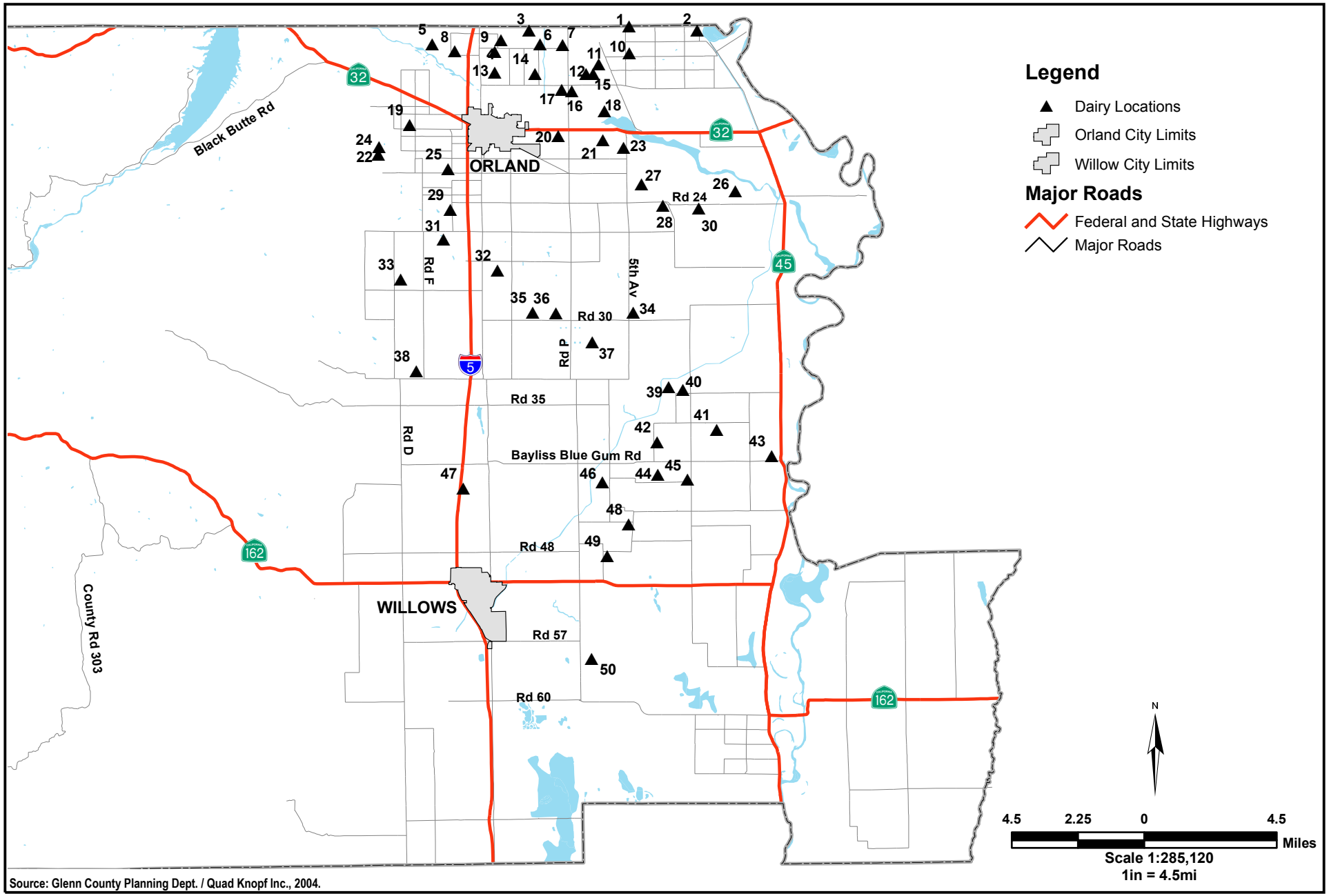
Road Category	Mileage	
	Category Breakdown	Totals
Unpaved	163	
U.S. Forest Service Roads		387
Total Roads in County		1,594

Source: Glenn County General Plan

A five-level rural functional classification system has been created for roads within Glenn County. The system applies outside of the urban area boundaries established by the U.S. Census for Orland and Willows. Table 2.9-2 summarizes the functions of each classification, allowable adjacent development, traffic volume range, speed limit, and design options.

Table 2.9-2
Rural Circulation Classifications

Classification/Function	Adjacent Development	Traffic Volume/Travel Speed/Design Options
Rural Principal Arterial Interstate highway or roadway connecting a principal arterial with cities ≤50,000 in population or two or more cities with ≤50,000.	Minimize driveways. No access to residential lots.	10,000 VPD 55 mph (non-Interstate), 65 mph (Interstate) 2/3-lane undivided 4-lane undivided 4/6-lane divided
Rural Minor Arterial Integrated intercounty road connecting major communities (3,000-50,000 pop.) or principal/minor arterials.	Provide adequate spacing for driveways.	2,500 to 10,000 VPD 55 mph 2/4-lane undivided
Rural Major Collector Primarily intracounty travel serving smaller communities (≤2,500 pop.) and countywide trip generators.	Minimize single driveways for residences. Minimize on-street parking. Medium-scale commercial/industrial development permissible.	500 to 2,500 VPD 45 to 55 mph 2-lane undivided
Rural Minor Collector Carries traffic from residential subdivisions/settlements, farms, and other local area trip generators to higher classification roads.	Mix of single driveways and common driveways or local roads for groups of dwelling units. On-street parking acceptable where appropriate. Small-scale commercial or industrial development permissible.	200 to 1,000 VPD 35 to 45 mph 2-lane undivided
Rural Local Access to adjoining property, primarily residences, farms, or resource extraction operations.	Primarily residences facing street with single-residence driveways. On-street parking desirable except for estates and rural areas. No commercial or industrial development.	50 to 500 VPD 25 to 30 mph 2-lane undivided



Source: Glenn County Planning Dept. / Quad Knopf Inc., 2004.

Quad Knopf

Figure 2-18

REGIONAL ROADWAY NETWORK IN GLENN COUNTY

Job No. 03157

The rural functional classification system applies outside of the urban area boundaries established by the U.S. Census for Orland and Willows.

General Plan Standards and Policies

The *Glenn County General Plan* calls for a Level of Service C for road segments and signalized intersections within the county. Exceptions to this standard where Level of Service D or E is forecast are granted only where it can be demonstrated that topography, environmental impacts, or other significant factors make mitigation measures impractical. Level of Service F is considered unacceptable under all conditions.

Table 2.9-3 shows the road design standards for new construction or projects that upgrade roadway widths.

Table 2.9-3
Road Design Standards

Design Hourly Volume (ft.)	Traveled Way Each Side (ft.)	Paved Shoulder	Total Roadbed Width (ft.)
100-200 vehicles/hour	22	6	34
Over 200 vehicles/hour	24	8	40

Source: Glenn County General Plan

Generally, confined animal facilities do not generate significant amounts of traffic and have limited effect on LOS and demand for additional roadways. Truck traffic generated by such facilities does, however, have a potentially adverse effect on roadway integrity and can cause pavement deterioration and contribute to the need to upgrade and rebuild existing roadways. The General Plan proposes that roadbed design should be reviewed on a case-by-case basis because of the significant variation in soil conditions that occur within the county. In general, poor drainage of soils in the south create additional costs for roadbed construction. Other General Plan policies that may apply are listed in Appendix B.

2.10 CULTURAL RESOURCES

Previous archaeological record searches have revealed that numerous sites have been recorded in Glenn County. These sites include 164 villages, 92 campsites, 90 lithic scatters, 104 historic sites, 11 quarries, and 3 rock shelters. The location and environmental context of the sites vary, based on the following four general environmental zones which are described from east to west across the county:

- Riverine Zone
- Valley Zone (between the river and foothills)
- Foothill Zone
- Coast Range Zone

The Riverine Zone includes the Sacramento River and surrounding natural levees and floodplains. Within this zone, most sites are villages typically located on raised areas adjacent to the river. Within the Valley Zone most recorded sites are smaller villages or campsites located along the seasonal streams, and historic sites such as homesteads.

The Foothill Zone has the highest density of sites, including historic ranching and homesteading sites, prehistoric villages, and task sites, most of which are close to water sources. The Coast Range Zone has a lower density of sites, with most sites located on ridge tops, along streams, and on mid-slope flats.

Confined animal facilities have the potential to disrupt such sites and it will be necessary to create a process ensuring that adequate precautions are taken prior to and during construction.

General Plan Policies

Glenn County's General Plan contains a goal to identify and preserve cultural resources within the county. General Plan policies are listed in Appendix B.

2.11 PUBLIC SERVICES

In the context of the development of confined animal facilities, the key public services that are likely to be affected are public safety (Sheriff's Office and Fire Protection) and gas and electric utilities. Confined animal facilities usually provide their own water and wastewater treatment.

Law Enforcement

The Glenn County Sheriff's Office provides law enforcement services within unincorporated areas of the county. The two incorporated cities within the county, Willows and Orland, are served by the Willows and Orland Police Departments, respectively. The California Highway Patrol polices State Highways 162, 45, and 32, Interstate Route 5 (I-5), and all unincorporated roadways.

The Glenn County Sheriff's Office currently has 23 sworn officers. Other personnel include 13 administrative staff, twenty-two correctional staff, and one food manager. The main Sheriff's station is located at 543 West Oak Street in downtown Willows with two substations located in Orland and in Hamilton City. The Office maintains roughly two dozen vehicles, including marked and unmarked patrol cars, jail-related vehicles along with two boats and a Wave Runner. Services provided include citizen and property protection, enforcement, and administration. In addition to providing its own dispatch services, the Sheriff's Office renders these services to both Willows and Orland Police Departments primarily during the evening and early morning hours. The Sheriff acts as the County Coroner investigating all deaths occurring in the county (pers. comm. Undersheriff Glenn Padula, March 12, 2004). The *Glenn County General Plan* calls for staffing levels to be at a ratio of one officer per 1,000 population. The County is currently four officers short of that level.

Fire Hazards and Fire Protection

Fire protection in Glenn County is provided by twelve individual fire districts which include the cities of Willows and Orland. On a seasonal basis, protection is also provided by the California Department of Forestry (CDF) in the unincorporated foothill and rural areas. In the areas covered by the CDF that are also served by a fire district, both respond to fires during the fire season (approximately May 1 to November 1).

The U.S. Forest Service responsible for wildland fire protection within the Mendocino National Forest boundary. The Forest Service has an agreement with CDF to provide protection to private in-holdings within the National Forest. The Willows Fire District is the only district in the county with full-time paid personnel. The General Plan calls for an ISO rating of no less than eight for rural areas and an ISO rating of no less than five for areas within urban limit lines.

Utilities

Natural gas and electrical service in the county are provided by Pacific Gas and Electric Company (PG&E). PG&E owns, operates and maintains electric service in the Glenn county region. The Pacific Northwest-Pacific Southwest Intertie transmission line runs in a north-south

direction through Glenn County approximately four miles west of I-5. The California-Oregon Transmission Project, completed in 1993, added 500,000 volts of capacity within the existing transmission corridor.

There are currently four primary natural gas transmission pipelines serving Glenn County, including a thirty-six inch diameter pipeline that spans the county from north to south along I-5. Smaller gas pipelines transport natural gas from gas field sites within the county to PG&E's main gas pipeline system.

Chapter Three

Analysis of Opportunities & Constraints

CHAPTER THREE
ANALYSIS OF OPPORTUNITIES AND CONSTRAINTS

3.1 POTENTIAL TARGET AREAS FOR NEW CONFINED ANIMAL FACILITIES

Existing confined animal facilities in Glenn County are scattered around the eastern third of the county (Figure 1-2, Dairy Locations). The majority of these facilities, mostly dairies, are located within a five-mile radius of Orland. Other, smaller groups are located east of Artois and Willows. A handful are located within a narrow corridor west of Interstate 5 (I-5).

Newer confined animal facilities are likely to be located in areas where large acreages are available, allowing sufficient room for application of manure liquids and solids for fertilizer and for the production of silage to feed milking cows and support stock. Most applications for dairy projects reviewed by California counties are for projects with herd sizes of at least several thousand head, including support stock. A 2004 USDA study confirms that economies of scale available to larger operations results in lower costs (Short, February 2004). Animal densities for new dairies range from three to eight head per acre. Assuming new confined animal feeding operations have herd sizes of 2,000 head or greater, applicants will require properties that are at least a half a section or 320 acres. Figures 3-1 through 3-4 show possible targets for new dairies in Glenn County based on this minimum property size. However, given current economic trends and increasingly strict requirements of the Central Valley Regional Water Quality Control Board (RWQCB), most confined animal facility applicants are likely to select properties of at least 640 acres.

3.2 LAND USE CONFLICTS

Land-use conflicts involving agricultural versus non-agricultural uses usually revolve around nuisances or quality-of-life issues as described in Table 3-1. Residents at home or those associated with sensitive land uses, such as schools or medical facilities most often complain about unpleasant odors, dust, flies, or truck traffic. Depending on the location and size of a confined animal facility, some residents may also complain about what they consider to be unattractive views associated with concentrations of barns, stalls, pens, and large numbers of animals in confined spaces.

Table 3-1
Types of Land-Use Conflicts Involving Confined Animal Facilities

Typical Concerns Associated With Confined Animal Facilities	New Residential Impacts on Existing Confined Animal Facilities
Odor Dust Flies Truck Traffic Visual	Encroachment of a residence or other non-agricultural development on barns, stalls, pens, and waste treatment facilities, creating a nuisance condition that did not previously exist.

Source: Quad Knopf, Inc.

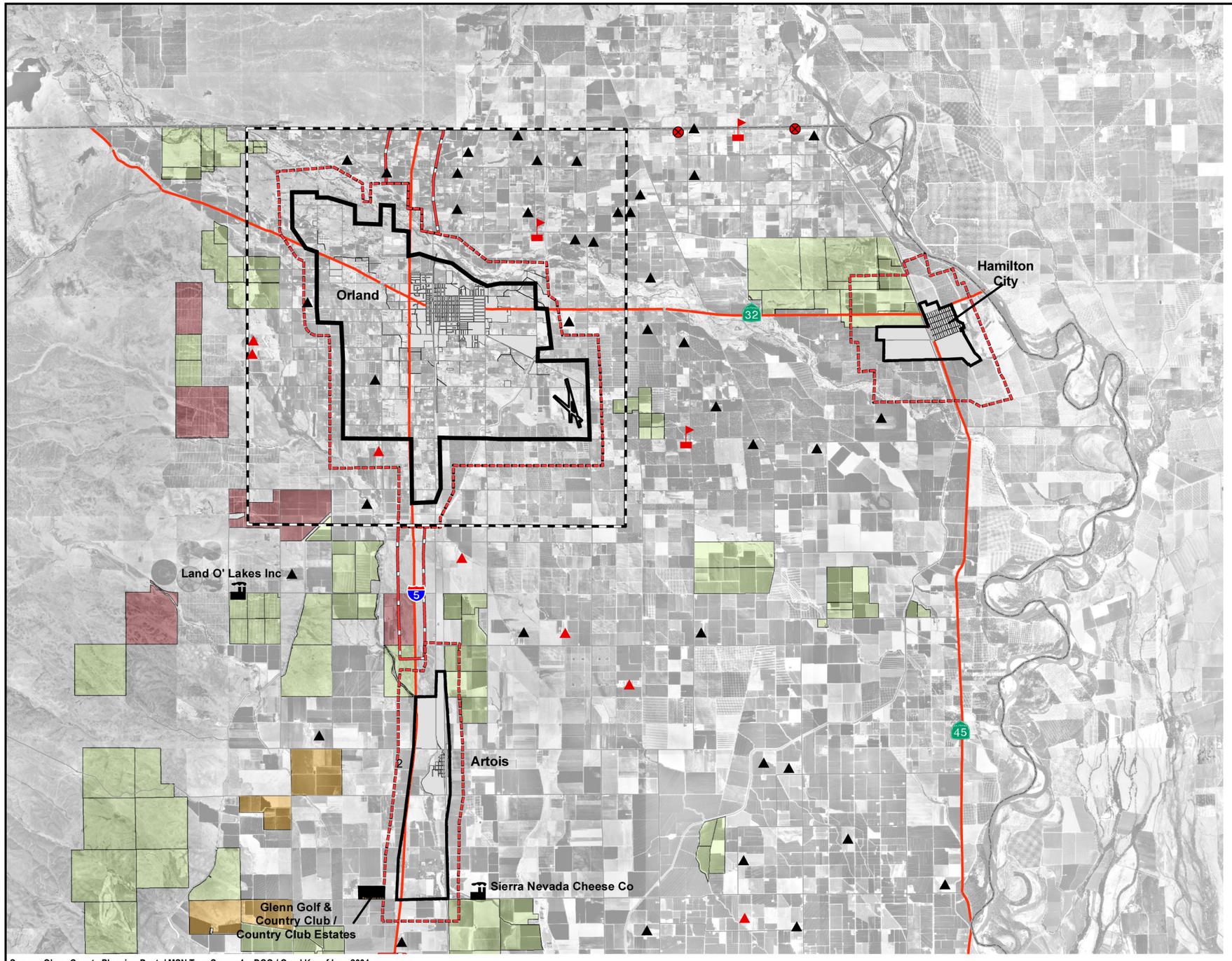
Odors

Among these complaints, odor is the most controversial nuisance problem associated with confined animal facilities. Odors are discussed in the context of Air Quality in Chapters Two, Section 2.5 and Chapter Three, Section 3.4. Complaints about odor come from downwind neighbors, for the most part. Odors from confined animal facilities come from three primary sources: manure storage units, animal housing, and land application of manure (Jacobson, Schmidt, Nicolia, Bicudo). The odors consist of gases, such as ammonia, hydrogen sulfide, methane, and organic compounds produced during decomposition of manure. Although some of the gases are known to be harmful or toxic in large amounts, the principal effect upon humans is annoyance or nuisance. The rules and regulations controlling livestock odors and air emissions are based primarily on the concept of nuisance, not the regulation of pollution per se under the Clean Air Act or other federal environmental laws.

Odor lends itself to control through the use of improved manure management practices in the three sources listed above. Control practices include diet manipulation, manure additives, oil sprinkling in animal pens, solid separation, solid composting, anaerobic or aerobic digestion, exhaust air treatment, covers, and the control of odor-causing dust. A discussion of these techniques can be found in "Odor Control for Animal Agriculture" from the University of Minnesota Extension Program (see Appendix C).

Although the effect of odor on people varies by the individual, some attempts have been made at quantifying a relationship between distance from confined animal facilities as a source of odors and the level at which such odors would be considered an annoyance, as opposed to just detectable. Researchers at the University of Minnesota have developed an "Odor from Feedlots Setback Estimation Tool" (OFFSET) that provides a worksheet for calculating a Total Odor Emission Factor based on information calculated for a particular source (Jacobson, 2001). An article describing the tool and its use can be found in Appendix D. This tool has been used in field surveys to estimate the odor nuisance factor for various types of feedlots, including beef cattle, dairy, and poultry farming. "Total Odor Emission Factors" have also been plotted against a range of separation distances to calculate frequencies at which the odor would be an annoyance. The conclusions show that even at a "high" Total Odor Emission Factor (poor management practices), a 2,500-foot setback brings the annoyance-free frequency up to 91%. At "low" levels of Total Odor Emission Factor (good management practices), the 91% level can be achieved with a setback of 1000 feet.

OFFSET estimates, however, are not necessarily guaranteed to work for conditions in Glenn County, at least for evaluating the effectiveness of buffers for the types of confined animal facilities projects now in the planning stages. OFFSET was validated in Minnesota on farms in the range of 500 - 1000 animal units. University of Minnesota researchers note that larger dairies would stretch the limits of the model and that new emission factors would need to be developed and validated. OFFSET researchers also note that weather patterns are also different in the Sacramento Valley, although they consider wind speed and stability factors to be more critical than relative humidity.



Legend

- Dairy Locations
- Dairy Locations (Herd Size Greater than 1000)
- School Locations
- Cluster of Homes (5 or more)
- Urban Constraint (Primary Conflict Zone)
- Windshed Buffer*
- I-5 Quarter Mile Buffer
- Secondary Conflict Zone
- Large Properties **
- Existing Large Orchard Fields
- Existing Large Rice Fields

* 1/2 mile in prevailing wind directions, 1/4 mile in other directions. (See Windrose in Figure 3-5.)

** Parcels greater than or equal to 320 acres, zoned AE-20, AE-40, AP-80.

N

2 1 0 2 Miles

Scale 1:126,720
1in = 2mi

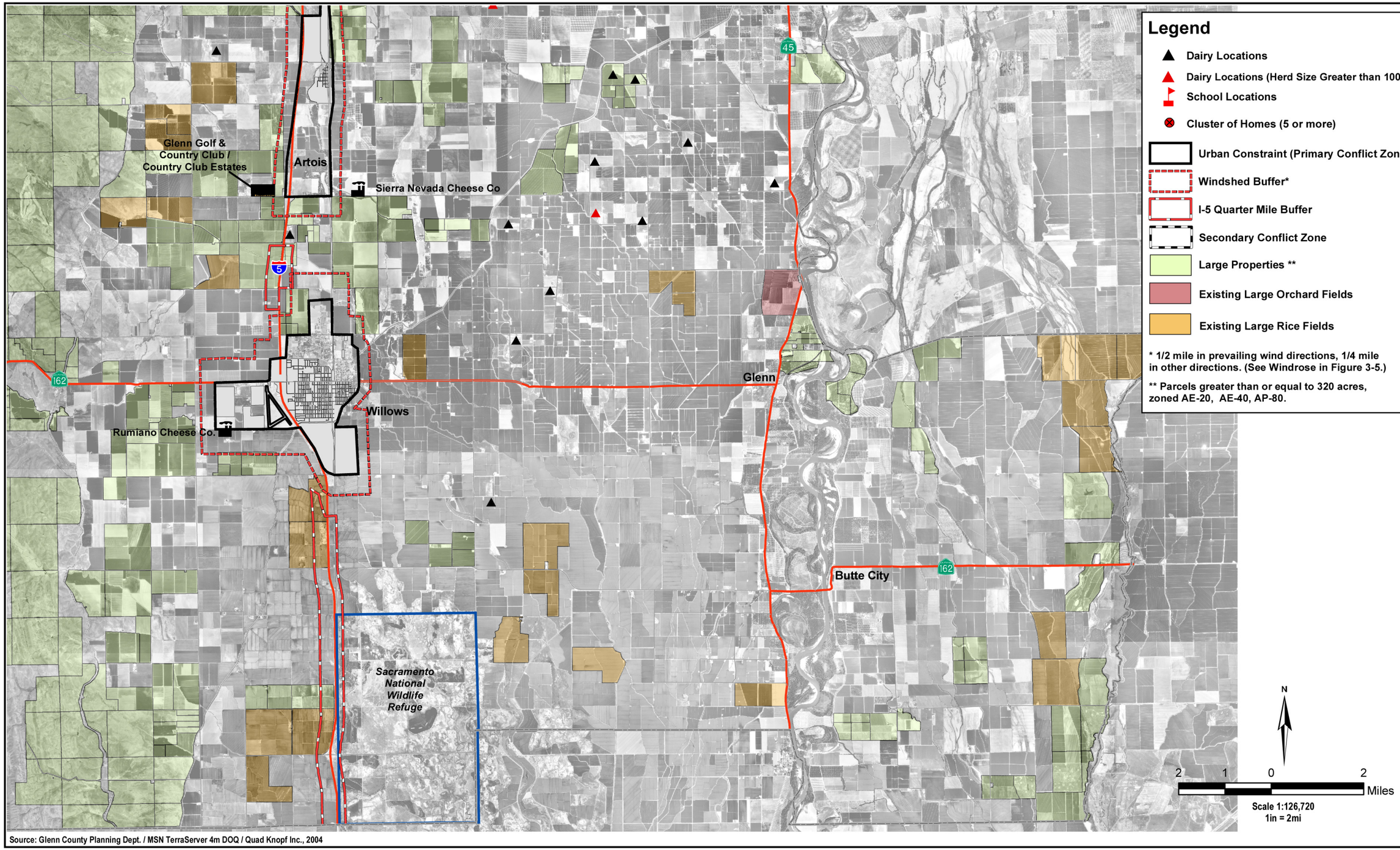
Source: Glenn County Planning Dept. / MSN TerraServer 4m DOQ / Quad Knopf Inc., 2004

Quad Knopf

Figure 3-1

LAND USE OPPORTUNITIES AND CONSTRAINTS - NORTH GLENN COUNTY

Job No.: 03157



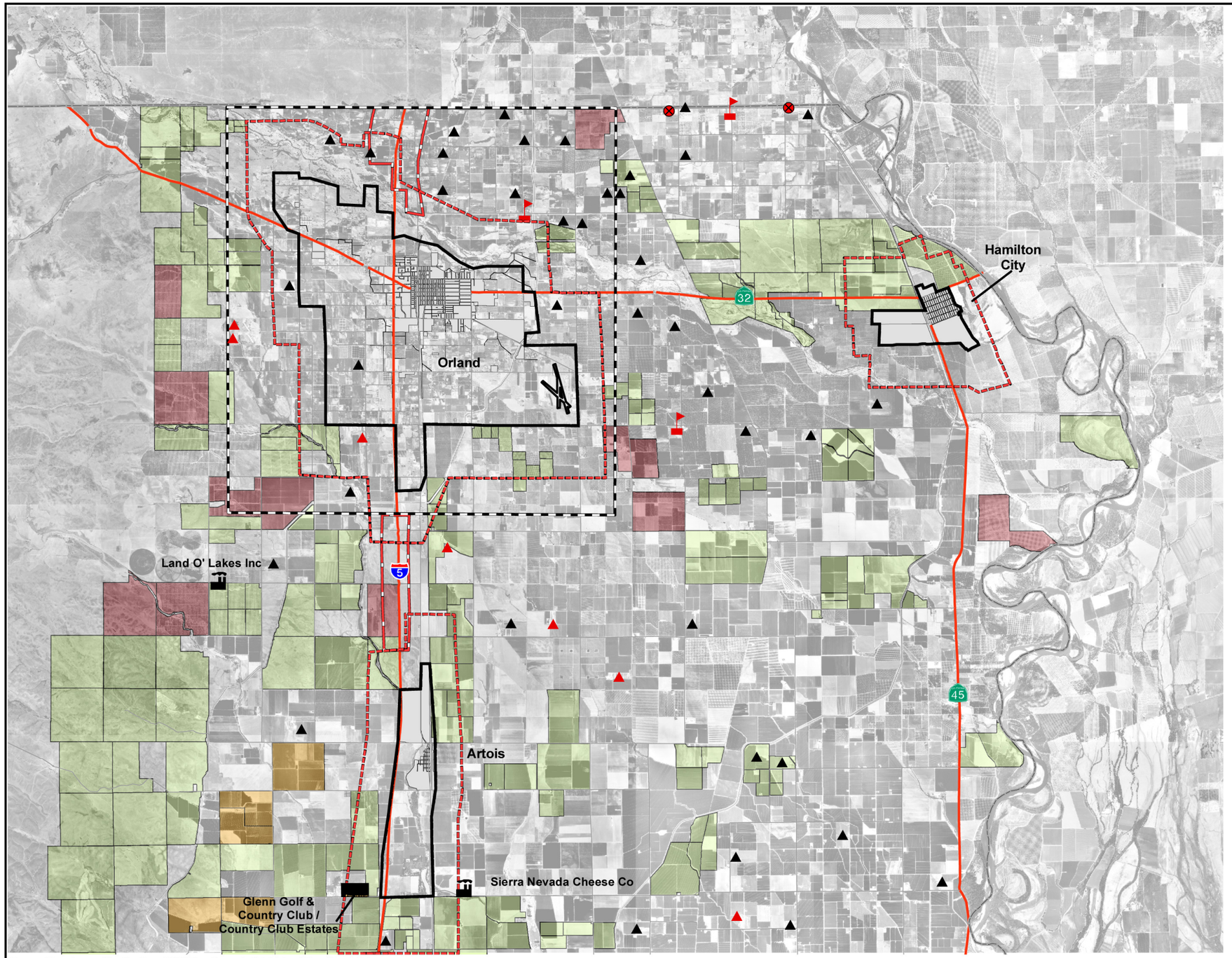
Source: Glenn County Planning Dept. / MSN TerraServer 4m DOQ / Quad Knopf Inc., 2004

Quad Knopf

Figure 3-2

LAND USE OPPORTUNITIES AND CONSTRAINTS - SOUTH GLENN COUNTY

Job No.: 03157



Legend

- Dairy Locations
- Dairy Locations (Herd Size Greater than 1000)
- School Locations
- Cluster of Homes (5 or more)
- Urban Constraint (Primary Conflict Zone)
- Windshed Buffer*
- I-5 Half Mile Buffer
- Secondary Conflict Zone
- Large Properties **
- Existing Large Orchard Fields
- Existing Large Rice Fields

* 1 mile in prevailing wind direction, 1/2 mile in other directions. See Windrose in Figure 3-5.

** Parcels greater than or equal to 320 acres, zoned AE-20, AE-40, AP-80.

N

2 1 0 2 Miles

Scale 1:126,720
1in = 2mi

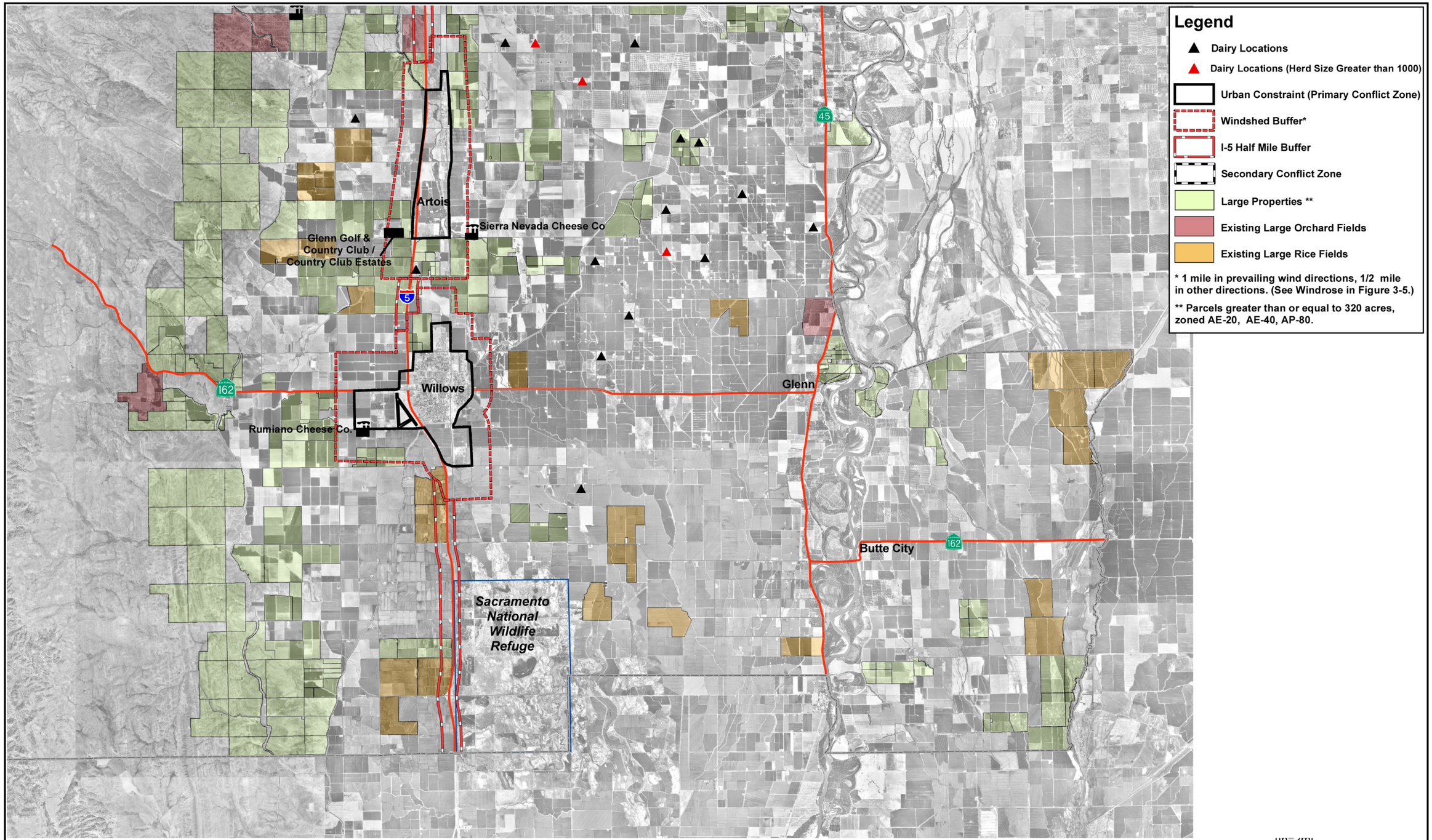
Source: Glenn County Planning Dept. / MSN TerraServer 4m DOQ / Quad Knopf Inc., 2004

Quad Knopf

Figure 3-3

LAND USE OPPORTUNITIES AND CONSTRAINTS - NORTH GLENN COUNTY

Job No.: 03157



Source: Glenn County Planning Dept. / MSN TerraServer 4m DOQ / Quad Knopf Inc., 2004

Quad Knopf

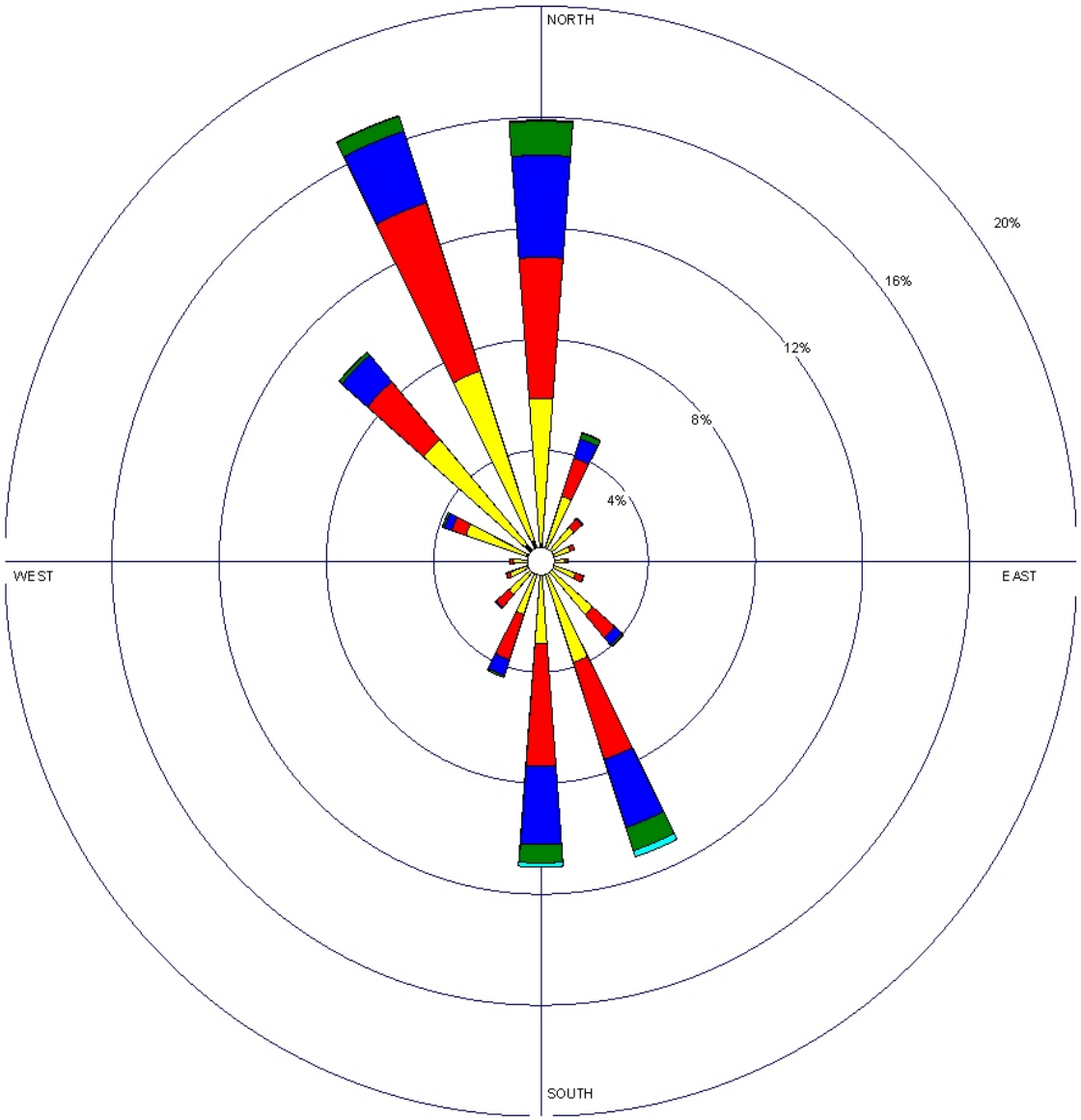
Figure 3-4

LAND USE OPPORTUNITIES AND CONSTRAINTS - SOUTH GLENN COUNTY

Job No.: 03157

WIND ROSE PLOT

Station #24216 - RED BLUFF/MUNICIPAL ARPT, CA 1984-1985



Wind Speed (m/s) > 11.06 8.49 - 11.06 5.40 - 8.49 3.34 - 5.40 1.80 - 3.34 0.51 - 1.80	MODELER	DATE **5/28/2003**	COMPANY NAME
	DISPLAY **Wind Speed**	UNIT **m/s**	COMMENTS
	AVG. WIND SPEED **4.08 m/s**	CALM WINDS **7.03%**	
	ORIENTATION **Direction (blowing from)**	PLOT YEAR-DATE-TIME **1984** **Jan 1 - Dec 31** **Midnight - 11 PM**	PROJECT/PLOT NO. **1984-1985**

Source: Red Bluff/Municipal Airport, 1984 / Quad Knopf, Inc 2003.

Quad Knopf

Figure 3-5

WINDROSE

Job No.: 03157

Dust

Dust can be both an air pollution issue and a nuisance. In the context of air quality, small dust particles (under 10 microns) are covered under the topic of PM_{10} in Chapter Two, Section 2.5. As a nuisance, dust may also be considered for mitigation at the local level as a land-use conflict.

A combination of manure solids, dander, hair, bedding, and feed cause the majority of the dust problems in confined animal facilities. The major source of dust in the feed yard comes from the pens. However, dust also can come from roads, service areas and feed processing. Contributing factors include animal activity, temperature, relative humidity, ventilation rate, stocking density and feeding methods. Dust reduction can significantly reduce problem odors because dust harbors gases and odors. Dust can be controlled both through design of confined animal facilities and through operational practices. Free stall barns with well-designed pens tend to produce less dust than open pens because the cattle spend less time kicking around their manure. Maintenance of surface moisture levels, routine cleaning of pen surfaces, and operation of on-site vehicles at low speeds also helps to minimize dust problems. Since the emphasis on combating dust emissions tends to be on control at the source, local governments have not generally addressed this impact using land-use tools, such as buffers.

To a large extent, dust emissions are regulated by air quality management districts under rules for particulate matter (particles between 2.5 and 10 microns in size, or PM_{10}). However, it should be noted that up to two-thirds of the dust from agricultural operations consists of particles that are greater than 10 microns in size.

Research on the contribution of dairies to dust emissions is ongoing. Research by Peters and Blackwood (1978) estimated an emission factor for feed yards of 127 kg/1000hd/day of total suspended particulate matter, which translates to 280 pounds per day per 1000 head of cows. The Environmental Protection Agency (EPA) estimates that 25% of that amount or 70 pounds would be classified as $PM_{10.}$ However, more recent research by Goodrich and Parnell, 2002) conducted in West Texas feed yards estimates the contribution at only 19 pounds lb/1000hd/d, substantially less than the 280 lb/1000hd/d estimate. It should be noted that feedyards are not necessarily representative of all confined animal facilities. The California Air Resources Board (CARB) has used data from this study to derive an emission for dairy cattle of 6.72 lbs PM_{10} per 1,000 head per day (May 2004). This factor is derived from an emission factor of 4.4 lbs PM_{10} per 1000 lactating head per day (Goodrich and Parnell, 2002).

Vector/Fly Issues

Nuisance flies are commonly associated with confined animal agricultural facilities such as dairies because they breed in the manure, animal feed, and other organic materials found on these facilities. Nuisance fly dispersal behavior is poorly understood and difficult to predict. According to Alec Gerry, Ph.D., University of California, Riverside, Entomology Department, flies move randomly, not with the wind. Fly numbers will be higher at sites with harborage or food, but there is no way to know at what distance flies make a determination to fly to or from such sites. Because flies move randomly, it becomes impossible to predict if the flies will impact any particular offsite area.

Most nuisance flies associated with confined animal facilities are not known to disperse great distances. Residential neighbors may complain of garbage flies that they contend come from the dairy, but in most cases flies are locally generated in household garbage, backyard animals and pet droppings. Studies using marked houseflies show that 80 percent of houseflies were captured within one mile of their release point. 85 percent to 95 percent were caught within two miles of the release site within the first four days after they were turned loose (Schoof, 1959). A few flies have been shown to travel further, but in general, fly control efforts should be focused within one mile of the source. Again dispersal was random.

Truck Traffic

Large confined animal facilities are a significant contributor to localized traffic in agricultural areas. But congestion is seldom an issue. Complaints about truck traffic typically revolve around noise in early morning or evening hours. Potential impacts to roads are addressed under Transportation and Circulation in Chapter Three, Section 3.5.

Zones of Conflict in Glenn County

Figures 3-1 and 3-2 show potential target areas for new confined animal facilities in Glenn County based on the previously discussed criteria of minimum 320-acre parcel sizes. Each zone may contain more than one parcel of that minimum size or greater. Existing dairies already occupy some of these properties. Most are located away from primary or secondary conflict zones. Exceptions include an area on the northeast corner of the secondary conflict zone surrounding Orland, land to the north of Hamilton City, and an area on the eastern border of Artois. Note that these properties may be subject to environmental constraints, including depth to groundwater, flooding, and biological resources protection.

Zones of conflict can be identified by comparing land-use designations that support existing or potential development of non-agricultural uses with existing confined animal facilities, as well as with primary target areas for expansion or new development of confined animal facilities. The smaller the distance between incompatible uses, the more likely it is that complaints will arise. The distance itself tends to be subjective and elastic in nature, since complaints are based on individual perceptions of nuisances rather than on any ability to quantify impacts.

Existing land-use designations can provide a quantitative framework for identifying where conflicts may occur. Figures 3-1 to 3-2 illustrate the concept by showing sensitive use areas, such as urban areas, urbanizing fringes (greater Orland), schools, and recreation areas (e.g., golf courses and parks). Figure 3-1 shows the northern half of the agricultural portion of Glenn County, while Figure 3-2 shows the southern portion.

Primary zones of conflict are identified as areas consisting of current urban footprints and/or areas of small parcels designated in the General Plan for residential use in a semi-agricultural setting. These designations are agricultural/residential (10-acre minimum parcel size), rural residential (5-acre minimum parcel size), and suburban residential (1-to-2-acre minimum parcel size depending on soil permeability). Primary zones of conflict include the incorporated and

unincorporated communities of Orland, Willows, Artois, and Hamilton City. One dairy is currently located on the western border of the primary zone of conflict for Orland.

Secondary zones of conflict are identified as areas that are designated agricultural but where parcel sizes are still small enough that a confined animal facility could be located near (less than 1,000 feet) from an existing residence or from a potential site for a residence. The area around Orland designated General Agriculture (20-acre minimum parcel size) is an example of a secondary zone of conflict. Ten to twelve existing dairies are located in Orland's secondary zone, particularly to the north near the Tehama County line. Secondary zones on a micro-scale may exist in agricultural areas where small parcels (20-40 acres) and large parcels (40-160 acres) are adjacent in such a way that a home-site might be built next to an existing confined animal facility or to a potential target for a new confined animal facility - a property 320 acres or greater in size.

Potential Use of Buffers

The zones of conflict illustrated on Figures 3-1 and 3-2 can also serve as a basis for discussion involving use of buffers to minimize future conflicts over nuisance issues. For example, a buffer could be set up around primary or secondary conflict zones. Project applicants would need to locate their animal confinement facilities outside the buffer, although row crops could be permitted as part of the buffer. Although not fixed on a map, minimum setbacks for development in agricultural areas could provide buffers between existing confined animal facilities and new residences, new facilities or expansions and existing residences. The setback would be a condition of development and would be implemented in the zoning code.

Buffers can also be designed as windsheds by contouring the borders according to prevailing wind patterns. Since nuisances such as odor and flies are likely to be noticed further when the observer is located downwind than upwind, the buffers would be stretched in the downwind direction and squeezed in areas that are mostly not in the path of winds coming from confined animal facilities. Prevailing winds in Glenn County travel up and down the valley, coming primarily from the north-northwest and secondarily from the south-southeast. Figure 3-5 contains a wind rose to illustrate predominant wind directions and the distribution of speeds in the area. Using the wind rose for orientation, Figures 3-1 and 3-2 illustrate the concept of windsheds around urban areas, with a ¼ mile buffer in areas out of the direction of prevailing winds, and a ½ mile buffer for areas in the path of prevailing winds. Alternatively, Figures 3-3 and 3-4 double those distances to ½ miles and 1 mile, respectively. Besides urban areas, Figures 3-1 through 3-4 also show more isolated sensitive areas, such as schools, a country club, and clusters of five or more homes that also might be considered for protective buffers or windsheds.

Buffers may also be appropriate to mitigate what may be perceived as aesthetic impacts, including the use of such buffers or setbacks along transportation corridors, recreational and open space areas. Setbacks would apply only to the confined animal facilities and could be used for crop cultivation and disposal of wastewater. As an example, Figures 3-1 through 3-4 show buffers along I-5 at quarter-mile (north and south county) and half-mile (north and south county) distances, respectively.

Conflicts Caused by Residential Encroachment

Glenn County's right-to-farm ordinance (Ord. 943 §1 (part), 1989) was designed to address encroachment of residential development in rural areas and the effect of complaints on the part of new residents on the viability of agricultural operations (see Appendix A for full text). The ordinance requires disclosure to buyers of property adjacent to property being used for agricultural operations that such operations will not be considered by the County to be a nuisance if they had not been determined to be a nuisance when those operations began. Although a few established dairy operators have received complaints from neighbors who have signed the disclosure statement, as of 2004, no disputes under this ordinance have been referred to the agricultural grievance committee.

Although in theory such disclosures can head off land-use conflicts between residents and farmers, the reality is that homeowners often fail to read the disclosure statements that they sign and do not necessarily take them seriously when they do. And when the number of such homeowners is growing, the political will to protect existing agricultural operations may eventually weaken, putting established operations at risk from increased regulation. Therefore, it is important to avoid such encroachments whenever possible. A windshed concept can potentially be used to prevent future conflicts by requiring new residences in agricultural areas to be built at a distance from existing confined animal facilities (see Figure 3-6). The same concept can be applied to protecting existing residences from encroachment from new confined animal facilities.

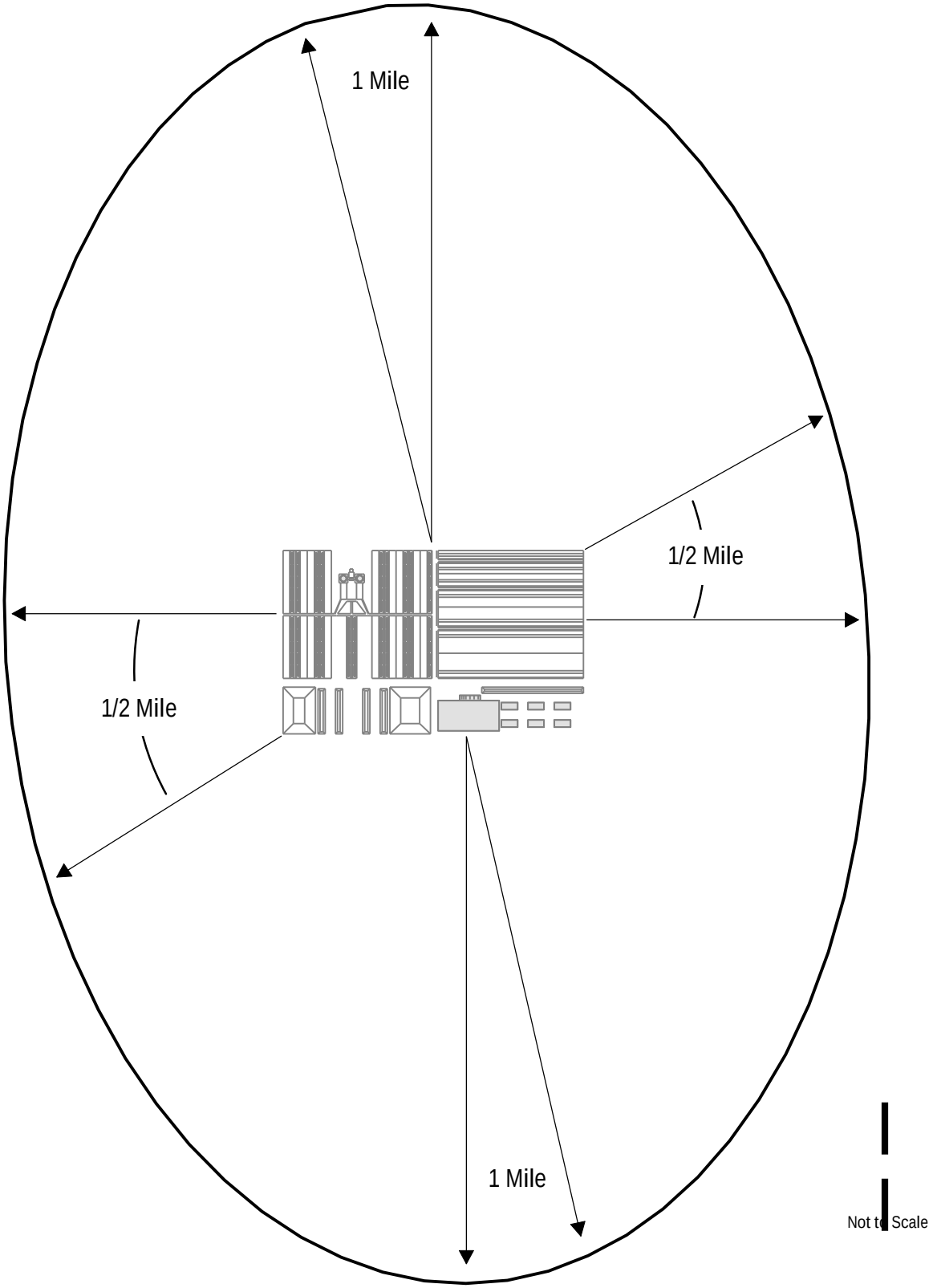
Conflicts with Other Agricultural Uses

Some counties use buffers, or separations, to protect agricultural operations that may be sensitive to dust and flies. Fruit and nut growers, such as those growing cherries, peaches and pistachios have requested buffers around their operations to reduce such impacts. The argument frequently heard is that dust and flies potentially reduce the quality of the fruit and its marketability. Of course the establishment of such buffers does not prevent tree crops from being planted proximate to an existing confined animal facility.

Counties have also established buffer zones between confined animal facilities to minimize impacts, such as inter-herd disease transmission, and to reduce the potential for groundwater and soil contamination from too great a concentration of livestock. The issue of soil and groundwater contamination from over-concentration has been reduced with the advent of comprehensive nutrient management plans; however, inter-herd disease transmission is still known to occur.

3.3 HYDROLOGICAL CONSTRAINTS

The key hydrological constraints for location of confined animal facilities are flood zones (100-year/500-year), groundwater recharge areas, and areas of low depth-to-groundwater. The hydrologic features of Glenn County are described in Chapter 2 under Hydrology/Water Quality. Although the County does not directly regulate waste discharge, it intends for the Confined Animal Facilities Element and permitting process to be synchronized with the permitting process



Source: Quad Knopf Inc., 2004.

of the Regional Water Quality Control Board (RWQCB), which has primary regulatory authority over water quality.

Flood Zones in Glenn County

If not properly designed, confined animal facilities located in flood zones may discharge waste into streams during periods of unusually high run-off from winter storms. RWQCB (Central Valley Region) has published requirements to prevent stormwater from causing confined animal facilities from discharging wastewater. These requirements include a prohibition against the application of process water (from manure waste) to land (fertilization) during and up to 24 hours after a storm. RWQCB also prohibits discharge of stormwater from areas where manure or wastewater has been applied unless the land application area has been managed to prevent runoff consistent with a certified Nutrient Management Plan and the manure and/or wastewater has been incorporated into the soil. In addition, a confined animal facility must be designed, constructed, operated, and maintained to contain all manure and process wastewater including the runoff and direct precipitation from a 25-year, 24-hour rainfall event.

Glenn County contains several major areas of flood zones (See Figure 2-14). Most of these areas are classified as 100-year flood zones with some smaller areas of 500-year flood zones. One 100-year flood zone stretches in a narrow band north of Orland and trending in a southeasterly direction toward the Sacramento River (See Figure 3-7). The Sacramento River is surrounded by a 100-year flood zone that varies in width but is almost entirely east of Highway 45. A large 100-year floodplain is located east of Butte City. Finally, a complex of floodplains exists in an area starting roughly five miles west of I-5, extending eastward between Willows and Artois, and then east of Willows in a southeasterly direction (See Figure 3-8).

Existing dairies in Glenn County are largely located outside of floodplains. However, a large number of properties that might be considered targets for new dairies are located in or near 100-year flood zones, particularly west of I-5 between Artois and Willows. Glenn County does not prohibit development in 100-year floodplains. However, the County currently prohibits the building of structures in the regulatory floodways established in the Federal Insurance Administration (FIA) of the Federal Emergency Management Agency (FEMA). A floodway is the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot.

Some of the properties with flood zones crossing them may still support confined animal facilities, but developers are well-advised to site the dairy production facilities on portions of those properties outside the zones. Theoretically, a confined animal facility could be constructed in a floodplain by raising the lowest adjacent grade of the site and floors of buildings on the site above flood elevation. However, “filling in” of part of the floodplain can have the effect of shifting waters to other areas or raising the flood elevation, potentially causing damage to other property owners in the area.

Surface Water Constraints

In addition to major waterways such as the Sacramento River and Stony Creek, eastern Glenn County is laced with numerous year-round and seasonal creeks that potentially can be polluted by uncontrolled run-off of wastewater from confined animal facilities (see Figure 2-9). To avoid pollution to surface waters from confined animal facilities, State Water Resources Control Board regulations require that discharges of facility wastewater to disposal fields shall not result in surface runoff from disposal fields. In addition, confined animal facilities must be designed and constructed to retain all facility wastewater generated, together with all precipitation on, and drainage through, manured areas during a 25-year, 24-hour storm.

The Glenn County code currently does not require setbacks from waterways, although it does prohibit construction in designated floodways, which are often associated with rivers and creeks. Most existing Glenn County dairies are set back from significant waterways. A number of potential target properties for new confined animal facilities on the west side of I-5 are crossed by streams. The lower reaches of these streams are associated with 100-year flood zones in that area.

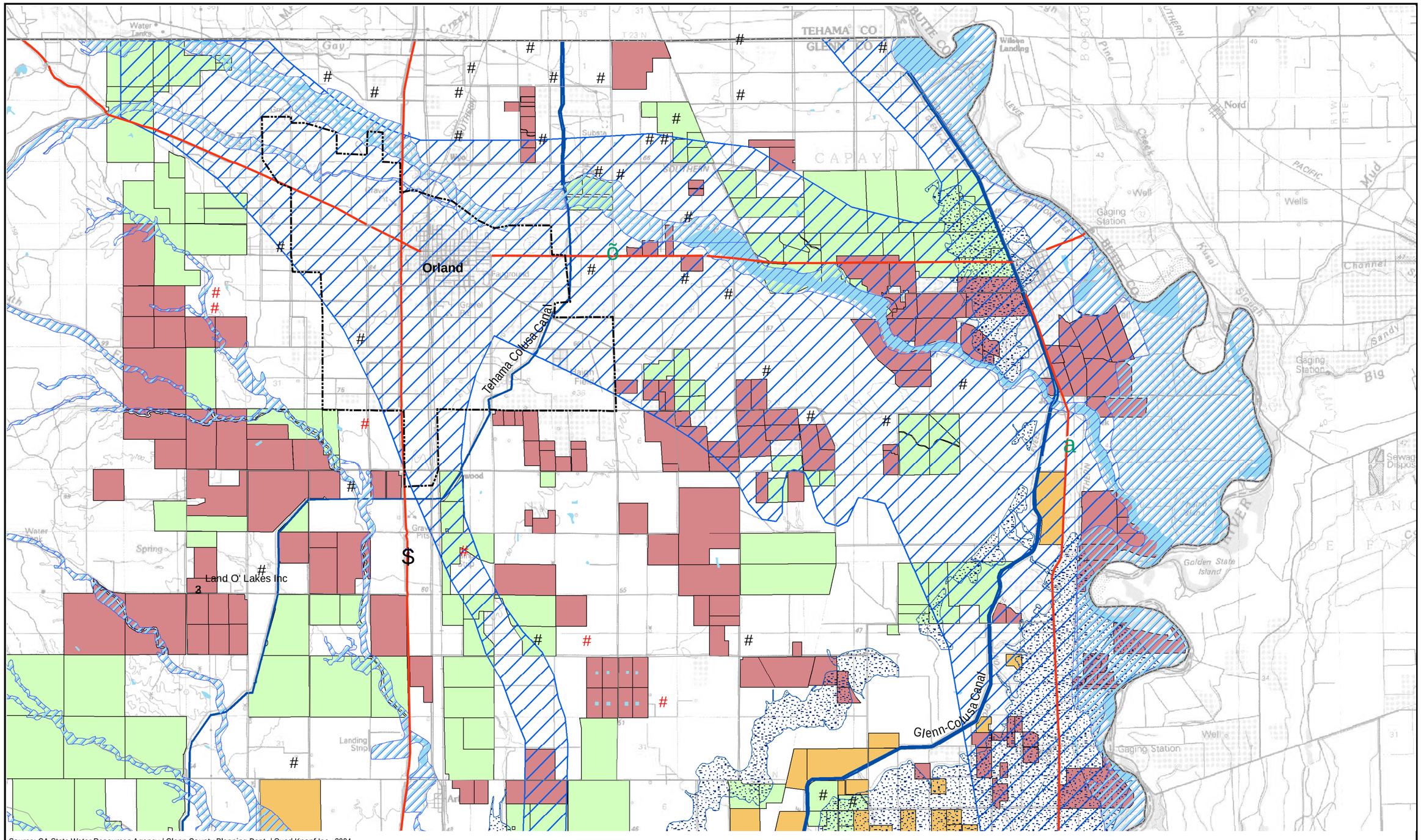
Groundwater Constraints

In groundwater recharge areas, the RWQCB is primarily concerned with nitrates that leak from facilities and seep through gravelly soils aquifers. Excessive nitrates in drinking water can cause methemoglobinemia, also known as Blue Baby Syndrome. This illness begins when large amounts of nitrates in water are ingested by an infant and converted to nitrite by the digestive system. The nitrite then reacts with oxyhemoglobin (the oxygen-carrying blood protein) to form metheglobin, which cannot carry oxygen. If a large enough amount of metheglobin is formed in the blood, body tissues may be deprived of oxygen, causing the infant to develop a blue coloration of their mucous membranes and possibly digestive and respiratory problems.

The eastern portion of Glenn County overlies the 5,000 square-mile Sacramento Valley Groundwater Basin (see Figure 2-10). Critical to the health of this basin, both in terms of water supply and water quality, are recharge areas made up of permeable soils that allow run-off from precipitation to drain into underground aquifers. In Glenn County, the recharge area covers a large area from northwest of Orland to Hamilton City, straddling Highway 32, and extending along the Sacramento River. A finger also extends south from Orland east of I-5, ending northwest of Willows. A small recharge area is located southeast of Willows.

More than a half a dozen existing dairies are located in groundwater recharge areas, particularly east of Orland on either side of Highway 32. Most potential target areas for new dairies are not located in these recharge areas. RWQCB is primarily concerned with nitrate leakage affecting groundwater quality, so dairy design features, such as clay lining of wastewater holding ponds, becomes a critical factor in recharge areas.

In areas of high depth-to-groundwater, the impact of groundwater contamination can occur more quickly and easily because the groundwater is located nearer the surface. RWQCB requires a separation of at least five feet between the bottom of wastewater holding ponds and groundwater.



Source: CA State Water Resources Agency / Glenn County Planning Dept. / Quad Knopf Inc., 2004

Job No.: 03157

In areas where depth-to-groundwater is 10 feet or less, additional mitigation measures are required. Areas where groundwater is likely to be 10 feet or less from ground surface are concentrated along the Sacramento River and southeast of Glenn-Colusa canal (see Figure 3-7 and Figure 3-8). Up to a dozen existing dairies in Glenn County are located in these areas.

Figure 3-7 and Figure 3-8 were prepared using March 2003 mapping provided by the Glenn County Water Advisory Committee and United States Geological Survey topographic mapping for Glenn County. This mapping should only be considered as illustrative of potential shallow groundwater areas. Data from wells near proposed confined animal facilities sites should be used for groundwater level analysis wherever such data is available over a sufficient historic time period.

Another concern of the RWQCB is the degradation of groundwater due to excessive salts loading from wet manure usage for irrigation or dry manure disposal. Such excessive loading is prevented by the Board's requirement that a comprehensive nutrient management plan be prepared for each new or expanded dairy to be permitted. That plan must demonstrate that the total wet manure and dry manure to be utilized on the dairy site will not exceed either the nitrate or salts loading specified by the Board as limits which will prevent groundwater degradation. The numeric value of these limits is currently being studied by a University of California committee and they are likely to be modified in the foreseeable future.

3.4 AIR QUALITY CONSTRAINTS

As noted in Chapter Two, Section 2.5, Glenn County is currently designated unclassified/attainment for five major types of pollutants – carbon monoxide (CO), sulfur dioxide, nitrogen dioxide (NO_2), PM_{10}, and Ozone – under Federal standards. Under California standards, it is in attainment for sulfur dioxide, NO_2, and CO. The California Air Resources Board (CARB) has designated it as in non-attainment for PM_{10} and ozone.

The magnitude of the impact that confined animal facilities have on regional air quality is unclear. Part of the reason is a general lack of research on air pollution caused by agricultural operations, since these operations had been previously exempt from emissions regulation. Complicating the situation is that the current assumption by regulators concerning how much reactive organic gases (ROGs) – a factor in the generation of ozone – are contributed by cows is based on a faulty understanding of research from the 1930s. In 1938 scientists studying the nutritional physiology of ruminants published a figure of 160 pounds per year for the amount of methane generated by a typical cow. The figure was picked up and reported in 1978 by researcher H. Tabeck as the amount of total organic gases produced by a cow, including ROGs. The problem with this conclusion is that while methane is organic, it is not reactive. Therefore, using it as a proxy for ROGs is not a true measure and likely overstates the contribution from cows. The error was later compounded by other researchers, and in 1997 the San Joaquin Valley Air Pollution Control District used the figure to create a livestock emissions factor for ROGs. Research efforts to better understand livestock emissions and provide the tools to quantify the impact are discussed below (See Research on Air Emissions from Confined Animal Facilities).

Pollutants Associated with Confined Animal Facilities

Major emissions associated with confined animal facilities fall into three categories: Ozone precursors, $PM_{10,}$ and $PM_{2.5}$. As noted above, Glenn County is currently in non-attainment under California standards for ozone and PM_{10}. A standard for $PM_{2.5}$ is still being developed, so it is not yet known how the County will be designated for this particulate and to what extent confined animal facilities will be affected. Other associated emissions – methane and hydrogen sulfide – are not considered significant pollutants in the current regulatory environment.

Ozone Precursors. The major ozone precursors associated with confined animal facilities are ROGs, classes of organic compounds – mainly olefins, substituted aromatics, and aldehydes – that react rapidly in the atmosphere to form photochemical smog or ozone. The other major type of ozone precursor, oxides of nitrogen (NO_x), is mostly generated in Glenn County by vehicle operation and the production of oil and gas.

Respiratory Particulate Matter (PM_{10}). PM_{10} refers to airborne dust containing particles small enough (10 microns or less in diameter) to remain suspended in the air for long periods. Major sources of in Glenn County include farming operations, dust from unpaved roads, and waste burning. In May of 2004, the California Air Resources Board published a PM_{10} emission factor for dairy cattle of 6.72 lbs PM_{10} per 1,000 head per day. This factor is derived from an emission factor of 4.4 lbs PM_{10} per 1000 lactating head per day developed by Texas A&M (see "Dust" under Land-Use).

$PM_{2.5}$ Precursors. The primary precursor for $PM_{2.5}$ associated with confined animal facilities is ammonia, which is generated during the anaerobic decomposition of manure. Although in high concentrations ammonia can irritate the eye, ear, and throat, regulators are more concerned with the reaction of ammonia with acids in the atmosphere to form ammonium nitrates or sulfphates, particulates capable of reaching the deepest recesses of the lungs. Health problems linked to these $PM_{2.5}$ particulates include lung damage, aggravated asthma, and chronic bronchitis. $PM_{2.5}$ can also be released directly into the air by stationary and mobile sources. Confined animal facilities are not considered a major direct source of these particulates.

Other Emissions. Hydrogen sulfide is a primary contributor to odor and is generated by animal digestion and anaerobic decomposition of manure. It can cause dizziness, nausea, and headaches at low concentrations, and more serious effects at higher concentrations. In 1969, California adopted a state-wide ambient air quality standard for hydrogen sulfide of 0.03 ppm averaged over a period of 1 hour to protect against nuisance odor ("rotten egg smell") for the general public, but the standard appears to have little practical effect. The U.S. EPA current does not classify hydrogen sulfide as either a criteria air pollutant or a Hazardous Air Pollutant. California counties typically respond and make policy on the basis of odor complaints rather than ambient air measurements (See Chapter Three, Section 3.2, Land-Use Conflicts).

Another natural by-product of animal digestion is Methane. It is not considered a regional air pollutant under state or federal law but is considered a greenhouse gas. The U.S. government has reported that methane makes up approximately 16% of greenhouse gas emissions from human sources, second after CO_2. The gas is known to have a relatively short life span in the

atmosphere compared with other greenhouse gases due to chemical reactions. In addition, microbes in the soil can also take up methane.

Greenhouse gases are not currently regulated in the U.S. In addition, most of the focus on greenhouse gases has been on CO_2 generated by vehicle emissions and power plants. Legislation enacted in California in 2002 (AB 1493) requires the California Air Resources Board to develop carbon pollution standards for vehicles in model year 2009 and beyond. The standards will apply to automakers' fleet averages, rather than each individual vehicle, and carmakers will be able to partially achieve the standards by reducing pollution from non-auto sources (e.g. factories, etc.).

Methane can be used as a relatively clean energy source ("biogas") through use of anaerobic digester technology. This technology could in fact help offset CO_2 emissions from electricity generation in the midwest and south, where coal instead of natural gas is the predominant energy source. Digester technology could also make operators of confined animal facilities self-sufficient in energy and potentially provide another source of income through sales of electricity to utilities.

Regulatory Implications for Glenn County

Senate Bill No. 700 (SB 700), which became effective January 1, 2004, for the first time removes the exemption for agricultural operations from air pollution regulations. The state legislation, which amends the Health and Safety Code, directs CARB to develop by July 1, 2005 a definition for the air pollution source category of "large confined animal facility" for domesticated animals maintained in restricted areas for agricultural purposes. Although the legislation applies to a variety of domesticated animals, the impetus for passage of the bill was concerns over the impact of concentrations of large dairies, particularly in the San Joaquin Valley, which has been designated non-attainment for PM10 and ozone by both CARB and EPA.

Under SB 700, large confined animal facilities as defined by CARB that are located in areas in non-attainment for ozone under EPA standards will have to submit plans to reduce air contaminants to the extent feasible. However, even in areas whose Federal designation is attainment for ozone, such as Glenn County, large confined animal facilities will have to submit air pollution control plans unless the local air quality district board makes a finding in a public hearing that large confined animal facilities will not contribute to a violation of any state or federal standard. The California Air Resources Board has defined a large dairy as 1,000 lactating cows in severe or extreme areas, and 2,000 lactating cows in moderate or serious areas.

In air districts that are required or choose to regulate large confined animal facilities, the emphasis is likely to be on having facility operators submit plans based on best available control technologies or reasonably available control technologies (depending on the severity of the problem) rather than on mandating particular control technologies. This reliance on operators to make best efforts at solutions as opposed to issuing orders stems in part from the lack of research to provide a basis for estimating emissions from confined animal facilities and setting thresholds in terms of tons/year of pollutants, as is possible in other industries. As research advances to the

point of measuring the problem, districts in air basins with severe problems will likely adopt more strict requirements.

Although Glenn County has the option of adopting a finding that large confined animal facilities will not violate state or federal standards, it may take a more active approach in mitigating air emissions from confined animal facilities for other reasons, such as minimizing nuisance factors such as dust and odor (See Chapter Three, Section 3.2, Land Use Conflicts). One approach, similar to the process that is unfolding as a result of SB 700, would be to require new confined animal facilities to submit plans for controlling fugitive dust emissions and minimizing sources of odors as part of the application for a conditional use permit.

A more active approach to requiring mitigation plans from new or expanding confined animal facilities may reduce air quality impacts to a less than significant level for individual projects under CEQA. However, the program EIR for this element will also have to make the determination of whether allowing the development of large confined animal facilities in Glenn County will lead to a cumulatively considerable impact on air quality. If the impact is found to be cumulatively considerable, then the impact will be declared significant and unavoidable in the program EIR. As a result, the County will not be able to conduct environmental reviews on these projects using mitigated negative declarations, but instead will have to produce EIRs for each project.

Research on Air Emissions from Confined Animal Facilities

Increasing federal air quality standards are coming at a time when scientists and air quality regulators are only beginning to understand and quantify emissions from agricultural operations. Part of that knowledge base will come from a monitoring program that the Federal Environmental Protection Agency has set up in the San Joaquin Valley, which is out of attainment for ozone and PM_{10} under state and federal standards and will likely be out of compliance with whatever $PM_{2.5}$ standard is developed by EPA and CARB. The EPA program requires large farms to identify pollution sources and track them.

Dozens of studies on agricultural air pollution are now taking place throughout the U.S. Two projects of note involving research on the specific contribution of confined animal facilities are taking place at Cal State Fresno and UC Davis. At the CSUF Center for Irrigation Technology, Researchers (Krauter, Goodrich, Goorahoo, and Beene) have experimented with sampling of ammonia and ROGs at three medium-sized (defined as 2000 head) free stall dairies in Kings, Merced, and Fresno counties. The sampling has taken place every three months since the summer of 2003. The research is as much aimed at developing a sampling methodology for ongoing use as it is to provide reliable data on the emissions themselves. Sampling is complicated by issues of where to put monitoring equipment, shifting winds, attenuation of emissions that can occur from crops downwind of the emissions, the effect of dilution of manure waste from periodic flushing, temperature and season, and intensity and timing of animal activity.

The research at UC Davis is using a more controlled approach to measuring emissions. Frank Mitloehner and his staff are keeping 40 heifers inside four climate-controlled enclosures to

measure the gases that come from these animals and their waste as well as dust particles generated by manure underfoot. The researchers are also testing ways to mitigate these emissions, with results expected to be available by early in 2005. Potential approaches to reducing ammonia include changing the composition of feed for livestock.

Other research questions scientists and regulators are interested in answering in regard to the effect of emissions from confined animal facilities include:

- To what extent do ROGs react with NO_X to produce ozone?
- How do emissions of ROGs, ammonia, and PM_{10} vary among different locations and processes on a confined animal facility (e.g., direct animal emissions, retention ponds, corrals, application of manure to crops)?
- To what extent will reductions in ammonia lead to reductions in $PM_{2.5}$?
- What mitigations are proven to be most effective?
- How do other components of operations, such as crops, offset overall air emissions from animals?

3.5 TRAFFIC AND CIRCULATION CONSTRAINTS

Truck traffic is a common daily contributor to localized traffic in agricultural areas of Glenn County. The Glenn County General Plan assumes truck traffic will use major roadways and many rural local roads to service agricultural operations. Roadways identified in the General Plan are shown on Figure 2-18.

Impacts of Confined Animal Facilities

Construction of confined animal facilities may result in a temporary and minor increase in traffic associated with the movement of construction vehicles, equipment, and personnel on the transportation network serving the project area. Operation of confined animal facilities results in traffic from milk tankers, feed trucks, service providers, and employees. The increase in traffic typically does not have a significant effect on levels of service for local intersections.

The condition of rural roads in Glenn County varies. Some have been upgraded recently, while others may have not been resurfaced in many years. These roads have traditionally serviced seasonal agricultural operations and a very low traffic volume which did not require a higher standard road surface. On the other hand, confined animal facilities, such as dairies, change the agricultural activity from a seasonal traffic activity to a daily traffic activity servicing the needs of the operation. The increased load from truck traffic can lead to rapid deterioration of older, infrequently maintained surfaces.

Mitigation of Road Impacts

Glenn County and other counties typically require new development to construct additional roads, improve upon existing ones to ensure maintenance of the road system under additional traffic caused by the new development. In the case of confined animal facilities in Glenn County, the rules for frontage road improvements would apply (Ord. 852 § 2 (part), 1986, 17.38.040). The right-of-way width must equal the right-of-way width for a standard street of the same classification, less 10 feet, and should not be less than a total of 50 feet in width. The surfaced roadbed should be equal to the improved width for a standard street of the same classification, less six feet for parking lanes, and should not be less than a total of 30 feet in width.

The Glenn County Transportation Element of the General Plan and Glenn County Code do not specifically detail size and weight/load limits for any roadways in the county. The California Vehicle Code does provide standards for truck size and weight:

- The gross weight imposed upon the highway by the wheels on any axle of a vehicle shall not exceed 20,000 pounds and the gross weight upon any one wheel, or wheels, supporting one end of an axle, and resting upon the roadway, shall not exceed 10,500 pounds.

- The maximum wheel load is the lesser of the following: (a) the load limit established by the tire manufacturer, or (b) a load of 620 pounds per lateral inch of tire width, as determined by the manufacturer's rated tire width.

- The gross weight imposed upon the highway by the wheels on any one axle of a vehicle shall not exceed 18,000 pounds and the gross weight upon any one wheel, or wheels, supporting one end of an axle and resting upon the roadway, shall not exceed 9,500 pounds, except that the gross weight imposed upon the highway by the wheels on any front steering axle of a motor vehicle shall not exceed 12,500 pounds; maximum allowable gross combination weight is 80,000 pounds (State of California Vehicle Code, Section 35550-35559).

- The maximum allowable vehicle height is 14 feet (State of California Vehicle Code, Section 35250-35252).

- The maximum allowable vehicle width is 102 inches (State of California Vehicle Code, Section 35100-35111).

- Maximum allowable length for single vehicle is 40 feet.

- Maximum allowable length for combination of vehicles is 65 feet.

- Maximum allowable length for combination of vehicles consisting of a truck tractor and two trailers is 75 feet, provided each individual trailer length does not exceed 28 feet 6 inches (State of California Vehicle Code, Section 35400-35414).

As noted in the Vehicle Code, these provisions would not apply if the county specifically permitted the operation and transport of vehicles and loads on county roadways in excess of the maximum gross limits specified in the Vehicle Code (State of California Vehicle Code, Section 35780-35796).

Impact Fees

In addition to requiring roadway improvements of developers of new confined animal facilities, the County has the option of assessing road improvement fees. In general, local jurisdictions do not establish such fees on a single type of development but on any development that will generate commercial, residential, or industrial traffic. Impact mitigation fees are governed by California Government Code 66000 et seq., the "Mitigation Fee Act." Fees can be established when the following conditions exist:

- New development creates the need for improvements.
- A rational connection (nexus) exists between a development project and the need for additional facilities.
- The development will benefit from the improvements it is funding.
- The new improvements can be translated into a cost per unit of new development.
- The total of new revenue generated by all fees does not exceed 100% of the cost of the projects.
- The collected funds are segregated from general revenues and earmarked to pay for specific improvements, within a reasonable time frame, and directly and primarily benefit users of the property on which the fees are imposed.

Typically, before establishing a fee system, the local jurisdiction will initiate a study in which traffic on the regional road network is modeled, and traffic levels are forecasted over a 20-25-year period. A Capital Improvement Program is also developed to determine how much revenue will need to be collected from the fee program. Once a fee system is determined, the county or city implements it through an ordinance. The fee is levied on the basis of peak hour trips per unit, which in the case of residential is a dwelling unit and for commercial and industrial uses is typically 1,000 sq. ft. gross floor area (GFA). For an agricultural operation such as a dairy, the GFA could be based on covered areas, such as various barns and covered pens and any office space.

3.6 BIOLOGICAL CONSTRAINTS

Glenn County has established a goal that promotes the "preservation and enhancement of the county's biological resources in a manner compatible with a sound local economy" (NRG-3). To support this goal, the county's General Plan contains policies and implementation measures,

which are listed in Appendix B. When reviewing development related proposals, NRP-47 of the Glenn County General Plan calls for the County to recognize and protect areas of unique biological importance. These areas have been identified in a Special Overlay Designation: Areas of Biological Importance (see Figure 2-17). Below is a brief description of the designation.

> **Biological Importance.** This overlay designation reflects areas of biological importance in Glenn County which are critical to the preservation of plant and animal life. The purpose of the designation is to identify areas where certain types of development may have an adverse impact on biological resources. In some instances, development should not occur; in others, development should occur only when it can be shown that proper protection of resources will be achieved either through mitigation or compensation. Areas identified include the Sacramento River corridor, the Sacramento National Wildlife Refuge, migratory deer herd range, naturally occurring wetlands, and stream courses such as Butte and Stony Creeks.

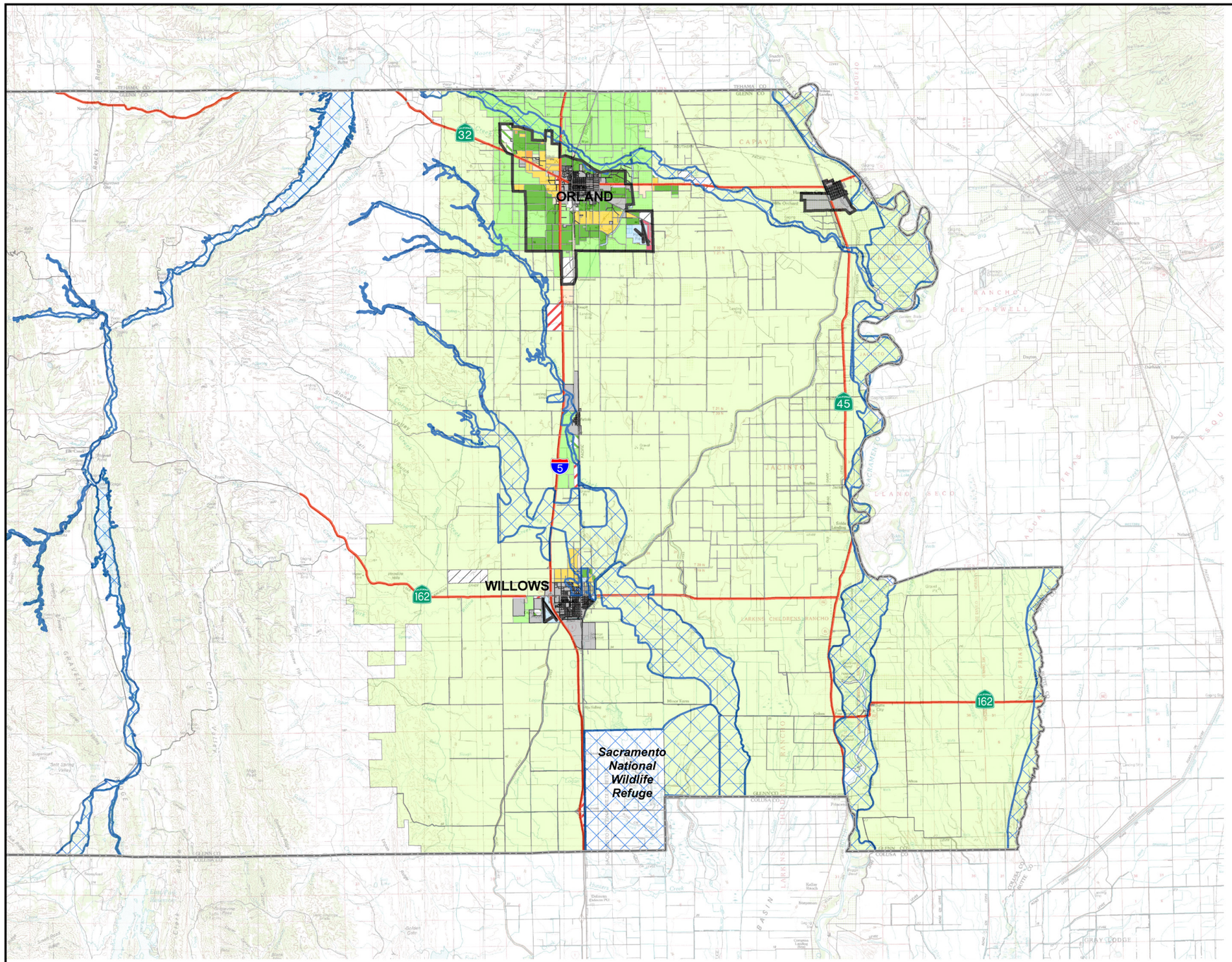
In addition to the general areas mentioned above, twelve specific sites were identified in the Environmental Setting Technical Paper as part of the preparation of the 1993 General Plan update:

- Llano Seco Area
- Oxbow Waterfowl Area
- Oxbow Heron Rookery
- Sacramento NWR
- Princeton Riparian Woodland
- Sacramento River Wildlife Area
- Sacramento River Oxbow Preserve
- St. John's Mountain
- Sheetiron Mountain
- Black Butte Reservoir
- Stony Gorge Reservoir
- Orland Buttes

Other Areas of Biological Importance

There are several other biological resources that were not identified in the original "Biological Importance" designation in the General Plan, but are now documented in the California Natural Diversity Database and are protected under state and federal laws (see Figure 3-9). These biological resources are collectively referred to as "Special Status Species." Special-status animals include the following:

- Federal threatened or endangered and candidate species (FESA);
- California threatened or endangered (California ESA -CESA);



Legend

Biological Importance

General Plan & Land Use Designations

LANDUSE

- Agricultural / Residential
- Business Park
- Community Commerical
- General Agriculture
- Highway & Visitor Commerical
- Intensive Agriculture
- Industrial
- Multiple Family Residential
- Public
- Rural Residential
- Service Commerical
- Single Family Residential
- Suburban Residential
- Suburban Residential - 2 acres
- Urban Area

N

4 2 0 4 Miles

Scale 1:253,440
1in = 4mi

Source: Glenn County Planning Dept. / Quad Knopf Inc., 2004

Quad Knopf

Figure 3-9

AREAS OF BIOLOGICAL IMPORTANCE GENERAL PLAN OVERLAY

Job No.: 03157

- California fully protected (Section 3511 of the California Fish and Game Code); and
- California species of special concern (CDFG's Special Animals List).

Special-status plants include the following:

- Federal threatened or endangered and candidate species (FESA);
- California threatened or endangered species (CESA);
- Species listed on Lists 1, 2, 3, or 4 of the California Native Plant Society (CNPS); and,
- Species identified as California rare (California Native Plant Protection Act).

Documented Occurrences

In an effort to identify biological resources that could constrain development of a confined animal facility or other development in Glenn County, a California Natural Diversity Database (CNDDB) search was conducted on August 17, 2004. The results CNDDB are included in Appendix E and are described briefly below.

The CNDDB is a database that is regularly maintained by the California Department of Fish and Game. The information contained in the CNDDB is continually updated by the California Department of Fish and Game based on new information obtained from biological surveys and the ever changing protective status of a species. The information contained in this CNDDB search and the figures presented herein should not be considered a reliable source of information indefinitely. Rather it should be used as a preliminary planning tool to identify potential biological constraints in the County. A biological survey and a current CNDDB search should be conducted at the time a project is proposed to verify the presence or absence of a species on, or in the vicinity of a project site.

Threatened and Endangered Species

As of August 17, 2004, there were 112 documented occurrences of 15 different species that are listed as either "Threatened" or "Endangered" under the state and/or federal endangered species acts. Figure 3-10 presents the locations of each occurrence and the common name of each species in northern Glenn County. Figure 3-11 presents the locations of each occurrence and the common name of each species in southern Glenn County. A detailed description of the species and the locational information is included in Appendix E.

Special Status Plants, Animals, and Sensitive Plant Communities

As of August 17, 2004, there were 137 documented occurrences of 20 different special status animal species, 117 documented occurrences of 31 different special status plant species, and 49 documented occurrences of 7 different special status species located in Glenn County. Many of the documented occurrences are located along or near the Sacramento River, although several are scattered throughout the County. Figure 3-12 and 3-13 Special Status Animals, Figure 3-14 and 3-15 Special Status Plants, and Figure 3-16 and 3-17 Sensitive Plant Communities illustrate the locations of each occurrence and the common name of the species or plant community. A

detailed description of the species and plant communities and the locational information is included in Appendix E.

Note that some occurrences are shown with different size circles. The size of the circle is based on the accuracy of the information. For example a Swainson's hawk occurrence may be depicted by a small circle, which generally would mean that the exact location of a nest was determined. A larger circle may indicate that the species was observed, but the location of the nest was not identified and the nest could be located within a wide radius of the observation.

Updated Biological Importance Designation

Some of the documented occurrences of Special Status Species are not included in the "Biological Importance" overlay designation, but a disturbance to one of these species or the species habitat could be considered a take and require permits from either the CDFG or USFWS. Figure 3-18 and 3-19 presents the Biological Importance map that was adopted with the General Plan, with the additional areas of biological importance as suggested by CNDDB data, existing dairy locations, and potential targets for confined animal facilities.

For the most part, Special Status animals and plants identified by the CNDDB search are contained within the existing "Biological Importance" overlay designation, mostly along the Sacramento River and Butte Creek at the Butte County line. A notable exception for animal species is the documented presence of Swainson's hawk's nests on both sides of I-5 between Willows and Orland. In addition, several special status plants are located in the vicinity of Willows and west of the Sacramento National Wildlife Refuge. Areas not cited by CNDDB may also contain unknown biological resources that have special permit requirements, and a biological survey of these areas should be conducted at the time a specific development is proposed.

Restorable Wetlands

In addition to Areas of Biological Importance, the General Plan also contains an overlay designation for restorable wetlands. It reflects those areas approved by the Glenn County Board of Supervisors, by Resolution No. 92-56, for waterfowl or wetland habitat easement acquisition by the U.S. Fish and Wildlife Service. The U.S. Fish and Wildlife Service proposes to acquire easements, upon a willing seller basis, using Migratory Bird Conservation Funds in accordance with the North American Waterfowl Management Plan and Central Valley Habitat Joint Venture Implementation Plan.

Orland

Hamilton City

Chico

Legend

Threatened and Endangered

Common Name

- Colusa grass
- Conservancy fairy shrimp
- Hoover's spurge
- Indian Valley brodiaea
- Swainson's hawk
- Tracy's eriastrum
- bank swallow
- giant garter snake
- hairy orcutt grass
- palmate-bracted bird's-beak
- valley elderberry longhorn beetle
- vernal pool fairy shrimp
- western yellow-billed cuckoo

2 1 0 2 Miles

Scale 1:126,720
1in = 2mi

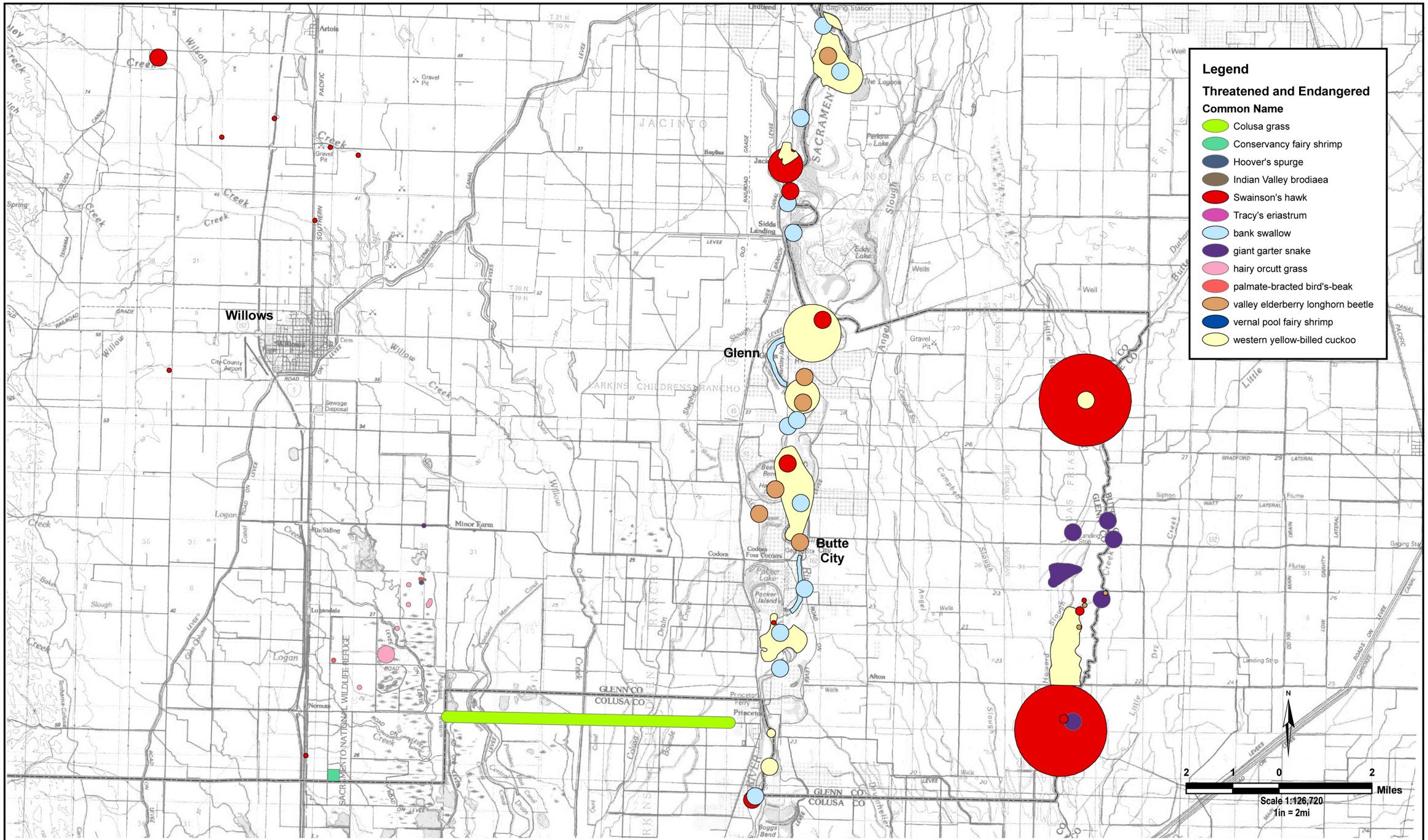
Source: CA Dept. of Fish and Game, CNDDB 2004 / Quad Knopf Inc., 2004

Quad Knopf

Figure 3-10

DOCUMENTED THREATENED AND ENDANGERED SPECIES - NORTH GLENN COUNTY

Job No.: 03157



Source: CA Dept. of Fish and Game, CNDDB 2004 / Quad Knopf Inc., 2004

Quad Knopf

Figure 3-11

DOCUMENTED THREATENED AND ENDANGERED SPECIES - SOUTH GLENN COUNTY

Job No.: 03157

Orland
Hamilton City
Chico

Legend

Special Status Animals

Comman Name

- California tiger salamander
- Conservancy fairy shrimp
- Swainson's hawk
- bank swallow
- burrowing owl
- giant garter snake
- great egret
- valley elderberry longhorn beetle
- western yellow-billed cuckoo

N

2 1 0 2 Miles

Scale 1:126,720
1in = 2mi

Source: CA Dept. of Fish and Game, CNDDB 2004 / Quad Knopf Inc., 2004

Quad Knopf

Figure 3-12

DOCUMENTED SPECIAL STATUS ANIMALS - NORTH GLENN COUNTY

Job No.: 03157

Legend

Special Status Animals

Comman Name

- California tiger salamander
- Conservancy fairy shrimp
- Swainson's hawk
- bank swallow
- burrowing owl
- giant garter snake
- great egret
- valley elderberry longhorn beetle
- western yellow-billed cuckoo

Willows

Butte City

2 1 0 2 Miles

Scale 1:126,720
1in = 2mi

Source: CA Dept. of Fish and Game, CNDDB 2004 / Quad Knopf Inc., 2004

Quad Knopf

Figure 3-13

DOCUMENTED SPECIAL STATUS ANIMALS - SOUTH GLENN COUNTY

Job No.: 03157

Legend

Special Status Plants

Common Name

- Baker's navarretia
- Columbian watermeal
- Colusa grass
- Ferris's milk-vetch
- Heckard's pepper-grass
- Hoover's spurge
- San Joaquin saltbush
- brittlescale
- caper-fruited tropidocarpum
- hairy orcutt grass
- heartscale
- palmate-bracted bird's-beak
- pink creamsacs
- recurved larkspur
- rose-mallow
- round-leaved filaree
- vernal pool smallscale

Orland

Hamilton City

Ordbend

2 1 0 2 Miles

Scale 1:126,720
1in = 2mi

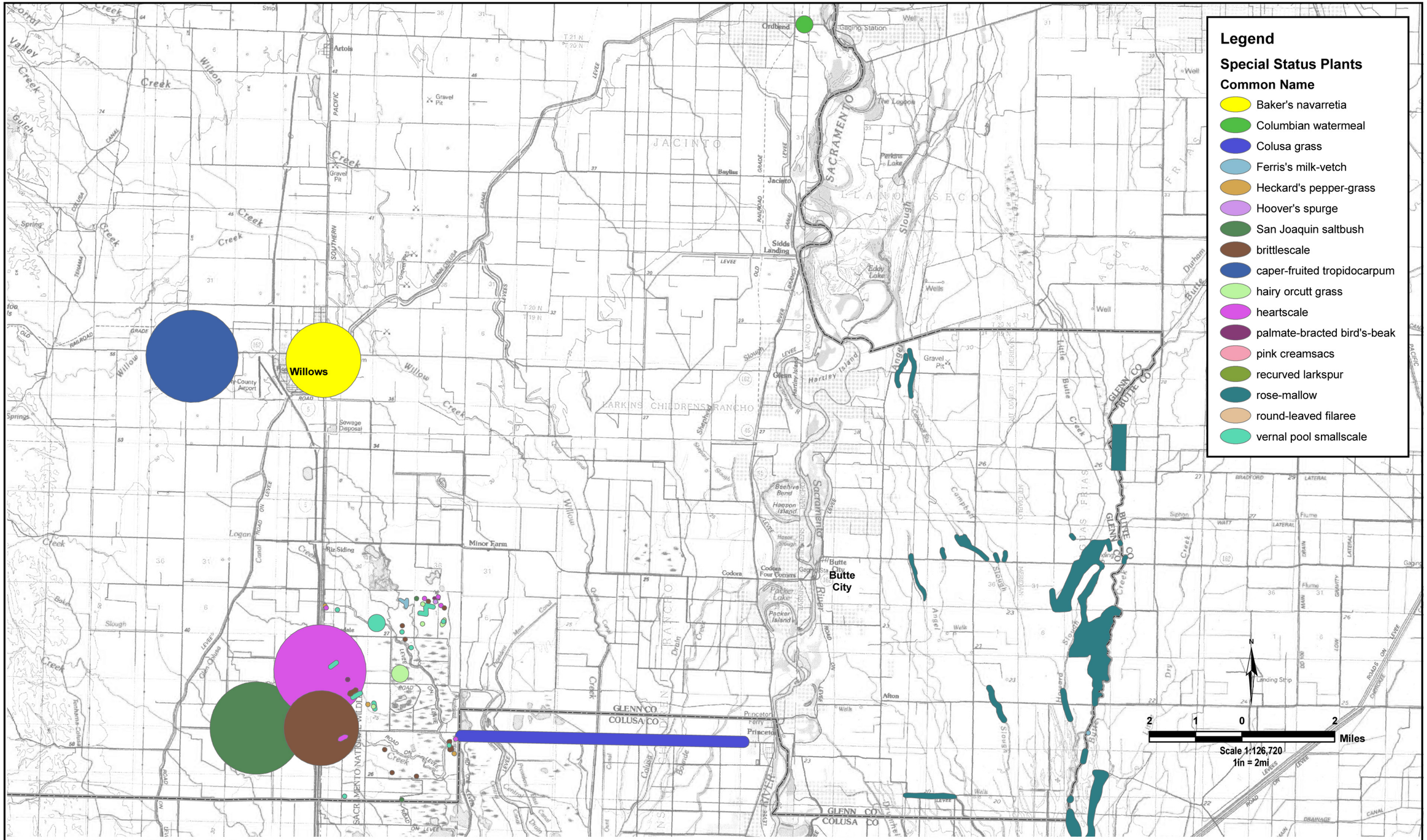
Source: CA Dept. of Fish and Game, CNDDB 2004 / Quad Knopf Inc., 2004

Quad Knopf

Figure 3-14

DOCUMENTED SPECIAL STATUS PLANTS - NORTH GLENN COUNTY

Job No.: 03157



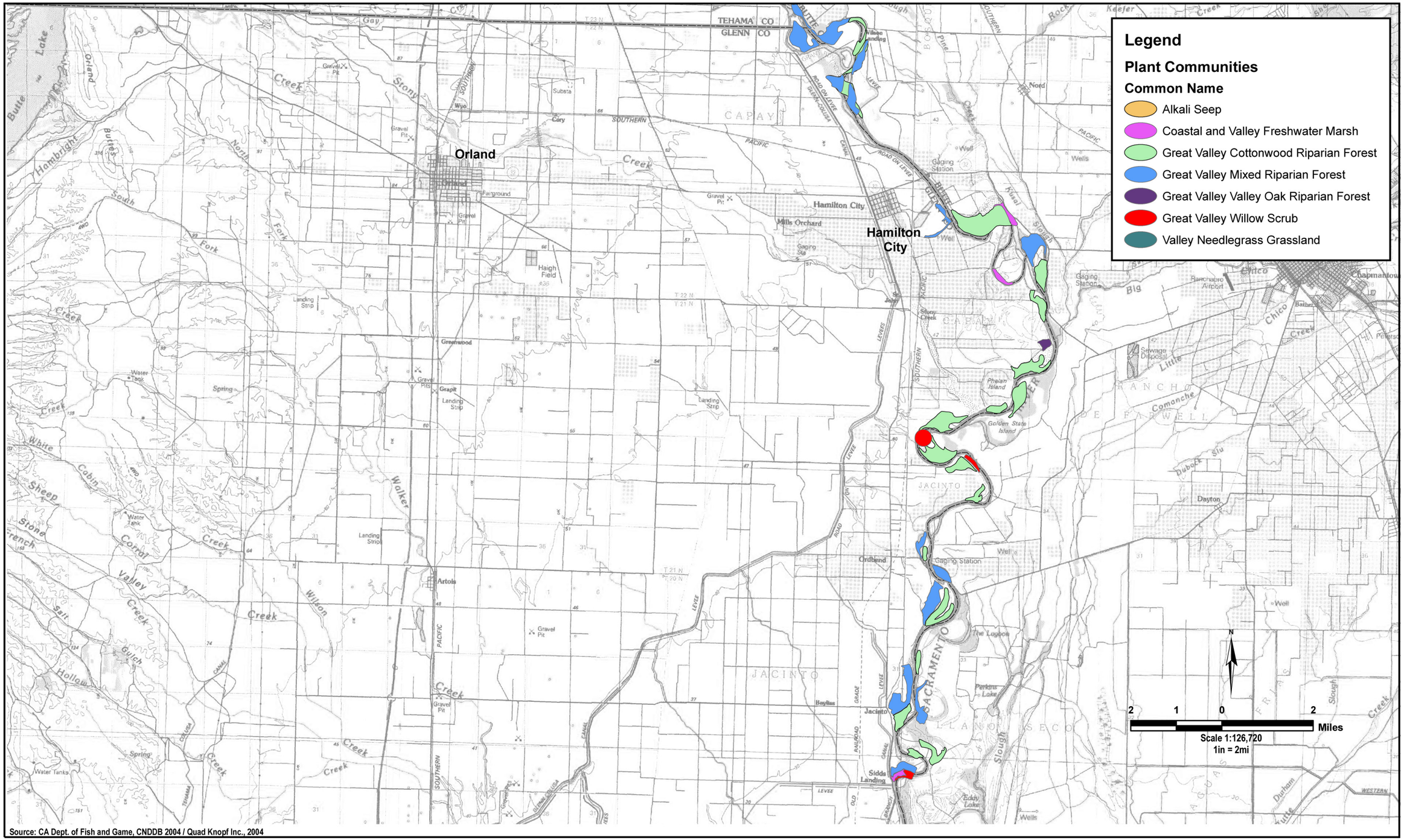
Source: CA Dept. of Fish and Game, CNDDB 2004 / Quad Knopf Inc., 2004

Quad Knopf

Figure 3-15

DOCUMENTED SPECIAL STATUS PLANTS - SOUTH GLENN COUNTY

Job No.: 03157



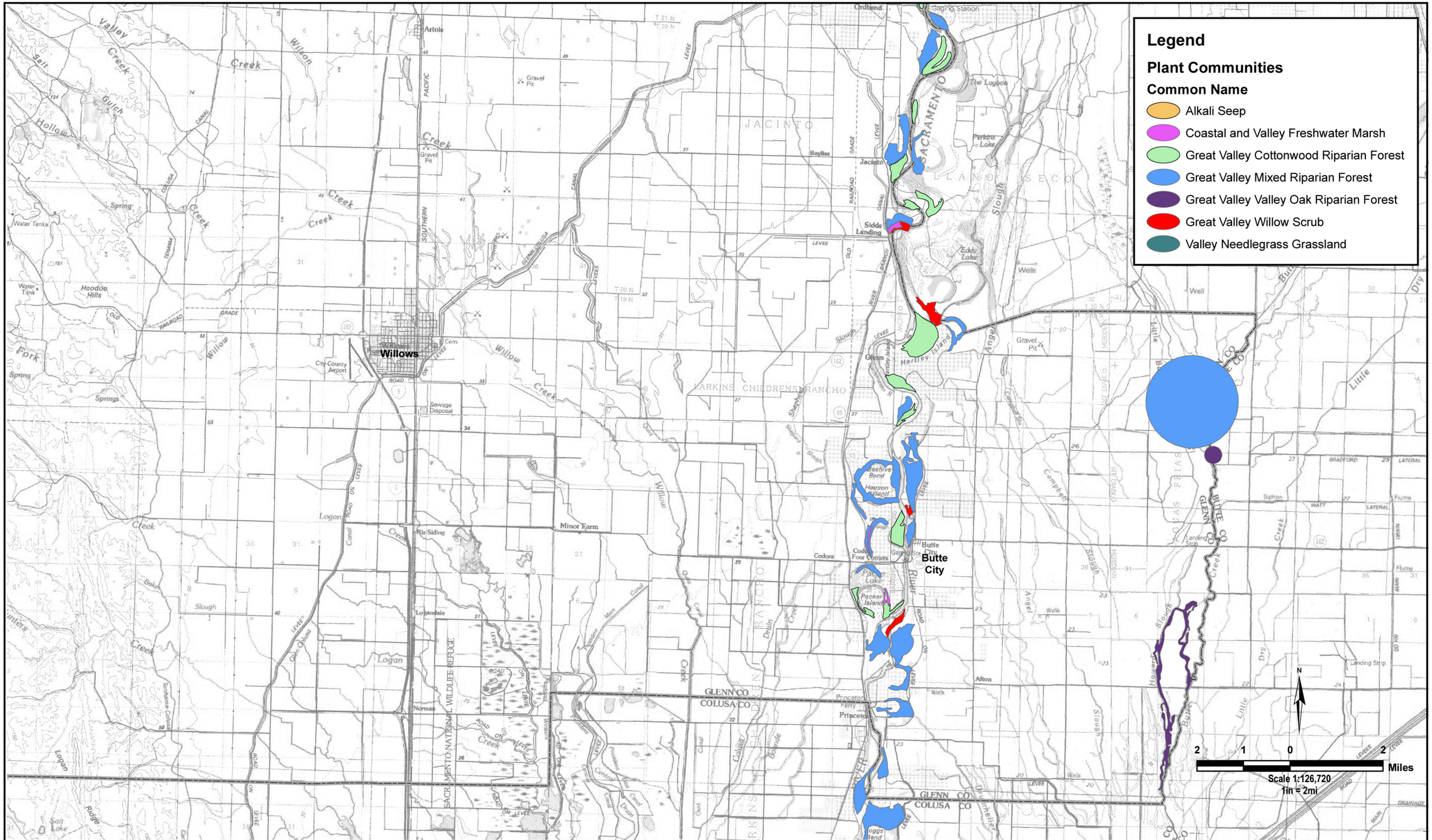
Source: CA Dept. of Fish and Game, CNDDB 2004 / Quad Knopf Inc., 2004

Quad Knopf

Figure 3-16

DOCUMENTED SENSITIVE PLANT COMMUNITIES - NORTH GLENN COUNTY

Job No.: 03157



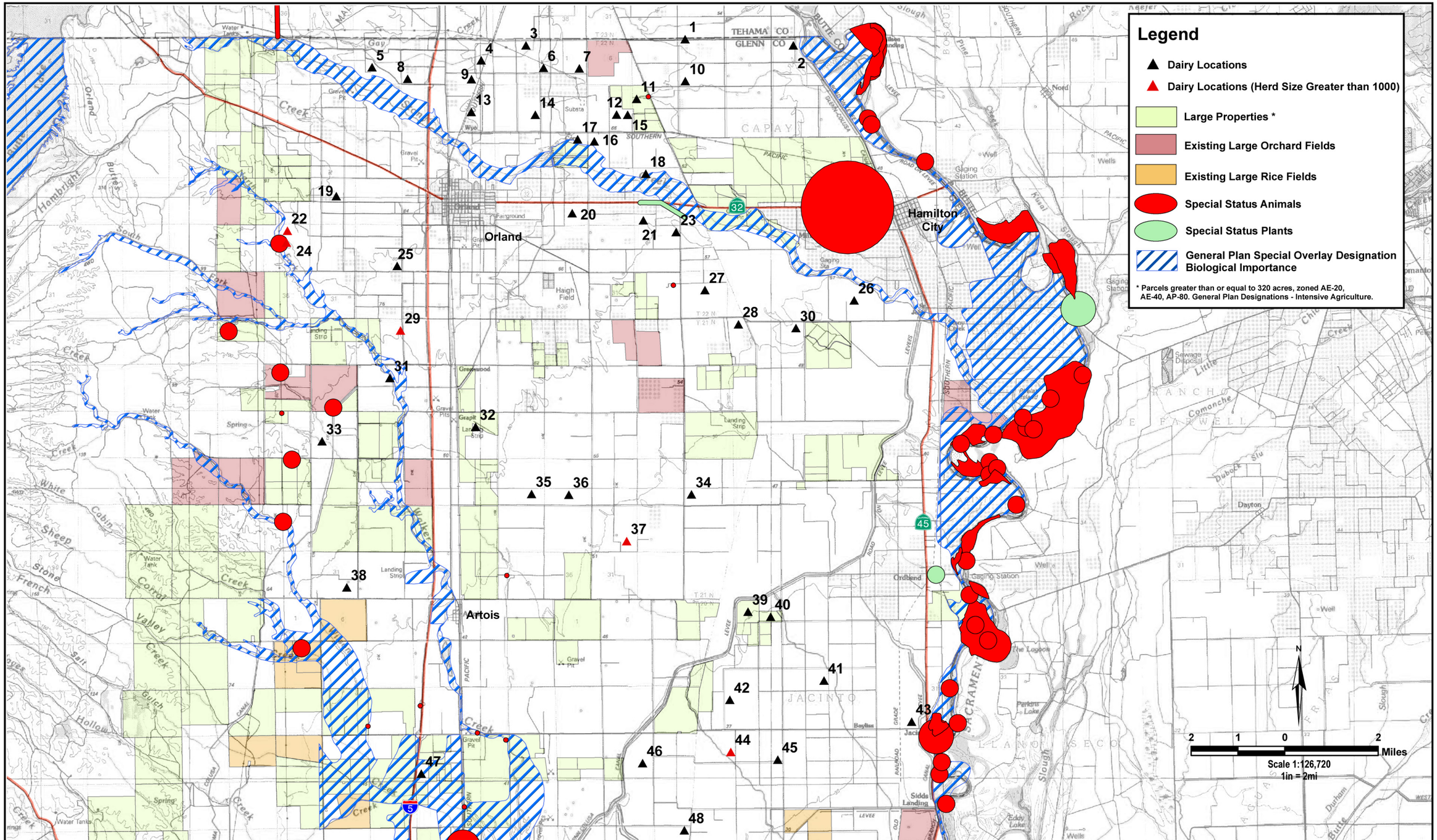
Source: CA Dept. of Fish and Game, CNDDB 2004 / Quad Knopf Inc., 2004

Quad Knopf

Figure 3-17

DOCUMENTED SENSITIVE PLANT COMMUNITIES - SOUTH GLENN COUNTY

Job No.: 03157



Source: Glenn County Planning Dept. / MSN TerraServer 16m DRG / CA Dept. of Fish and Game, CNDDD, 2004 / Quad Knopf Inc., 2004

Quad Knopf

Figure 3-18

AREAS OF BIOLOGICAL IMPORTANCE OPPORTUNITIES AND CONSTRAINTS - NORTH GLENN COUNTY

Job No.: 03157

Legend

- Dairy Locations
- Dairy Locations (Herd Size Greater than 1000)
- Large Properties *
- Existing Large Orchard Fields
- Existing Large Rice Fields
- Special Status Animals
- Special Status Plants
- General Plan Special Overlay Designation Biological Importance

* Parcels greater than or equal to 320 acres, zoned AE-20, AE-40, AP-80. General Plan Designation - Intensive Agriculture.

Artois
Willows
Rumiano Cheese Co.
Glenn
Butte City
Sacramento National Wildlife Refuge
Dairy 39
Dairy 40
Dairy 41
Dairy 42
Dairy 43
Dairy 44
Dairy 45
Dairy 46
Dairy 47
Dairy 48
Dairy 49
Dairy 50

2 1 0 2 Miles

Scale 1:126,720
1in = 2mi

Source: Glenn County Planning Dept. / MSN TerraServer 16m DRG / CA Dept. of Fish and Game, CNDDD, 2004 / Quad Knopf Inc., 2004

Quad Knopf

Figure 3-19

AREAS OF BIOLOGICAL IMPORTANCE OPPORTUNITIES AND CONSTRAINTS - SOUTH GLENN COUNTY

Job No.: 03157

Chapter Four

Goals, Policies & Development Standards

CHAPTER FOUR
GOALS, POLICIES AND DEVELOPMENT STANDARDS

Goal CAF 1: Attraction of new confined animal facilities to Glenn County.

Policy CAF 1.1: Glenn County shall provide a user-friendly process in which confined animal facility projects that meet the standards of the Confined Animal Facilities Element may be approved.

Policy CAF 1.2: Glenn County shall provide a streamlined, multi-tiered permitting process tailored to project type.

Policy CAF 1.3: The County shall provide the Confined Animal Facilities Element to all persons interested in confined animal facility expansion and development in Glenn County.

Goal CAF 2: Protection of established confined animal facilities from encroachment by incompatible land uses.

Policy CAF 2.1: New dwelling units may not be sited within a "confined animal facility windshed" of the production facilities or, where this cannot be attained due to parcel size, the dwelling unit shall be located to the maximum extent possible from the property line bordering an existing confined animal facility. The confined animal facility windshed shall be defined as an area around the production facilities of the confined animal operation that is one mile in the direction of prevailing winds and one-half ($^1/_2$) mile in any other direction from the production facilities.

Policy CAF 2.2: On projects involving conversion of land with a general plan designation of either General Agriculture or Intensive Agriculture, to other land uses, dwelling units may not be constructed within the confined animal facility windshed (as defined in CAF 2.1) of the production facilities of the confined animal operation.

Goal CAF 3: Facilitation of County and State regulatory processes for permitting of confined animal facilities.

Policy CAF 3.1: An expansion of an existing confined animal facility shall require a use permit and environmental review if any of the following conditions are met:

- The original use permit has expired.
- The applicant must acquire more acreage for reuse of waste or wastewater to prevent impacts to surface water or groundwater quality (19.04.020-30a).
- The project will increase the capacity of the retention pond to maintain compliance with the conditions of the "Waste Discharge Requirements or Discharges from Confined

Animal Facilities" for adequate flood protection and wastewater containment (19.04.020-30b).

- The production facilities, including corrals, barns, manure storage areas, feed, storage areas, lagoons, etc. are to be physically expanded through construction at a different and non-contiguous site on the property away from the existing production facilities.

- The proposed project conflicts with development standards contained in the Confined Animal Facilities Element.

Policy CAF 3.2: A new or expanded confined animal facility project that meets the development standards set forth in the Confined Animal Facilities Element will be eligible for a discretionary Minor Use Permit with no public hearing set unless it is requested by the applicant or other affected person. Public notices shall be sent to owners of adjacent properties that are within a minimum of 600 feet of the property line or within or bordering the confined animal facility windshed of the existing or proposed production facilities of the confined animal operation as defined in CAF 2.1.

Policy CAF 3.3: Confined animal facility projects that do not meet the development standards of the Confined Animal Facilities Element shall be subject to a Conditional Use Permit, including a public hearing before the Planning Commission.

Policy CAF 3.4: All applications for new confined animal facilities shall be submitted to the Glenn County Planning and Public Works Agency. Each application for a new or expanded confined animal facility that requires a Minor Use Permit or a Conditional Use Permit shall include a technical report. Copies of the technical report shall be distributed to the Glenn County Health Services Agency, Environmental Health Department; and the Glenn County Air Pollution Control District. The technical report shall include the following components:

A. General Site Information
B. Geotechnical Report
C. Drainage Analysis
D. Groundwater Evaluation
E. Nutrient Management Plan
F. Dead Animal Management Plan
G. Pest and Vector Control Plan
H. Dust Control Plan
I. Odor Control Plan
J. Traffic Analysis
K. Biological Resources Survey
L. Cultural Resources Evaluation
M. Light and Glare Control Plan

Policy CAF 3.5: Glenn County shall encourage applicants to develop project designs and management plans using Best Management Practices available from government, university extension, and industry association sources.

Policy CAF 3.6: Glenn County shall support the appropriate ongoing regulatory and compliance activities of the California Regional Water Quality Control Board for the protection of water quality as related to confined animal facility expansion and new confined animal facility development and operation. The County shall require all such construction and expansion projects to obtain appropriate permits from the Regional Water Quality Board as required by the State of California.

Policy CAF 3.7: To facilitate the regulatory activities of the California Regional Water Quality Control Board, all applications for new confined animal facilities and expansions of confined animal facilities that require a use permit shall include a Geotechnical Report, a Groundwater Evaluation, a Drainage Analysis, and a Nutrient Management Plan as part of the Technical Report (see CAF 3.4).

Policy CAF 3.8: Glenn County shall encourage new confined animal facility development in portions of the County which are not identified as groundwater recharge areas or shallow groundwater areas.

Policy CAF 3.9: For new or expanding confined animal facilities requiring a use permit, Glenn County shall encourage development of wastewater pond and waste separation pond linings in conformance with Natural Resource Conservation Service standards (Part 651/10 D) standards (See Appendix G).

Policy CAF 3.10: Glenn County shall support the appropriate ongoing regulatory and compliance activities of the California Air Resources Board with respect to "large confined animal facilities" as defined by the Air Resources Board.

Policy CAF 3.11: To facilitate compliance with air quality regulations, all applications for new confined animal facilities and expansions of confined animal facilities that require a Minor Use Permit or Conditional Use Permit shall include a Dust Control Plan as part of the Technical Report (see CAF 3.4).

Policy CAF 3.12: Glenn County shall encourage applicants seeking a use permit for a dairy to achieve certification under the California Dairy Quality Assurance (CDQA) Program (see Appendix H).

Policy CAF 3.13: The driveways and access points for confined animal facilities shall be designed to accommodate semi-tractor trailer trucks, and adjacent roads shall be built to meet the demands of extra weight and larger turning radii.

Policy CAF 3.14: Other than the primary residence of the property owner, housing built on the site of new confined animal facilities and expansions of confined animal facilities that require a use permit shall only be occupied by families of employees who work on the premises.

Goal CAF 4: Protection of the environment and residents from the potential impacts of confined animal facilities.

Policy CAF 4.1: All applications for new confined animal facilities and expansions of confined animal facilities that require Minor Use Permit or Conditional Use Permit shall include a Biological Resources Survey as part of the Technical Report (Policy CAF 3.4).

Policy CAF 4.2: All new confined animal facilities and expansions of confined animal facilities that require a Minor Use Permit or Conditional Use Permit shall comply with state and Federal laws regarding protection of Special Status species and their habitats.

Policy CAF 4.3: All applications for new confined animal facilities and expansions of confined animal facilities that require a Minor Use Permit or Conditional Use Permit shall include a Cultural Resources Evaluation as part of the Technical Report (Policy CAF 3.4).

Policy CAF 4.4: All applications for new confined animal facilities and expansions of confined animal facilities that require a Minor Use Permit or Conditional Use Permit shall include a Traffic Analysis as part of the Technical Report (Policy CAF 3.4).

Policy CAF 4.5: All applications for new confined animal facilities and expansions of confined animal facilities that require Minor Use Permit or Conditional Use Permit shall include a Light and Glare Control Plan as part of the Technical Report (Policy CAF 3.4).

Policy CAF 4.6: Production facilities for new or expanding confined animal facilities requiring a Minor Use Permit or Conditional Use Permit may not be located within urban windsheds. The urban windshed shall be defined as an area around urban limit lines, as denoted in the Glenn County General Plan, that is one mile in the direction of prevailing winds and one-half ($^1/_2$) mile in any other direction from urban limit lines.

Policy CAF 4.7: Production facilities for new or expanding confined animal facilities requiring a Minor Use Permit or Conditional Use Permit may not be located within the windshed of existing public or private school sites, medical or nursing care facilities, or concentrations of five or more residences. The windshed shall be defined as an area that is one mile in the direction of prevailing winds and one-half ($^1/_2$) mile in any other direction from existing public or private school sites, medical or nursing care facilities, or concentrations of five or more residences.

Policy CAF 4.8: Production facilities for new or expanding confined animal facilities requiring a Minor Use Permit or Conditional Use Permit may not be located less than a one-half ($^1/_2$) mile from Interstate 5.

Policy CAF 4.9: To minimize the public nuisances caused by odors, dust, flies, vectors, and excessive light and glare, all applications for new confined animal facilities and expansions of confined animal facilities that require a Minor Use Permit or Conditional Use Permit shall include an Odor Control Plan; a Dust Control Plan; a Dead Animal Management Plan, a Pest and Vector Control Plan; and a Light and Glare Control Plan (see CAF 3.4).

Policy CAF 4.10: No confined animal facility shall be constructed or expanded in a manner which, or in an area in which, its construction or expansion will substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a

stream or river, in a manner that would result in substantial erosion or siltation on- or off-site; or substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river; or substantially increase the rate or amount of surface runoff in a manner that would result in flooding on- or off-site.

Policy CAF 4.I1: No confined animal facility shall be constructed or expanded in a manner that would create or contribute runoff water that would exceed the capacity of existing or planned stormwater drainage systems or create a sources of polluted runoff.

Policy CAF 4.I2: No confined animal facility shall place housing within a 100-year flood hazard area as mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map unless the drainage analysis includes assurances that such housing will be above maximum flood levels; neither shall confined animal facility design place within a 100-year flood hazard area structures which would impede or redirect flood flows without approval by the County of drainage analysis data and design that assures no downstream impact.

DEVELOPMENT STANDARDS

- A Technical Report shall be submitted with each application for a new or expanded confined animal facility that requires a Minor Use Permit or a Conditional Use Permit. The Technical Report shall include the following components, which are described in Appendix F of the Confined Animal Facilities Element:

  A. General Site Information
  B. Geotechnical Report
  C. Drainage Analysis
  D. Groundwater Evaluation
  E. Nutrient Management Plan
  F. Dead Animal Management Plan
  G. Pest and Vector Control Plan
  H. Dust Control Plan
  I. Odor Control Plan
  J. Traffic Analysis
  K. Biological Resources Survey
  L. Cultural Resources Evaluation
  M. Light and Glare Control Plan

- Applicants shall develop project designs and management plans using Best Management Practices available from government, university extension, and industry association sources.

- The driveways and access points for confined animal facilities shall be designed to accommodate semi-tractor trailer trucks, and adjacent roads shall be built to meet the demands of extra weight and larger turning radii.

- Other than the primary residence of the property owner, housing built on the site of new confined animal facilities and expansions of confined animal facilities that require a use permit shall only be occupied by families of employees who work on the premises.

- Production facilities for new or expanding confined animal facilities requiring a Minor Use Permit or Conditional Use Permit may not be located within urban windsheds. The urban windshed shall be defined as an area around urban limit lines, as denoted in the Glenn County General Plan, that is one mile in the direction of prevailing winds and one-half ($^1/_2$) mile in any other direction from urban limit lines.

- Production facilities for new or expanding confined animal facilities requiring a Minor Use Permit or Conditional Use Permit may not be located within the windshed of existing public or private school sites, medical or nursing care facilities, or concentrations of five or more residences. The windshed shall be defined as an area that is one mile in the direction of prevailing winds and one-half ($^1/_2$) mile in any other direction from existing public or private school sites, medical or nursing care facilities, or concentrations of five or more residences.

- Production facilities for new or expanding confined animal facilities requiring a Minor Use Permit or Conditional Use Permit may not be located less than a one-half ($^1/_2$) mile from Interstate 5.

DEFINITIONS

Confined Animal Facility

"Confined animal facility" means a facility that consists of any structure, building, installation, barn, corral, coop, feed storage area, milking parlor, or system for the collection, storage, treatment, and distribution of liquid and solid manure, if domesticated animals, including, but not limited to, cattle, calves, horses, sheep, goats, swine, rabbits, chickens, turkeys, or ducks are corralled, penned, or otherwise caused to remain in restricted areas of the facility for commercial agricultural purposes and feeding by means other than grazing."

This definition is derived from Senate Bill 700, which is incorporated into the state Health and Safety Code. It would replace the current definition in Glenn County Code 19.04.020-30.

Windshed

An area around the production facilities of the confined animal operation that is one mile in the direction of prevailing winds and one-half ($^1/_2$) mile in any other direction from the production facilities.

Cluster

A concentration of five or more residential dwellings that are located no more than 200 feet from each other. A cluster is equivalent to the smallest number of dwelling units in a subdivision.

Appendices

Appendix A

APPENDIX A
GLENN COUNTY ZONING CODE

AGRICULTURE/SOILS

Glenn County Agricultural Preserve Program (Zoning Code 19.34.010).

Uses and structures permitted in the Agricultural Preserve (AP) zones:

- One single-family residence or mobilehome for each parcel of land (refer to mobilehome standards);

- Additional residences and mobilehomes may be permitted providing that:
  - Such additional residences and mobilehomes may only be occupied by relatives of the owner or by employees who work on the property
  - Such additional residences and mobilehomes shall meet the following density requirements
    - Number of Dwelling Units: 1 to 4, density: 80 acres per dwelling unit
    - Number of Dwelling Units: 5 to 8, density: 160 acres per dwelling unit
    - Number of Dwelling Units: 9 and over, density: 240 acres per dwelling unit;

- Accessory buildings such as garages, carports, greenhouses, gardening sheds, recreation rooms, storage of petroleum products for the use of persons residing on the property and any other structures which are customarily used in conjunction with and incidental to a principal use or structure;

- Home occupations as defined in Chapter 19.64;

- Growing and harvesting of fruit and nut trees, vines, vegetables, horticultural specialties and timber;

- Growing and harvesting of field crops, grain and hay crops, and the growing of grass for pasture and grazing;

- Livestock farming, including the raising, feeding, maintaining and breeding of horses, cattle, sheep, goats and similar livestock;

- Operation of apiaries and dairies;

- Curing, processing, packaging, packing, storage and shipping of agricultural products; however, those particular operations, uses and structures which create smoke, fumes, dust, odor and other hazards may be permitted only if a conditional use permit is first secured;

- Accessory buildings or structures required for the storage of any crops, products, equipment or uses lawfully permitted or produced on the premises. Structures such as barns, stables, coops, tank houses, storage tanks, wind machines, windmills, silos and other farm buildings;

- Game preserves and hunting clubs, private or public, but shall not include permanent facilities such as hotels, motels, restaurants, club houses;

- Agricultural service establishments primarily engaged in performing agricultural animal husbandry services or horticultural services to farms;

- Temporary landing of aircraft engaged in agricultural uses;

- Dehydrators but not for the general public on a commercial basis;

- Stands for the purpose of displaying and selling agricultural, floricultural or farming products which are grown or produced on the premises; provided, that there shall not be more than one stand per parcel of land. The stand shall be set back from the street or highway right-of-way a distance of at least twenty feet. Such stand must be of good frame construction; and

- Seasonal farmworker housing which meets the Seasonal Farmworker Housing Standards as set forth in Chapter 19.67 and approved for such use pursuant to Title 25 of the California Code of Regulations. Seasonal farmworker housing shall also conform to such public health, building, and fire safety criteria as may be established by resolution or ordinance of the board of supervisors.

Zoning Code 19.34.030 allows the following uses in AP zones with a conditional use permit:

- Irrigation and flood control facilities, public utility and public service structures including electric transmission and distribution substations, gas regulator stations, communications equipment buildings, public service pumping stations and reservoirs over fifty acre-feet or over twenty-five feet high;

- Agricultural labor camps;

- Injection wells;

- Hunting clubs and facilities including spaces for recreation vehicles, horse racing establishments, golf courses, sporting clay courses and other similar uses;

- Air strips and/or airports;

- Mining and related processing activities;

- Power generation;
- New confined animal facilities; and
- Confined animal facility expansion.

Maximum building height (19.34.060) in the AP zone is 35 feet for residential structures, 50 feet for agricultural buildings or structures. However, water tanks, silos, granaries, barns, pole buildings, electronic towers, antennas and similar structures of necessary mechanical appurtenances may exceed fifty feet in height, provided they do not exceed the airport height restrictions.

Minimum distance between structures (19.34.070) are as follows:

A. The distance between any accessory building and a dwelling unit shall conform to Uniform Building and Fire Codes.

B. All pens, coops, stables, barns, corrals or other structures housing livestock or poultry shall be located not less than one hundred feet from all structures used for human habitation.

Minimum yard requirements (19.34.080) are as follows:

A. Front Yard. The minimum front yard shall be thirty feet. The measurement shall start at the edge of the existing county right-of-way as shown on the adopted Glenn County Circulation Plan.

B. Side Yards. The minimum side yards shall be twenty-five feet.

C. Rear Yard. The minimum rear yard shall be twenty-five feet.

Glenn County Farmland Security Zone (19.35.010)

The following uses and structures are permitted in FS zoned areas:

- One single-family residence or mobilehome for each parcel of land (Refer to Minimum Residential Construction Standards);
- Accessory buildings to the single-family residence such as garages, carports, greenhouses, gardening sheds, recreation rooms and other structures which are customarily used in conjunction with a single-family residence;
- Home Occupations as defined in Chapter 19.64;
- Growing and harvesting of fruit and nut trees, vines, vegetables, horticultural specialties and timber;

- Growing and harvesting of field crops, grain and hay crops, and the growing of grass for pasture and grazing;

- Livestock farming, including the raising, feeding, maintaining and breeding of horses, cattle, sheep, goats and similar livestock;

- Operation of apiaries and dairies. (Refer to dairy standards);

- Curing processing, packaging, packing, storage and shipping of agricultural products;

- Accessory buildings or structures required for the storage of any crops, products, equipment or uses lawfully permitted or produced on the premises. Structures such as barns, stables, coops, tank houses, storage tanks, wind machines, windmills, silos, and other farm buildings;

- Game preserves and hunting clubs, that do not include permanent facilities or buildings;

- Temporary landing of aircraft engaged in agricultural uses; and

- Seasonal Farmworker Housing which meets the Seasonal Farmworker Housing Standards as set forth in Chapter 19.67 and approved for such use pursuant to Title 25 of the California Code of Regulations. (Ord. 1109 § 1, 1999)

LAND USE AND PLANNING

Right-to-Farm Ordinance

21.06.020 Findings and Policy.

A. It is the declared policy of this county to enhance and encourage agricultural operations within the county. It is the further intent of this county to provide to the residents of this county proper notification of the county's recognition and support through this chapter of those persons and/or entities' rights to farm.

B. Where nonagricultural land uses extend into agricultural areas or exist side by side, agricultural operations are frequently the subject of nuisance complaints and are forced to cease or curtail operations. Such actions discourage investments in farm improvements to the detriment of adjacent agricultural uses and the economic viability of the county's agricultural industry as a whole. It is the purpose and intent of this chapter to reduce the loss to the county of its agricultural resources by limiting the circumstances under which agricultural operations may be considered a nuisance. This chapter is not to be

construed as in any way modifying or abridging state law as set out in the California Civil Code, Health and Safety Code, Fish and Game Code, Food and Agricultural Code, Division 7 of the Water Code, or any other applicable provision of state law relative to nuisances, rather it is only to be utilized in the interpretation and enforcement of the provisions of this code and county regulations.

C. An additional purpose of this chapter is to promote a good neighbor policy between agricultural and nonagricultural property owners by advising purchasers and users of property adjacent to or near agricultural operations of the inherent potential problems associated with such purchases or residence, including but not limited to the noises, odors, dust and chemicals, smoke and hours of operation that may accompany agricultural operations and be prepared to accept attendant conditions as the natural result of living in or near rural areas.

21.06.030 Nuisance

No agricultural activity, operation or facility or appurtenances thereof, conducted or maintained for commercial purposes, and in a manner consistent with proper accepted customs and standards and with all present or future chapters of this code, as established and followed by similar agricultural operations, shall be or become a nuisance, public or private, pursuant to this code, if it was not a nuisance when it began.

21.06.040 Disclosure

A. The following statement shall be signed and recorded at the time and in the manner required by subsection B of this section:

> "If your real property is adjacent to property used for agricultural operations or included within an area zoned for agricultural purposes, you may be subject to inconveniences or discomforts arising from such operations, including but not limited to noise, odors, fumes, dust, the operation of machinery of any kind during any twenty-four-hour period (including aircraft), the storage and disposal of manure and the application and spraying or otherwise of chemical fertilizers, soil amendments and pesticides. Glenn County has determined that the use of real property for agricultural operations is a high priority and favored use to the county and will not consider to be a nuisance those inconveniences or discomforts arising from agricultural operations if such operations are consistent with accepted customs and standards."

B. The statement set forth in subsection A of this section shall be used under the following circumstances and in the following manners:

1. Upon transfer of real property by sale, exchange, installment land sale contract, lease with an option to purchase, or other option to purchase, or ground lease coupled with improvements with dwelling units, the transferor shall require that the agricultural statement of acknowledgment for residential development in the form set forth in Section 21.06.070 of this chapter be signed by the purchaser and recorded in the county recorder's office in conjunction with the deed conveying the real property;
2. Upon the issuance of a discretionary development permit including but not limited to subdivision maps and use permits, for use on or adjacent to lands zoned for agricultural operations. The discretionary development permit shall include a condition that the owners of the property and the party seeking the discretionary permit shall be required to sign an agricultural statement of acknowledgment for residential development in the form set forth in Section 21.06.070 of this chapter which form shall then be recorded in the county recorder's office.

21.06.050 Separability

If any section, subsection, sentence, clause, or phrase of this chapter is for any reason held to be invalid or unconstitutional by the decision of a court of competent jurisdiction, it shall not affect the remaining portions of this chapter.

21.06.060 Resolution of disputes

Should any controversy arise regarding any inconveniences or discomforts occasioned by agricultural operations, including but not limited to noises, odors, fumes, smoke, dust, traffic, the operation of machinery of any kind during any twenty-four-hour period (including aircraft), the storage and disposal of manure and the application by spraying or otherwise of chemical fertilizers, soil amendments and pesticides, the parties may submit the controversy to the agricultural grievance committee as set forth below in an attempt to resolve the matter prior to the filing of any court action:

A. Any controversy between the parties shall be submitted to the agricultural grievance committee as established in Section 21.06.080 of this chapter within thirty days of the date of the occurrence of the particular activity giving rise to the controversy or of the date a party became aware of the occurrence;

B. The county recognizes the value and importance of full discussion and complete presentation and agreement concerning all pertinent facts in order to eliminate any misunderstandings;

C. The controversy shall be presented to the committee by written request of one of the parties within the time limits specified. The request shall be delivered to the committee at the office of the Glenn County agricultural commission in Willows. Thereafter the committee may investigate the facts of the

controversy, but must, within thirty days, hold a meeting to consider the merits of the matter and within twenty days of the meeting must render a written decision to the parties. At the time of the meeting both parties shall have an opportunity to present what each considers to be pertinent facts;

D. The decision of the committee shall not be binding. If, however, one of the parties is not satisfied with the committee decision, upon agreement of both parties, the matter may be submitted to binding arbitration according to the procedures set forth in subsection E of this section;

E. Binding Arbitration Procedures:

1. The controversy between the parties shall be submitted to arbitration upon the written agreement of both parties and any decision resulting therefrom shall be binding upon both parties.
2. The parties shall each appoint one person to hear and determine the dispute. If these two arbitrators cannot agree, then the two arbitrators shall choose a third impartial arbitrator who shall make the decision. The cost of the arbitration shall be borne by the losing party or in such proportions as the arbitrators shall decide.

21.06.070 Agricultural statement of acknowledgment

Section 21.06.040 of this chapter requires this acknowledgment to be recorded prior to issuance of a building permit, transfer of real property by sale, exchange, installment land sale contract, lease with an option to purchase or other option to purchase, or ground lease coupled with improvements with dwelling units, the issuance of a discretionary permit including but not limited to subdivision permits and use permits, for use on or adjacent to lands zoned for agricultural operations.

"If your real property is adjacent to property used for agricultural operations or included within an area zoned for agricultural purposes, you may be subject to inconveniences or discomforts arising from such operations, including but not limited to noise, odors, fumes, dust, the operation of machinery of any kind during any 24-hour period (including aircraft), the storage and disposal of manure and the application by spraying or otherwise of chemical fertilizers, soil amendments and pesticides. Glenn County has determined that the use of real property for agricultural operations is a high priority and favored use to the county and will not consider to be a nuisance those inconveniences or discomforts arising from agricultural operations, if such operations are consistent with accepted customs and standards."

21.06.080 Agricultural grievance committee

A. Creation. There is created in the county an agricultural grievance committee.

B. Composition. The county agricultural grievance committee to consist of five members, not officials of the county, shall be appointed by the board of supervisors, selected as follows:

1. One representative of the orchard and vineyard industry;
2. One representative of the dairy industry;
3. One representative of the field crops industry;
4. One representative of other agricultural interests (for example, implement or chemical dealer);
5. One representative of the Glenn economic development committee or the Glenn County Chamber Of Commerce.

C. Ex Officio Members. The Glenn County farm advisor and agricultural commissioner shall serve as ex officio members.

D. When Legally Constituted. The county agricultural grievance committee shall be legally constituted and have jurisdiction to proceed to act upon the appointment of the members thereof as hereinabove stated and evidenced by an order of the board of supervisors duly entered upon the minutes of such board.

E. Terms-Appointments, Vacancies. The terms of office of each member shall be four years and until the first appointment and qualification of his or her successor. A vacancy is filled only for the unexpired term. All vacancies on the committee shall be immediately reported to the board of supervisors by the committee chairman.

F. Regular Meetings. There shall be at least one regular meeting of the committee per calendar year and such additional meetings as needed. Additional meetings of the committee may be called by any two members of the committee.

G. Members Compensation Traveling Expense. All members of the committee shall serve without compensation. The members of the committee shall receive their actual and necessary traveling expenses to and from the place of meeting of the committee and while traveling in connection with the business of the committee.

Appendix B

APPENDIX B
GLENN COUNTY GENERAL PLAN POLICIES

AGRICULTURE/NATURAL RESOURCE LANDS

General Plan policies that address agriculture and natural resource lands are as follows:

NRP-I. Maintain agriculture as a primary, extensive land use, not only in recognition of the economic importance of agriculture, but also in terms of agriculture's contribution to the preservation of open space and wildlife habitat.

NRP-2. Support the concept that agriculture is a total, functioning system which will suffer when any part of it is subjected to regulation resulting in the decline of agricultural productivity, unmitigated land use conflicts and/or excessive land fragmentation

NRP-3. Recognize the value of rice lands for waterfowl habitat, watershed management, and for groundwater recharge in an effort to preserve such lands and to maintain necessary water supplies in Glenn County.

NRP-4. Support efforts underway to explore the potential to utilize rice lands as temporary storage reservoirs in winter months, thus increasing groundwater recharge and supplies of surface water for both agriculture and wildlife, and potentially providing an alternative to rice straw burning.

NRP-5. Continue participation in the Williamson Act, and allow new lands devoted to commercial agriculture and located outside urban limit lines to enter the program, subject to the specific standards for inclusion contained in this General Plan.

NRP-6. Lobby on a continuing basis for maintenance and enhancement of the Williamson Act subvention program in concert with other interested counties and organizations.

NRP-7. Recognize the importance of the dairy industry, as well as other confined animal agricultural uses, to the agricultural economy by actively supporting efforts to attract new dairies and to expand existing facilities.

NRP-8. Assure that future land use decisions protect and enhance the agricultural industry while also protecting existing uses from potential incompatibilities.

NRP-9. Encourage use of agricultural lands preservation tools such as in-county transfer of development rights, conservation easements, exclusive agricultural zoning and continuation of minimum parcel sizes.

NRP-I0. Limit the application of rural residential and similar zoning in the county, and follow standards for its application as contained in this General P1cm, 50 as not to encourage the premature conversion of otherwise viable agricultural land to rural residential environments which can no longer be farmed, and are typically too dispersed to be served efficiently by government services.

NRP-II. Monitor requests for subdivision of agriculturally developed and zoned parcels, located outside urban limit lines, in order to determine if present minimum parcel sizes are working effectively to discourage agricultural lands conversion.

NRP-I2. Review agricultural lands conversion findings as described in NRP-11 with decision makers annually.

NRP-I3. Establish urban limit lines around existing and planned future communities, development nodes and other areas of urban use, in an effort to protect agricultural land and to encourage infill and concentric growth.

NRP-I4. Consult Important Farmland Maps and other sources of information on the relative value of agricultural lands when planning areas of growth, in order to direct growth and development toward lesser value agricultural lands.

NRP-I5. Recognize that, in order to realistically provide for the necessary diversity and growth required in the local economy, some lands presently committed to agriculture may be consumed by other development activities, and plan for and monitor such conversion to assure that it does not hinder or restrict existing agricultural operations. Priority shall be given to industries related to agriculture.

NRP-I6. Retain grazing land in large contiguous areas of the foothills, in recognition of its value to the livestock industry and as open space for watershed management, and its contribution to groundwater recharge, wildlife and waterfowl

NRP-I7. Recognize that limited conversion of grazing lands to other uses maybe less harmful to agriculture than conversion of cropland, if the new uses are properly planned and serviced.

NRP-I8. Support the U.S.D.A~ Soil Conservation Service effort to update soils survey information in Glenn County.

NRP-I9. Support the erosion control programs, resource management programs, and agricultural conservation efforts of the Glenn County Resource Conservation District that benefit the county as a whole.

NRP-20. Recognize the potential restrictions urbanization places on nearby agricultural practices and mitigate such conflicts whenever possible. Continue to support the County's "right to farm" ordinance and effort.

NRP-2I. Require notices of nonrenewal for Williamson Act lands as a condition of land division and boundary line changes which result in parcel sizes below zoning minimums.

Land Use

CDP-I. Establish urban-rural interface areas within which all new development shall incorporate a buffer zone to separate the development from surrounding agricultural land. This requirement may be eliminated or modified if there are significant topographical differences, substantial vegetation, or existing physical barriers between urban and rural areas.

CDP-2. Require that permanent, well-defined buffer areas be provided as part of new non-agricultural development proposals located adjacent to agricultural land uses on Important Farmlands designated as prime, of statewide importance, unique, or of local importance. These buffer areas shall be dedicated in perpetuity, shall be of sufficient size to protect agriculture from the impacts of incompatible development and to mitigate the effects of agricultural operations on adjacent land uses, and shall be credited as open space.

CDP-3. Use permanent physical features or barriers to separate agricultural from rural or urban uses wherever possible. Such features include rivers, streams, canals, roads, railroads, and topographical features.

CDP-4. Encourage clustering of residential development when parcels are adjacent to commercial agricultural lands, so as to place dwellings as far as possible from the agricultural land.

CDP-5. Encourage use of rural residential lot design which allows for the resubdivision of such lots, particularly when rural residential development occurs in proximity to growing communities.

CDP-6. Utilize urban limit lines as a method to preserve agricultural land and promote orderly growth in the county.

CDP-7. Solicit and encourage the voluntary donation of conservation easements or other development restrictions to the county or a qualified private nonprofit corporation to preserve the agricultural use of the land in areas designated for agricultural use, where subdivision of land would promote incompatible development.

CDP-8. Provide for the orderly transition of lands within urban limit lines from agricultural to urban use, and encourage and allow agricultural uses to continue until such time as urban development occurs.

CDP-9. Permit the conversion of agricultural or open land to urban development within urban limit lines to occur only as an extension of the urbanizing area. Urban limit lines shall not be used as justification for leapfrog development.

CDP-I0. Encourage the preservation of agricultural lands, including those lands in production, and those which are potentially productive.

CDP-II. Direct nonagricultural development to marginal agricultural lands, avoiding Important Farmlands, wherever feasible alternative sites have been identified.

CDP-I2. Avoidance of land use conflicts in agricultural areas. Policies: It shall be the policy of Glenn County to: CDP-12 Utilize a “Right to Farm" Ordinance as a method to reduce the impacts of potential land use conflicts.

CDP-I3. Require any new agricultural use or application to mitigate anticipated conflicts between proposed new agricultural uses and existing agricultural activities.

CDP-I4. Require environmental review of all applications for residential building permits on undeveloped lots in antiquated subdivisions located in agriculturally designated areas.

CDP-I5. Encourage the merger of lots or the reversion to acreage of lots in antiquated subdivisions in areas where development of the lots is substandard for agricultural purposes, and where development to non-agricultural use would impair surrounding agricultural operations.

CDP-I6. Recognize that due to discrepancies arising from the original land surveys conducted in the State, which resulted in acreage shortages in sections of land, the existence of physical barriers such as canals, roads, streams, levees, etc., and parcel configuration, exceptions to minimum parcel size for properties zoned to exclusive agricultural categories may be necessary and appropriate to promote the spirit and intent of the General P1cm.

CDP-I7. Encourage agricultural water suppliers to make changes in their service requirements to increase the minimum sized parcel to be served in agricultural areas to ten (10) acres, and recommend that new parcels created within water supply district boundaries which are less than ten (10) acres in size be detached from the district(s), except for the Orland Unit Water Users' Association, for which the minimum size shall be 5.01 acres.

CDP-18. Within the Orland-Artois Water District, approve no zone changes allowing parcels smaller than twenty (20) acres in size, and approve no tentative maps for parcels less than twenty (20) acres in size.

CDP-19. Limit residential uses on agriculturally designated lands to farm-related single-family residences and quarters for farm labor and senior citizens, in accordance with State law. Goal: CDG-3 Appropriate distribution and regulation of land uses.

CDP-20. Assure that adequate provision is made in this General Plan for all types of uses and establish coherent land use patterns.

CDP-21. Establish standards for population density and building intensity for each land use category identified on the Land Use Diagram.

CDP-22. Allow a limited number of new planned communities and include within an existing or establish a new urban limit line for all approved planned communities.

CDP-23. Allow development nodes along the I-S corridor at Road 7, Road 27, Road 33, Road 39, Road 57 and Road 68, and establish urban limit lines for all approved developments. All developments within development nodes shall be developed through the Planned Development process.

CDP-24. Discourage development of new planned communities away from established urban centers unless it can be demonstrated that they are self-sufficient and functional.

CDP-25. Prepare community plans for the unincorporated communities of Artois, Elk Creek, Hamilton City and Butte City which are consistent with this General Plan.

CDP-26. Adopt land use plans for the areas within the Orland and Willows urban limit lines, as recommended by the respective city, and as modified by the County to maintain consistency with this General Plane

CDP-27. Encourage the cities of Orland and Willows to utilize the County-adopted urban limit lines as planning boundaries for their respective General Plans.

CDP-28. Locate major new residential development in proximity to opportunities for employment.

CDP-29. Establish distinct land use categories for single family and multiple family residential uses.

CDP-30. Relate decisions concerning land use to the functional classification of nearby roadways.

CDP-3I. Encourage commercial and industrial development in areas where adequate facilities and services exist or where facilities and services can be made available, including areas within incorporated cities, planned communities and along the I-5 corridor. Adequate facilities and services shall include community water and sewer if located within an incorporated city or urban limit line. k other areas, adequacy of sewer and water service shall be as determined by local health standards/regulations.

CDP-32. Encourage a diverse range of commercial and industrial development, consistent with community plans and the level of service available.

CDP-33. Prevent the loss of designated industrial land to other nonindustrial uses.

CDP-34. Ensure that industrial or commercial development which requires public water, sewer and other urban services is located within an urban limit line.

CDP-35. Allow resource-dependent industrial uses to locate outside urban limit lines and other areas planned for development, when such uses are dependent upon close proximity to resource production lands, and are not dependent on an urban level of service.

CDP-36. Where appropriate, promote development of well planned and designed industrial parks catering to local businesses, as well as to outside opportunities.

CDP-37. Discourage strip commercial development and locate future commercial development in well designed commercial centers having adequate and controlled access to public roads.

CDP-38. Allow home occupations in areas not otherwise designated for commercial and industrial use, subject to review.

CDP-39. Design commercial and industrial subdivisions and uses to prevent the intrusion of incompatible uses.

CDP-40. Discourage scattered unplanned urban development.

CDP-4I. Establish a procedure for utilizing development agreements in conjunction with development proposals, and provide for the rezoning of property where development agreements are violated.

CDP-42. Encourage the clustering of radio and other communication towers exceeding present zoning height requirements in specific locations in order to minimize overall visual impacts, and to discourage unplanned location of towers.

CDP-43. Establish a threshold for when to use gross or net acreage to determine minimum parcel size in rural residential zones.

CDP-44. Discourage urban growth in floodplains, aquifer recharge areas, scenic and historic sites, or other sensitive areas as specified in this General Plan.

CDP-45. Refine existing design review guidelines for application to areas within urban limit lines, and establish new and creative design guidelines for development nodes along the 1-5 corridor area.

CDP-46. Require a general plan of development for large-scale development proposals, including planned communities and development nodes, and a specific plan for planned communities.

CDP-47. Reserve adequate sites for new and expanded public facilities needed to serve new growth and development and designate general locations for such facilities, including but not limited to schools, solid and liquid waste disposal facilities, drainage facilities, fire stations, and County government buildings and facilities.

CDP-48. Consider septic system and septage disposal limitations when determining areas suitable for new development not served by wastewater treatment facilities, and assure that density standards allow adequate area for septage disposal.

CDP-49. Support the orderly growth of the Willows-Glenn County and Orland-Haigh Field airports, the development of compatible uses for the areas surrounding these airports, and safeguard the general welfare of the inhabitants within the vicinity of each airport and the public in general.

Housing

CDP-87. Advocate and support proposed Siate and federal actions that will create a positive, stable climate for housing production.

CDP-88. Wherever appropriate, facilitate the use of federal or State programs that can assist in development of new housing consistent with identified countywide housing needs and adopted local plans and programs.

CDP-89. Support efforts which coordinate and improve the ability of the housing delivery system to effectively respond to local housing needs.

CDP-90. Encourage and participate in efforts to achieve economies and efficiencies which will facilitate the production of quality affordable housing.

CDP-9I. Promote balanced, orderly growth to minimize unnecessary development costs which add to the cost of housing.

Hydrology/Water Quality

Glenn County's General Plan contains a goal of "protection and enhancement of water quality." Relevant policies include the following:

PSP-43. Support ongoing regulatory and compliance efforts at the federal and State level for the protection of water quality.

PSP-44. Support the Rice Herbicide Action Plan and encourage other agricultural practices which reduce the threat of surface water pollution from agricultural chemical use.

PSP-45. Zone floodways and stream channels in a manner that promotes protection of water quality.

PSP-46. Discourage on-site sewage disposal systems on small lots in areas containing gravelly soils.

PSP-47. Support the preparation of area groundwater studies to ensure the protection of groundwater and to ensure that the holding capacity of the area is not exceeded.

PSP-48. Support education programs which increase the public awareness of the proper disposal of hazardous wastes in order to protect groundwater quality.

BIOLOGICAL RESOURCES

General Plan policies addressing biological resources include the following:

NRP-39. Approach the retention and enhancement of important habitat by preserving areas or systems which will benefit a variety of species or resources rather than focusing on individual species, resources or properties.

NRP-40. Consider sponsoring habitat conservation plans pursuant to tile Federal Endangered Species Act when sensitive species are encountered in areas proposed for development.

NRP-4I. Preserve natural riparian habitat, especially along Stony Creek and the Sacramento River and Butte Creek.

NRP-42. Eliminate tile E-M (Extractive Industrial) Zone from areas containing natural riparian vegetation/habitat and replace it with a category affording greater protection to stream courses and riparian habitats.

NRP-43. Support programs that expand public hunting and outdoor educational opportunities in Glenn County, including beneficial agricultural practices and pay-to-hunt enterprises.

NRP-44. Recognize that retention of natural areas is important to maintaining adequate populations of wildlife which is, in turn, important to the local economy.

NRP-45. Encourage development of hunting opportunities in tile county in an effort to offset the costs of natural habitat preservation while assuring that such activities are consistent with the public health and safety. \

NRP-46. Promote protection of native biological habitats of local importance such as riparian forests, foothill oak woodlands, Stony Gorge and Black Butte Reservoirs.

NRP-47. Recognize and protect areas of unique biological importance as identified on Figure 3-14 when reviewing development related proposals.

NRP-48. Study the feasibility of establishing buffer areas separating incompatible residential and commercial development from the Sacramento National Wildlife Refuge and other areas of unique biological importance.

NRP-49. Coordinate with State and federal agencies, private landowners, and private preservation/conservation groups in habitat preservation and protection of rare, endangered, threatened and special concern species, to ensure consistency in efforts and to encourage joint planning and development of areas to be preserved.

NRP-50. Recognize the Sacramento River corridor, the Sacramento National Wildlife Refuge, migratory deer herd areas, naturally occurring wetlands, and stream courses such as Butte and Stony Creeks as areas of significant biological importance.

NRP-5I. Coordinate with wildlife agencies, the Army Corps of Engineers and the State Lands Commission during review of development permits.

NRP-52. Utilize the Sacramento River Marina Carrying Capacity Study findings when reviewing proposals for development along the Sacramento River.

NRP-53. Direct development away from naturally occurring wetlands to the extent such policy is consistent with the concept of compact and contiguous development.

NRP-54. Coordinate closely with the Mendocino National Forest, if development proposals are forthcoming for private lands within the Forest.

NRP-55. Seek membership on the Sacramento Valley Bioregion Regional Council proposed to be created by State and federal land management agencies.

NRP-56. Provide notice to the Board of Supervisors prior to any final public or nonprofit agency decision to acquire land (fee title acquisition) or establish an easement for wildlife habitat and/or riparian habitat protection.

NRP-57. Oppose additional fee title purchases of land by State and federal land management agencies that do not provide payments in4ieu of taxes.

NRP-58. Advocate full federal funding of the federal Refuge Revenue Sharing Act.

NRP-59. Advocate a property tax replacement program applicable to lands diminished in value by easements purchased by State and federal land management agencies.

NRP-60. Work with State, federal and private agencies to ensure payment of in-lieu taxes.

NRP-6I. Support efforts to improve water availability and management when the potential exists to benefit fish and wildlife in cooperation with Glenn County agricultural water users.

AIR QUALITY

General Plan policies addressing air quality include the following:

PSP-34. Support State programs to reduce backyard and agricultural burning, including development of alternatives to rice straw burning and creating markets for rice straw.

PSP-35. Review development requests to determine the impact such development will have on the existing air quality and for compliance with the air pollution reduction measures specified in the Glenn County Air Quality Attainment Plan.

PSP-36. Promote jobs/housing balance when evaluating development projects.

PSP-37. Encourage design of new development which minimizes automobile trips and maximizes other modes of transportation.

AESTHETICS/LIGHT AND GLARE

General Plan policies addressing aesthetics/light and glare include the following:

NRI-56. Establish a local committee of citizens to determine the interest in a designated system of scenic highways, vistas or corridors and subsequently implement policies and standards for their protection.

NRP-87. Consider preparation of a scenic highways plan.

NRP-86. It shall be the policy of Glenn County to avoid light and glare impacts when considering development.

NRI-57. Condition development permits to require all exterior lighting accessory to any use to be hooded, shielded or opaque, and no unobstructed beam of light shall be directed beyond any exterior lot line or directed onto adjacent rights-of-way.

SOLID AND HAZARDOUS WASTE

Solid waste and hazardous materials policies are as follows:

PSP-57. Achieve maximum waste diversion through the expansion and/or development of cost-effective recycling and source reduction programs tailored for both rural and urbanized jurisdictions in the county.

PSP-62. Promote reduction of the amount of packaging material generated by local businesses through use of alternative materials.

PSP-63. Support State and national efforts that establish incentives for packaging to meet certain recycled content or post-consumer percentage.

PSP-64. Investigate the types of local incentives that can be implemented to promote business/industry source reduction and recycling activities.

PSP-68. Expand leaf collection programs to the agricultural and farming sector.

PSP-69. Reduce the volume of used tires disposed of in Glenn County.

PSP-72. Increase recovery of corrugated paper and newspaper currently in the waste stream.

POPULATION AND HOUSING

General Plan policies include the following:

CDP-87. Advocate and support proposed Sate and federal actions that will create a positive, stable climate for housing production.

CDP-88. Wherever appropriate, facilitate the use of federal or State programs that can assist in development of new housing consistent with identified countywide housing needs and adopted local plans and programs.

CDP-89. Support efforts which coordinate and improve the ability of the housing delivery system to effectively respond to local housing needs.

CDP-90. Encourage and participate in efforts to achieve economies and efficiencies which will facilitate the production of quality affordable housing.

CDP-9I. Promote balanced, orderly growth to minimize unnecessary development costs which add to the cost of housing.

TRAFFIC/CIRCULATION

General Plan policies include the following:

CDP-54. Support actions at the local level' that ensure roadways are adequate to accommodate present and future traffic.

CDP-55. Encourage actions at the State level that support local needs for road improvements.

CDP-56. Establish a minimum level of service for local roadways.

CDP-57. Determine the impact proposed development will have on the local road system and ensure that the established level of service is maintained.

CDP-58. Require new development to pay its fair share for the improvement of roadways.

CDP-60. Limit access to Principal Arterial streets consistent with their primary function as carriers of through traffic.

CDP-6I. Utilize a road improvement project priority system based on facility condition and usage characteristics.

CULTURAL RESOURCES

General Plan policies include the following:

NRP-82. Protect identified areas of unique historical or cultural value within the county and preserve those sites for educational, scientific and aesthetic purposes.

NRP-83. Recognize the following historic sites in future planning and decision making:

- Monroeville Cemetery Historical Site
- Will S. Green Monument
- Swift Adobe Monument
- Kanawha Cemetery Monument
- Monroeville and Ide Monument
- Willows Monument
- Jacinto Landing
- Historic School Sites

NRP-85. Require proper evaluation and protection of archaeological resources discovered in the course of construction and development.

PUBLIC SAFETY

Relevant General Plan policies include the following:

PSP-I. Establish a minimum level of service for the provision of law enforcement services.

PSP-2. Determine the impact proposed development will have on the provision of law enforcement services, and assure that the established level of service is maintained.

PSP-3. Require new development to pay its fair share for the provision of law enforcement services.

PSP-4. Actively involve law enforcement personnel in land use planning decisions.

PSP-5. Support consolidation of services for the areas located within the urban limit lines of the cities of Willows and Orland.

PSP-6. Continue to support a cooperative approach to law enforcement within the Mendocino National Forest.

PSP-7. Objectively evaluate proposals for regional and State correctional facilities within the county.

PSP-8. Require new development to be designed so that criminal activity is discouraged.

PSP-9. Continue to support the County's volunteer fire forces and offer incentives for continued participation.

PSP-10. Maintain existing fire service levels and not allow their deterioration.

PSP-11. Determine the impact proposed development will have on the provision of fire protection services, and ensure that the established level of service is maintained.

PSP-12. Regularly review and evaluate fire district boundaries to determine if the existing service areas are the most efficient and cost-effective.

PSP-13. Establish as a priority adequate funding and fire fighting personnel for those areas targeted for growth.

PSP-14. Encourage fire districts to work with the County to require new development to pay its fair share for the provision of new fire stations, equipment, personnel and fire suppression improvements necessary to provide adequate fire protection services.

PSP-15. Actively involve fire protection personnel in land use planning decisions.

PSP-16. Require new development to be designed with fire protection and prevention in mind.

PSP-17. Apply contemporary fire prevention standards to all development.

PSP-18. Evaluate the creation of urban area fire departments for the Willows and Orland areas which would serve both the developed areas and developing areas within established urban limit lines.

PSP-19. Study the use of mutual aid agreements or memoranda of understanding for structural as well as wildland fire protection in areas currently under California Department of Forestry and U.S. Forest Service jurisdiction.

PSP-20. Consider fire risk and hazard zones when approving residential development in areas subject to potential wildland fires.

PSP-21. Require that all community water systems serving new development meet or exceed Glenn County minimum standards for provision of water for peak-load demands and required fire flows.

PSP-22. Comply with the State of California Fire Safety Regulations for the State Responsibility Area located within Glenn County.

PSP-23. Assign house numbers for all structures within the county.

PSP-24. Communicate the Emergency Response Plan to all public safety agencies when reviewing future development proposals throughout the county.

PSP-25. Encourage development of educational programs that will increase public awareness of fire safety and emergency response planning.

PSP-26. Periodically update the Emergency Response Plan.

PSP-27. Recognize the autonomy of individual fire districts within the county.

PUBLIC SERVICES AND FACILITIES

CDP-111. Establish level of service standards for public services which can be used to evaluate the impact of development on the various services, and to evaluate service distribution and expansion needs.

CDP-112. Utilize urban limit lines as an official definition of the interface between future urban and agricultural uses, and to identify the areas set aside for those types of uses which benefit from urban services.

CDP113. Require new development within urban limit lines to connect to sewer and water services when available, and discourage installation of septic tanks in urban areas. When sewer and water services are not immediately available, commitments to serve in the future shall be obtained from service providers prior to development approval.

CDP-114. Encourage new urban development to occur within urban limit lines as an extension of existing urbanized areas, in order to provide necessary services in the most efficient manner.

CDP-115. Discourage the extension of public facilities which would generate growth in areas inconsistent with the policies of this General Plan.

CDP-116. Coordinate with the cities of Orland and Willows to develop policies and standards relating to building construction, public utility connections, sewer and water service, and other matters related to cost-effective development of unincorporated areas within urban limit lines.

CDP-I17. Require improvements for development within urban limit lines to be constructed to full County standard, including public roads.

CDP-I18. Encourage the expansion of private and special district utility systems consistent with the adopted General P1an.

CDP-I19. Encourage vacant or undeveloped land within the existing urban areas and presently served by public services to develop first.

CDP-I20. Encourage the coordination of service efforts of the special districts.

CDP-I21. Encourage LAFCO to amend Spheres of Influence for cities and special districts to be coterminous with County-adopted urban limit lines.

CDP-I22. Require new parcels created under the parcel map procedure within urban limit lines to meet County public road standards.

CDP-I23. Restrict growth in foothill and mountain communities to densities which may be supported by existing services until adequate services can be provided.

CDP-I24. Determine whether special districts are capable of meeting their service commitments; in the event they are not, consider formation of County Service Areas, other special districts or assessment districts, to deliver services as needed within urban limit lines.

CDP-I25. Undertake the siting of new wastewater treatment facilities as a coordinated effort between the County, cities and special districts.

CDP-I26. Within the communities of Willows, Orland and Hamilton City, collect and treat all wastewater at a single facility within each community.

CDP-I27. Place a high priority on the extension of sewer service to West Orland and to the South Orland area in the interest of protecting public health and safety and a valuable groundwater recharge area.

CDP-I28. Maintain and periodically review minimum parcel standards for lots created without public or community water service.

CDP-I29. Maintain coordination and cooperation between the County and water purveyors, and encourage special districts to comply with State law by referring capital projects to the County for review and evaluation for consistency with the General Plan.

CDP-I30. Site future fire and police stations to enable minimum acceptable response times to service calls.

CDP-I31. Require new planned communities to demonstrate that public services and facilities can be fully funded through private and/or public sources and that adequate provision has been made for long-term maintenance of facilities.

CDP-I32. Develop programs to assist with infrastructure financing when such assistance is determined to be in the best interest of the County, using a mix of techniques.

CDP-I33. Evaluate use of the redevelopment process to correct infrastructure and other deficiencies within blighted areas of unincorporated communities.

CDP-I34. Consider the impacts of growth and development on general County government services when developing cost recovery plans and considering new development proposals.

CDP-I35. Utilize County Service Areas when new service delivery agencies are required, to retain control and avoid a proliferation of small special purpose governmental units. Consider establishment of a countywide County Service Area which can provide a variety of public services.

CDP-I36. Consider supplemental school mitigation fees for those instances where supplemental fees are necessary to meet the facility funding needs of a school district and where other methods of school financing are not adequate. "Supplemental school mitigation fees" shall mean payments made to a school district by a developer of a residential, commercial or industrial project to mitigate the impact on school facilities caused by the project, in addition to fees imposed pursuant to Government Code Section 65995.

CDP-I37. Grant a discretionary land use approval which is necessary for residential, commercial or industrial development only if the school district or districts within whose boundaries the development is planned first certifies to the Board of Supervisors that:

- The subject development will not significantly impact school facilities,
- The developer has paid in full the supplemental school mitigation fees corresponding to the development, or
- That the developer has arranged and agreed to mitigate the impact on school facilities in some other manner satisfactory to the district, consistent with the district's financing plan.

As used in this policy, "discretionary land use approval" means a zoning change, general plan amendment, any other legislative action, and certification or approval of a negative declaration (ND) or an environmental impact report (EIR) pursuant to the California Environmental Quality Act (CEQA). This policy shall apply only if the affected school district has:

- Adopted a facilities plan;
- Adopted a school financing plan describing the sources and amounts of funds required to fully implement the facilities plan;
- Completed a valid study justifying the amount of the supplemental school mitigation fees.

CDP-I38. Ensure that supplemental school mitigation fees as established by the affected school district are in an amount which does not exceed the amount necessary, when added to other reasonably assured sources of funding identified in the school facilities financing plan, to fully implement the adopted school facilities plan.

CDP-I39. Establish sufficiently high densities in newly developing areas so as to make feasible centralized collection and treatment of wastewater, and limit the number of planned new communities to assure that there are adequate concentrations of population to support operation and maintenance of facilities.

CDP-I40. Establish mechanisms for funding park acquisition and development, as well as ongoing costs of park maintenance and recreation services.

CDP-I41. Recognize the importance of and support the continued operation of the Glenn County Hospital.

Appendix C

BIOSYSTEMS AND AGRICULTURAL ENGINEERING
UNIVERSITY OF MINNESOTA
EXTENSION PROGRAM

November1998

ODOR CONTROL FOR ANIMAL AGRICULTURE

BAEU-17

Larry Jacobson, David Schmidt, Richard Nicolai, Jose Bicudo
Extension Agricultural Engineers
Biosystems and Agricultural Engineering

INTRODUCTION

Reducing the impact of odors on the surrounding community is an essential part of managing livestock and poultry farms. Unfortunately, odor generation, emissions, and movement are very complicated processes. Several technologies can significantly reduce odors from livestock production. These technologies range from simple to complex, from low maintenance to high maintenance, and from inexpensive to expensive. Some of these technologies have demonstrated odor reduction based on scientific measurements while the effectiveness of other technologies is supported only by anecdotal evidence and testimonials. This anecdotal evidence is useful but should be verified where possible with actual measurements. This document reviews many odor control technologies, some that have been rigorously tested and others that have yet to be evaluated but are generally accepted by some engineers and/or producers.

SOURCES OF ODOR

It is important to realize that odor emissions from an animal production site originate from three primary sources: manure storage units, animal housing, and land application of manure. Table 1 shows the results of a 1982 study in the United Kingdom (Hardwick, 1985) which identified the odor source and animal species from justifiable complaints. It shows that almost 50% of all odor complaints were traced back to land application of manure, about 20% were from manure storage units, and another 25% from animal facilities. Between the three animal species, pigs received slightly more than half (54%) of the complaints, with cattle and poultry receiving 20% and 24% of the complaints, respectively. Even though these findings are from the U.K., general observations in Minnesota and the Midwest seem to agree with this distribution of odor sources. However, with the trend toward increased use of manure soil injection and longer manure storage times (larger manure storage structures), there may be a shift to a higher percentage of odor complaints associated with manure storage units and/or animal facilities.

Odor Source	Pigs		Cattle		Poultry		Total	
	No.	%	No.	%	No.	%	No.	%
Buildings	224	22	65	18	163	36	452	25
Slurry Storage	169	17	98	28	78	17	345	19

Slurry Spreading	526	52	122	34	190	42	838	46
Animal Feed Production	84	8	4	1	11	3	99	5
Silage Storage	10	1	68	19	8	2	86	5
Total	1013	100	357	100	450	100	1820	-
%	56	-	20	-	24	-	-	100

Research observations at the University of Minnesota agree with the common complaint of higher odors from manure storage units during the months of April and May when manure storage units "turn over" as a result of thermal stratification (Jacobson et al., 1997). Limited data exists on odor emissions from animal facilities but it can be expected that these odor emissions are fairly constant throughout the year, unlike the variable odor emissions from either manure storage units and during the application of manure on cropland.

Most odor control technologies are often specific to the odor source of the particular manure handling system. Therefore, some assessment of your situation is needed so an appropriate technology can be chosen to deal with your site specific odor sources.

ODOR REDUCTION DURING LAND APPLICATION

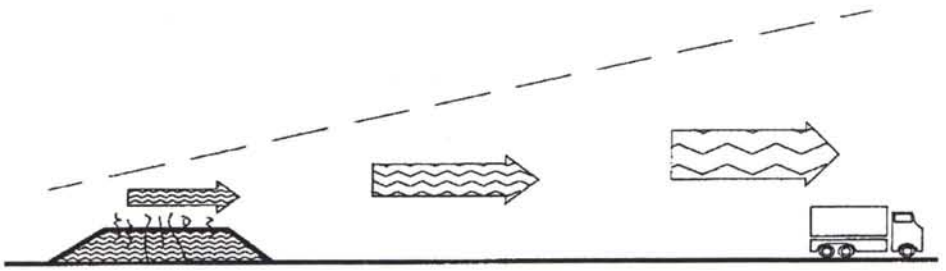
Land application of manure typically brings about the most complaints. Fortunately, odors from land application can virtually be eliminated by injection or immediate incorporation of the manure into the soil. These techniques also increase the amount of nitrogen and other nutrients available for crop uptake. Unfortunately, injection and incorporation are techniques most easily adapted to liquid manure application. Incorporation of solid manure typically requires another pass with some tillage implement. This is both time consuming and costly but is necessary to achieve effective odor control.

Another aspect of manure application that generates odors is the agitation of liquid manure storage facilities prior to manure removal. Agitation is necessary to reduce the solids buildup in storage, break up any surface crust, and evenly distribute the nutrients throughout the manure. Reports from many livestock producers suggest that some manure pit additives reduce solids buildup in the storage units. Although there is little university research to support this claim, this technique should be viewed as a possible odor control method. Chemical additives also have the potential to reduce specific gas formation such as hydrogen sulfide during agitation. These additives will have an immediate, short-term effect on gas emissions. More research is needed to determine dosage rates and costs for this technology.

The issue of reduction of odors and/or certain gases like hydrogen sulfide (especially in Minnesota due to the state regulatory agency's H_2S emission standard) during manure storage agitation is very critical. Weather conditions, primarily wind speed/direction and humidity, should be evaluated before manure is land applied to insure minimal impacts on neighbors and the public. The weather least suitable for spreading manure is high humidity and very light winds or clear, calm evenings. These conditions prevent odors from dispersing and thus increases the chance of creating a nuisance or receiving a complaint.

ODOR REDUCTION FROM MANURE STORAGE

Manure storage units are the most "apparent" odor source on many farms, especially if there is no visual barrier of the storage system from neighbors or passersby. Open storage systems are the most susceptible to seasonal effects as well as day-to-day weather changes.



ODOR AND GAS DISPERSION

Manure storage facilities can be the most significant source of on-farm odors. However, several technologies can significantly reduce odor emissions from manure storage. One way to reduce these odors is with a cover. A cover on a manure storage can act in one of two ways. A gas **impermeable** cover will capture the gases as they leave the manure. These gases need to be treated using a biofilter, a flare, or some other technique before they are released.

A gas **permeable** membrane serves to increase the boundary layer between the liquid and air, which decreases the gas emissions to the air. Farmers in the Netherlands have made extensive use of permeable covers to reduce ammonia emission from manure storage tanks.

A floating organic cover or crust is a combination of a gas permeable cover and a treatment system. The organic cover increases the boundary layer between the liquid and reduces the gases that are released. An organic cover or crust can develop naturally, depending on the type of feed use, total solids content, and weather conditions, or can be created artificially by using straw or some other organic material.

Anaerobic digestion is a technology that reduces odors from manure storages. Anaerobic digestion is a process that controls the microbial degradation process and results in the generation of biogas (primarily methane) which can be used to generate heat or produce electricity (Sweeten et al., 1981). About 15 to 20 days are needed to obtain a treated liquid effluent that is relatively stabilized. The treated material generates significantly less odor than the raw manure.

Aeration is another very effective means of controlling odors from stored manure. Aeration of manure results in the acceleration of the biological degradation and stabilization process. This is achieved by optimizing the supply of oxygen to microorganisms within the slurry. The odor producing compounds are oxidized and degraded within three to four days of continuous aeration (Svoboda, 1995). Although aeration is very effective at reducing odors, the cost to aerate can be substantial. Aeration research includes attempts to make the aeration process more efficient, or reduce the amount of manure that is aerated by creating an aerated layer near the top of the liquid manure storage system.

Anecdotal evidence suggests that windbreaks may impact the dispersion of odors released from manure storage. These windbreaks create turbulence in the odor plume which increases the dilution of the odors. Research from Iowa (Zahn et al., 1997) also indicates that the vegetation on trees and other plant material will collect certain odor components released from manure storage units and production sites. Windbreaks and creative landscaping can reduce the perception of odor by providing a visual barrier.

ODOR REDUCTION PRACTICES FOR BUILDINGS

Livestock buildings are a source of odors that are often overlooked. The most significant problem with reducing odors from buildings is the ability to control gas generation or capture the gases before they are emitted into the

atmosphere. Odorous gases are generated from manure soiled flooring, animals, and from any manure stored below the flooring. Each of these odor sources requires different control methods. The best approach to control odor in buildings seems to be eliminating the source of odor rather than capturing the odor and treating it. This means both design and management systems which minimize odor generation on floor surfaces and in manure storage gutters or pits.

In the last 20 or 30 years, animal genetics and ration formulation have improved swine feed conversion efficiencies from 5 lb feed per pound of gain to 2.5 lb feed per pound of gain (Barker, 1998). This improvement means less feed required and less manure produced by a given number of animals. Current U.S. and European research on diet manipulation indicates considerable progress being made in this area.

One obvious way to reduce odors that are released from buildings is to modify the diet feed to the animals housed so odors are minimized. Research work being carried out in Europe and also in the U.S. indicates that reducing the crude protein content of the diet (RCP diets) reduces the concentration of odorants and N in the slurry (Hobbs et al. 1996). Recently (Misselbrook et al., 1997) showed that RCP diets supplemented with synthetic amino-acids to give the ideal ratio of essential amino-acids, resulted in reduced N losses and improved utilization follwing pig slurry application to grassland. N losses due to ammonia volatilization were decreased by 35%, compared to conventional diet slurry.

Odor from flooring will be reduced if the floors are kept clean and dry. Anecdotal evidence suggests that some organic bedding, straw, compost, or newspaper may reduce odor emissions. European research seems to support the use of some type of bedding (especially sawdust) for reducing odor generation/levels in buildings and subsequent odor release or emission (Nicks et al., 1997). Relatively small bedding levels may be enough to have an effect on odor generation/emission. Recent preliminary research in Canada (Zhang et al, 1996) and in Minnesota (Jacobson et al., 1998) showed odor emission reductions when very small amounts of vegetable oils were sprinkled in swine pens on a regular (daily) basis. This practice was developed to reduce indoor dust levels and since particulates may transport odorous compounds, odors may be reduced as well.

Control of odors from under floor manure storage depends on the type of manure storage. Manure stored longer than five days will generate more offensive gases. Therefore, to reduce odors from gutters with shallow pull plugs, the manure should be removed at least once per week. Often weekly cleaning is not a standard practice but may become so if odor control is the main objective. One method of shallow gutter management for odor control that is still under debate is the practice of using recharge water. Some facilities use clean recharge water, some recycle recharge water, and others do not recharge their shallow gutters. Anecdotal evidence suggests that using clean or "treated" recycled recharge water may reduce odorous emissions compared to using no recharge water. However, these reductions are likely to be very dependent on the quality of recharge water.

There are very few options for reducing odor generation from manure stored below the barn in deep pits. The management of the pit ventilation system to regulate or minimize odor emission was investigated by a Canadian study (Choiniere et al., 1997). They found that the odor emissions could actually be increased with certain types of pit ventilation systems. A balance exists between maintaining good indoor air quality and minimizing the emissions of odor to the environment.

Odors from buildings can also be captured and treated, provided that the building is mechanically ventilated. Air from a livestock building can be passed through a biofilter. A biofilter is a bed of organic material where aerobic microbial activity takes place and breaks down odorous gases into non-odorous by-products (Figure 1). Biofilters have been very successful treating exhaust air from industrial processes and wastewater treatment plants. Research at the University of Minnesota now suggests that low-tech biofilters are effective and economical for agricultural uses.

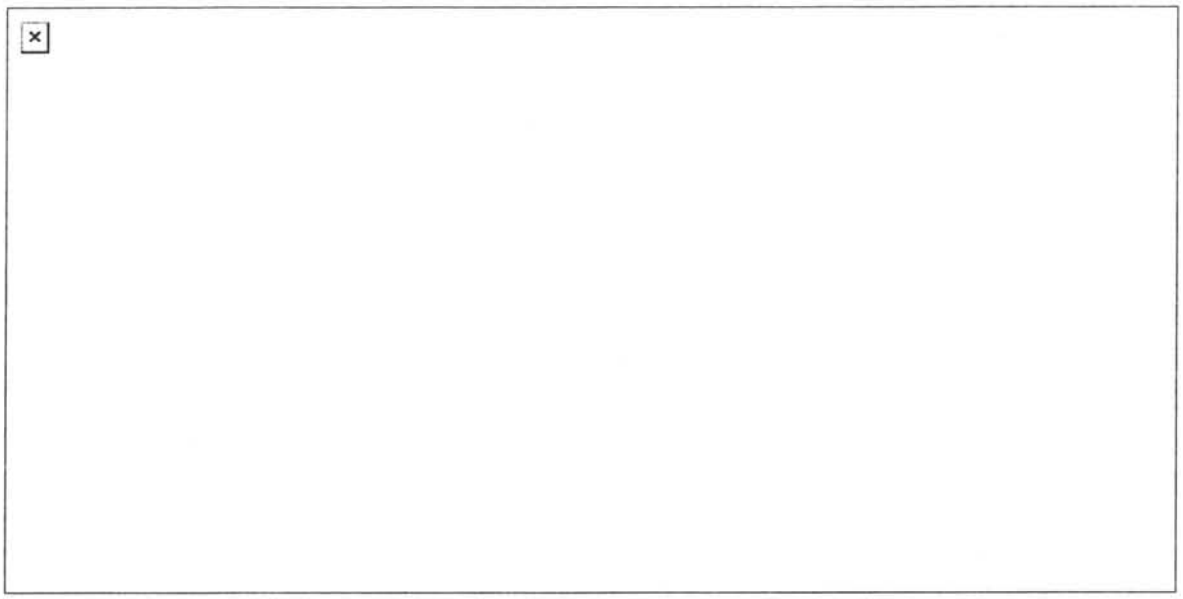


Figure 1. Biofilter schematic

ODOR MANAGEMENT PLANS

It is becoming a standard practice to have a manure management plan developed for an animal production system to document the proper handling and application of manure onto cropland. Likewise, in the near future, a similar "odor management plan" may be needed by animal producers to indicate what control technologies and strategies will be implemented to reduce odors emitted from a livestock or poultry farm.

Such a plan would need to systematically list each of the potential odor sources from a particular farm including the three sources outlined in this paper: manure land application, manure storage units, and buildings plus the farm's dead animal disposal method. After this inventory is taken, each building, storage unit, application method, and carcass disposal system would need to be assessed for odor potential. If a particular source has an odor potential above a given "threshold" level, even during a short period of time during the year, some control strategy(s) would be suggested and implemented to reduce the odor emissions below a reasonable level. Control strategies could be technologies like those listed in Table 2, management practices, or a combination of both.

Like the manure management plans, odor management plans could be optional or in some cases required as part of the permitting process-they would be reviewed regularly and assessed for effectiveness and costs. Such plans could serve to diffuse some of the controversies between producers and neighbors by directing the discussion to strategies and practices which will help to mitigate the problems.

Knowledgeable individuals to make these assessments and develop the odor management plans are in short supply at the present time. As odor research and application of that research becomes available more people will be able to make these decisions and assessments.

SUMMARY

The debate will continue on how much odor control is enough. However, one fact remains, odors from animal production systems must be reduced in order for producers to remain in business and still coexist with neighbors and the community. Several technologies are currently available to reduce odors, unfortunately,

economics often prohibit such technologies from being implemented. Currently, there is a substantial effort by university researchers, industry representatives, and producer groups to find and implement odor control technologies. These efforts can be enhanced through the efforts of everyone involved in the livestock industry. Producers, engineers, technicians, consultants, veterinarians, nutritionists, and others must combine their expertise with the basic principles of odor generation, emission, and dispersion to develop and implement practical odor control solutions.

Table 2. Sample Odor Management Plan

Odor Source	Potential Nusiance Risk and description*	Odor Control Plan
200 Sow Farrowing/Gestation Building	This mechanically ventialted building is a source of low odors throughout the year. The risk of nuisance problems form this building is LOW.	If odor complaints occur, I plan to implement an oil spray technique or add a biofilter.
Earthen Basin	This basin tends to be a large source of odor throughout the year. Complaints have been received during agitation and pumping. This basin is a HIGH risk for nuisance problems.	I am currently using an odor control additive. If nuisance complaints persist, I plan to blow a straw cover on the basin each spring. If complaints continue due to this manure storage, I plan to install a permananet synthetic cover.
Dead Pig Composting	The dead animal composting area typically emits very little odor. Occasionally odor problems exist when the compost pile is not covered properly. This compost facility is at a LOW risk for nuisance problems.	Add more carbon-based material to cover properly.
Land Application	Currently, manure is surface applied twice per year. Most fields have adequate separation distances from neighbors. Occasionally complaints come during land application. Land application is at MEDIUM risk for nuisance problems six days per year.	If odor complaints arise from land application, I plan to inject manure.
Proposed Two 100 Head Finishing Building	This building is a naturally ventilated building with a deep pit. Setback distances are approximately 1000 feet from the nearest property line and 1/4 mile from the nearest neighbor. It is anticipated that this will be a LOW source of odor problems.	If odor problems arise as a result of this building, I plan to implement oil spraying and a windbreak around the building.

*Potential nuisance risk is currently a subjective rating based on common sense, experience, and an understanding of how odors are generated. Most farm operators and owners are capable of making these decisions.

Table 3. Summary of Odor Control Technologies

Summary of Technologies for Odor Control

Process/System		Description	Advantages	Disadvantages	Cost	Observations
	Phytase	Product (enzyme) is mixed into the feed	Lower P content in the manure	Not known yet	N/A	On-going research

Diet Manipulation	Low phytase corn	Use low phytate corn for feed	Lower P content in the manure	Not known yet	N/A	On-going research
	Synthetic amino-acids and low crude protein content	Products are mixed into the feed	Lower N content in the manure, may reduce odor and NH_3 emissions	Not known yet	N/A	On-going research
	Feed additives (Yucca schidigera)	Products are mixed into the feed	May reduce odor and NH_3 emissions	Not known yet	N/A	On-going research
Oil Sprinkling		Vegetable oil is sprinkled daily at low levels in the animal pens	Helps in the reduction of airborne dust and odors	Creates an oily environment and greasy residue on the floor and pen partitions if too much oil is sprinkled	$1.00 per pig	On-going research
Manure Additives		Chemical or biological products are added to the manure	May redeuce odor and NH_3 emissions	Usually questionable products; may not achieve desirable results under field conditions	$0.25 to $1.00 per pig	Always ask for the product to be tested by a certified laboratory (ex: ISU, NCSU)

Summary of Technolgies for Odor Control

Process/System		Description	Advantages	Disadvantages	Cost	Observations
Manure Treatment	Solid separation	Solids are separated from liquid slurry through sedimentation basins or mechanical separators	May reduce odor and NH_3 emissions; reduced liquid volume; easier agitation and pumping	Capitol and operational costs; reliability; adds another "waste" stream to be dealt with by the farmer	$1.00 to $3.00 per pig	Contact a specialist for advice before buying the equipment
	Solid composting	Biological process in which aerobic bacteria convert organic material into a soil-like material called compost; it is the same process that decays leaves and other organic debris in nature	Reduces odor and organic matter; produces a saleable product; can include other by-products	Capital and operational costs; marketing skills required if product is to be sold	$0.20 to $0.40 per pig	Contact a specialist before implementing such a system
	Anaerobic digestion	Biological process where organic carbon is converted to methane by anaerobic bacteria under controlled conditions of temperature and pH	Reduces odor and organic matter; produces biogas; retains nutrients; easier handling or liquid	Capital cost; may require a resonably skilled operator; attractive where energy supply is an issue	$250,000 capital cost; may produce $$$ worth of energy if properly operated	Contact a specialist for advice before implementing such a system
	Aerobic	Biological process where organic matter is oxidized by aerobic bacteria; mechanical	Reduces odor, organic matter and nutrients (if	Capital and operating costs; separation step is	$2.00 to $4.00 per	Contact a specialist for advice before

	treatment	aeration is required in order to supply oxygen to the bacterial population	needed) effectively	necessary for most slurries	pig finished	implementing such a system

Summary of Technologies for Odor Control

Process/System		Description	Advantages	Disadvantages	Cost	Observations
Exhaust Air Treatment	Biofilters	Odorous gases are passed through a bed of compst and wood chips; bacterial and fungal activity help oxidize volatile compounds	Reduce odors and H_2S emissions effectively	May need special fans becuase of pressure drop	\$0.50 to \$0.80 per pig	On-going research
	Biological and chemical wet scrubbers	Odorous gases are passed through a column packed with different media types; water (and/or chemical) is sprayed over the top of the column to help optimize biological and chemical reactions	Reduce odors, H_2S and NH_3 emissions effectively	Capital and operational costs; disposal of collected pollutants	N/A	Contact a specialist for advice before buying the equipment
	Non-thermal plasma	Odorous gases are oxidized when passed through plasma	Reduces H_2S and NH_3 emissions effectively	Not known yet	N/A	On-going research
Covers	Straw (wheat and barley)	Straw is blown to the surface of the stored manure (about 100 bales to cover 1 acre of surface area with a layer of 12 inches)	Helps in the reduction of odors, H_2S and NH_3 emissions	Temporary solution; straw sinks after a certain period	\$0.10 per ft^2	On-going research
	Floating clay balls	Floating clay balls (Leca™ or Microlite™) are placed over manure	Helps in the reduction of odors, H_2S and NH_3 emissions	Care must be taken during agitation and pumping	\$2.00 to \$5.00 per ft^2	
	Geotextile	Geotextile membranes are placed over the surface of the manure; straw may be blown over the geotextile for more effective results	Helps in the reduction of odors, H_2S and NH_3 emissions	Not known yet	\$0.20 to \$0.40 per ft^2	On-going research
	Plastic cover	Several varieties of plastic can be placed over manure storages (floating or rigid	Helps in the reduction of odors, H_2S and NH_3 emissions	Capital cost	\$1.00 to \$2.00 per ft^2	

		structures)				

Summary of Technologies for Odor Control

Process/System		Description	Advantages	Disadvantages	Cost	Observations
Dust Reduction	Wind-break walls	Many odorous compounds are adsorbed on dust particles and conveyed on dust. A wall made of tarp or with any other porous material is place 3-6m from exhaust fans. The walls provide some blockage of the fan airflow in the horizontal direction. Dust and odor levels in the area downwind of the wind-breaks can be lower since the plume is deflected	May reduce dust and odor emissions effectively	Periodic cleaning of dust from the walls is necessary for sustained odor control	$1.50 per pig	On-going research
	Shelterbelts	Rows of trees and other vegetation are planted around a building, thus creating a barrier for both dust and odorous compoundremoval from building exhaust air. Trees can absorb odorous compounds and they create turbulence that enhances odor dispersion upward	May reduce dust and odor emissions effectively	It may take several years to grow an effective vegetative windbreak	N/A	On-going research
	Washing walls	A wetted pad evaporative cooling system is installed in a stud wall about 1.5m upwind of ventilation fans and downwind of hogs in a tunnel ventilated building. All of the ventilation airflow passes through the wet pad before being pulled through the fans	Reduces about 50% of dust and 33% of ammonia at medium ventilation rate	Residence time inside the pad is very samll thus odor removal may not be effective	$5.70 per pig	On-going research

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University of Minnesota, U.S. Department of Agriculture, and Minnesota Counties Cooperating

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Appendix D

FO-07680 2001 To Order

OFFSET
Odor From Feedlots Setback Estimation Tool

Larry Jacobson, David Schmidt, and Susan Wood

Introduction

When discussing odor problems related to animal agriculture, the following questions often arise:

- How far does odor travel?
- Are animal numbers or animal species accurate predictors of nuisance odors?
- How much odor control is needed to solve an odor problem from an existing facility?
- Can the odor impact from a new facility be predicted?

Figure 1. Prediction of odor problems is important as rural and non-rural areas converge.

Answers to these questions are as varied as the people having the discussion. Until now, scientific methods to predict odor impacts did not exist. This publication discusses a new tool that has been developed at the University of Minnesota to answer some of these questions. The tool, "Odor From Feedlots Setback Estimation Tool" (OFFSET), is the result of four years of extensive data collection and field testing. It is a simple tool designed to help answer the most basic questions about odor impacts from livestock and poultry facilities.

OFFSET is designed to estimate average odor impacts from a variety of animal facilities and manure storages. These estimations are useful for rural land use planners, farmers, or citizens concerned about the odor impact of existing, expanding, or new animal production sites. OFFSET is based on odor measurements from Minnesota farms and Minnesota climatic conditions. As such, the use of OFFSET for estimating odor impacts in other geographic areas should be done with caution and through consultation with the authors of this publication.

Getting Started

The amount of odor emitted from a particular farm is a function of animal species, housing types, manure storage and handling methods, the size of the odor sources, and the implementation of odor control technologies. However, the impact of these odors on the surrounding neighborhood or community is a function of both the amount of odor emitted and the weather conditions. Weather conditions strongly

influence the movement and dilution of odors. Odor impact includes the strength of the odors and the frequency and duration of the odor events. OFFSET combines odor emission measurements with the average weather conditions to estimate the strength and frequency of odor events at various distances from a given farm.

The worksheet on the next page (Table 1) outlines a step-by-step process for determining the total odor emissions for a specific animal production site. This Total Odor Emissions Factor (TOEF) is the sum of odor emissions from all odor sources (e.g. barns, manure storages) on the site. The procedure accounts for species, housing types and sizes, manure storage types and sizes, and odor control technologies used at the site.

Determining the Total Odor Emissions Factor (TOEF)

The following five steps and accompanying tables can be used to estimate the odor emissions from the farm site.

Step 1. List all the odor sources on the farm site in Column A of Table 1 (e.g. buildings, manure storage areas, lots, etc.).

Step 2. Use Tables 2 and 3 to determine the odor emission number for each odor source. Enter these values in Column B, Table 1.

Step 3. List the area of each odor source in Column C of Table 1 (in square feet).

Step 4. Enter any odor control factors from Table 4 in Column D of Table 1.

Step 5. Fill in Column E of Table 1 by multiplying the values in Columns B, C, and D and dividing by 10,000. (Dividing by 10,000 is done to make the numbers easier to work with.) Sum all the numbers in Column E to determine the Total Odor Emission Factor (TOEF) for the farm site.

Table 1. Worksheet for calculating the Total Odor Emission Factor.

Column A Odor source	Column B Odor Emission Number/ft.^{2}	Column C Area (sq. ft.)	Column D Odor Control Factor	Column E Odor Emission Factor (B x C x D/10,000)
1.				
2.				
3.				
4.				
Total Odor Emission Factor (TOEF) sum of Column E):				

Table 2. Odor emission numbers for animal housing with average management level.*

Species	Animal Type	Housing Type	Odor Emission Number/ft.^{2}
Cattle	Beef	Dirt/concrete lot; Free stall, scrape	4
	Dairy	Free stall, deep pit; Loose housing, scrape	6

		Tie stall, scrape	2
Swine	Gestation	Deep pit, natural or mechanical Pull plug, natural or mechanical	50 30
	Farrowing	Pull plug, natural or mechanical	14
	Nursery	Deep pit, natural or mechanical; Pull plug, natural or mechanical	42
	Finishing	Deep pit, natural or mechanical Pull plug, natural or mechanical Hoop bar, deep bedded, scrape; Cargill (open front), scrape Loose housing, scrape; Open concrete lot, scrape	34 20 4 11
Poultry	Broiler	Litter	1
	Turkey	Litter	2

Table 3. Odor emission reference rate for manure storage.

Storage Type	Odor Emission Number/ft.$_2$
*Earthen basin, single or multiple cells	13
Steel or concrete tank, above or below ground	28
Crusted stockpile	2

**Earthen basins are designed for manure storage without any treatment. Properly designed lagoons may have far less odor.*

Table 4. Odor control factors.

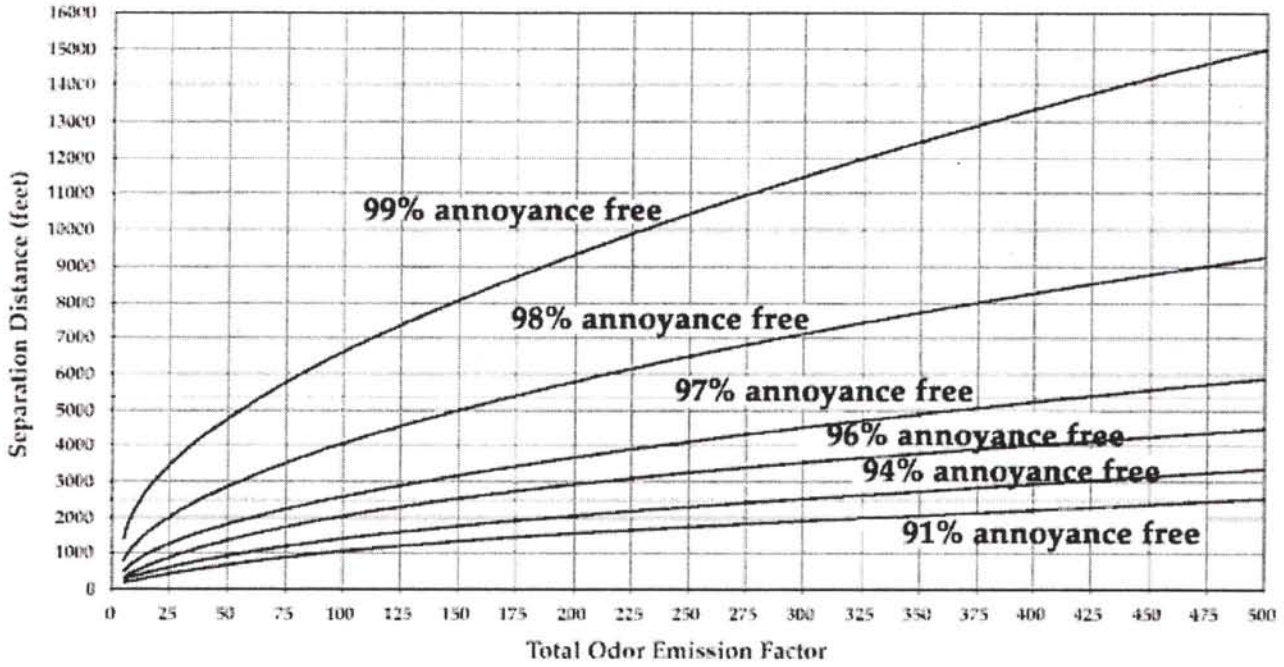
Odor Control Technology	Odor Control Factor
No odor control technology	1
Biofilter on 100% of building exhaust fans	0.1
Geotextile cover (≥2.4 mm)	0.5
Straw or natural crust on manure 4" 8"	 0.5 0.3
Impermeable cover	0.1
Oil sprinkling	0.8

Predicting Odor Events

Once the TOEF is calculated, the frequency of odor occurrences at various distances from the farm site can be estimated using Figure 2. The horizontal axis in Figure 2 is the TOEF as calculated in Table 1. The vertical axis is the distance from the farm site. The curves represent different frequencies of time when odors will not be at levels considered "annoying." **These odor annoyance-free frequency curves in Figure 2 represent the percent of time where odors are possibly detected, but at a level that is NOT typically considered annoying.** To find the separation distance for a specific frequency curve and TOEF, simply find the TOEF on the horizontal axis, then move vertically to the desired annoyance-free frequency curve, then move horizontally to the vertical axis. The number on the vertical axis is the separation distance (in feet) needed to

achieve the desired frequency of odors.

Figure 2. Estimated setback distances (in feet) from farms at different odor annoyance-free frequency requirements, leeward of the prevailing wind from animal operations. (Note: 1 mile = 5280 feet)



Different odor annoyance-free frequencies result in different setback distances for the same TOEF. For example, to achieve an odor annoyance-free frequency of 99% for a facility with a TOEF of 150 requires a separation distance of 1.5 miles. (This separation distance is measured from the edge of the nearest odor source.) During the rest of the time (1% or 7 hours per month), annoying odors will be detected at this distance. Reducing the frequency of annoyance-free odors to 96% would require a separation distance of less than 0.5 miles. At this distance, annoying odors would be experienced 4% of the time or 29 hours per month. Odor annoyance-free frequencies of 99%, 98%, 97%, 96%, 94%, and 91% correspond to 7, 15, 22, 29, 44, and 66 hours/month of annoying odors during the months of April through October. During the winter months less frequent odor events can be expected due to the reduced odor emissions during cold weather. Since these predicted frequencies are based on "average" weather conditions, actual frequencies of odor events may be significantly different.

Emission numbers

OFFSET bases the odor emission numbers on measured odor emission rates. The odor emission numbers (Tables 2 and 3) are the average of 200 odor emission measurements made on 79 different farms. The values reported are average values for a series of measurements from each odor source type. Unfortunately, there is a wide variation in odor emissions from similar sources and even from the same source. This variation is related to farm management, animal diet, or such things as ambient temperature, humidity, and wind speed. Note that the emission factors are based on odor emission measurements on Minnesota farms. Therefore, these emission factors may or may not be valid in other geographic areas.

Odor Control Factors

Several technologies are currently available to control odor, although little testing and research has been done to document their effectiveness. Technologies listed in Table 4 are the only technologies where sufficient information is

Figure 3. Odor control is a critical part of reducing the frequency of annoying odor events.

available to determine likely reductions in odor emissions for field conditions. Changes and additions to Table 4 will be made as more research is conducted and more technologies are developed. Currently, there is no standard procedure for getting control technologies listed on Table 4, nor is it required by OFFSET to allow only odor control technologies listed in Table 4. However, estimated reductions in odor emissions should be based on sound scientific research.

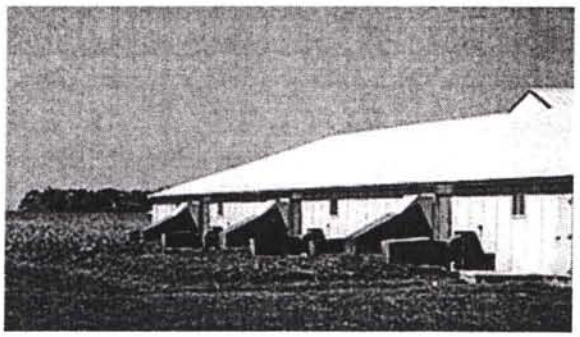


Figure 4. Wind direction and wind speed play an important role in odor movement and dispersion.

Annoyance Odors

The frequency curves in Figure 2 are based on "annoyance-free" odors. For purposes of OFFSET, annoyance-free odors are defined as those odors with an intensity less than 2 on a 0 to 5 scale. Odors with an intensity of less than 2 are weak or mild odors that are not likely to be annoying. A small percentage of the population is highly sensitive to odors. These individuals may detect odors at very low levels and be annoyed at intensities less than 2.

Meteorological Data

Weather is one of the most important factors that affect the movement and dispersion of odors. The frequency curves used in OFFSET combine the average wind speeds and atmospheric stability conditions in Minnesota from six weather stations over a nine-year period. The curves represent different weather stability classes and wind speeds. Since there is considerable variability in weather conditions, OFFSET will likely both overpredict or underpredict odor events in any given month.

The lowest annoyance-free frequency in Figure 2 is 91%. Annoyance-free curves of lower frequencies are not shown on the graph. These lower curves (e.g. 60, 70, or 80% annoyance-free) would show setbacks less than the typical minimum setbacks of 1000 feet. These minimum setbacks consider other factors besides odor impacts (e.g. noise, dust).

Prevailing Wind Direction

OFFSET assumes that the receptor (the resident or person smelling the odor) is always located downwind of the odor source in the prevailing wind direction. Therefore, receptors in other directions from the odor source will likely experience annoying odors less frequently than what is predicted in Figure 2. OFFSET can be modified to predict these frequencies in non-prevailing wind directions, but this would need to be done on a site specific basis.

Topography

Topography (hills, valleys, trees, buildings, etc.) also affects odor dispersion. During very stable meteorological conditions with cooling temperatures, odorous air may travel long distances along low lying areas. Wind breaks may increase the dilution of odorous air thus reducing the travel distance of annoying odors. The "odor annoyance-free" curves given in Figure 2 were obtained assuming flat terrain with no obstructions. Significantly more effort is required to conduct a site specific odor evaluation which would include topographic features.

Cumulative Impact

OFFSET may have the ability to consider the cumulative odor impact of multiple farm sites. However, to do this accurately would require site specific information. A general idea of cumulative impact on a specific location could be demonstrated by adding the annoyance-free frequencies from the surrounding farm sites.

Example

A farmer has a 1200-head sow gestation and farrowing operation with mechanical ventilation and pull plug gutters and a single stage earthen basin (Figure 3). The county suggests setbacks equal to the 97% annoyance-free curve at the nearest community. Currently, the nearest community is 0.5 miles (2640 feet) from the farm. Does this farm meet the county guidelines?

Step 1 There are three odor sources at the site, i.e. two buildings and one basin. The three source names are listed in Column A of Table 5 along with the odor emission numbers for each source from Table 2.

Step 2 The dimensions of the gestation building and farrowing building are 70 x 350 ft. and 70 x 230 ft., respectively. The areas are 24,500 ft.2 and 16,100 ft.2, respectively for these two buildings (Area = Width x Length). The dimensions of the basin are 200 x 200 ft (40,000 ft.2). These areas are entered in Column C of Table 5.

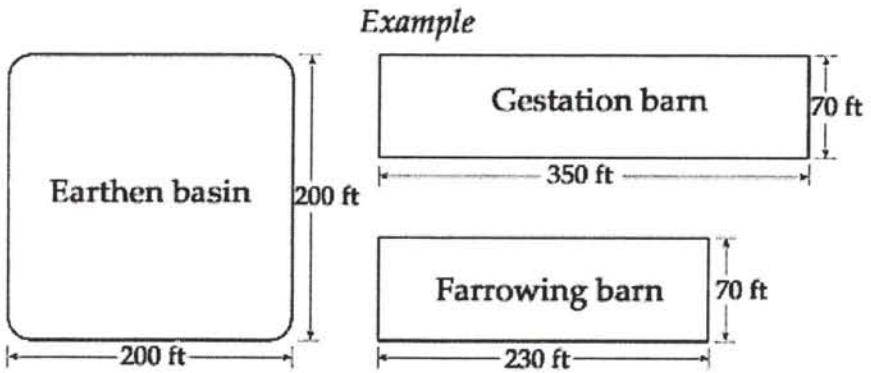
Step 3 There is no odor control technology for this site, so 1 is entered in Column D of Table 5 for each source.

Step 4 The odor emission factor (Column E) for each source is found by multiplying the above three numbers and dividing by 10,000.

Step 5 The three odor emission factors in Column E are summed to determine the TOEF for the site. In this case the TOEF is 148.

Step 6 In Figure 2, locate 148 on the x-axis. Then move vertically to the 97% "odor annoyance-free" curve. Moving horizontally to the vertical axis shows the minimum setback distance to achieve 97% annoyance-free is approximately 2900 ft. or 0.56 miles. Therefore, this farm does not comply with the county guidlines because the community will experience annoying odors greater than the allowable 3% per month (22 hours per month).

Figure 3. Example farm sketch.



To comply with county regulations, the farmer must reduce odor emissions from his animal production site. The question then becomes how much odor emission reduction is necessary to meet the 97% annoyance-free standard. The farmer contemplates the addition of a biofilter on the two buildings (odor control factor of 0.1) and a geotextile cover on the manure storage (odor control factor of 0.5). Table 6 indicates the changes in odor emissions with these two modifications. Note that Columns A, B, and C did not change between Table 5

and Table 6.

With a new TOEF, go to Figure 2 and find 30.5 on the horizontal scale. For this TOEF only the 99% annoyance-free curve is not reached by a 0.5 mile setback. The odor control technologies used in this example are presently available. Although not common, they can be seen on demonstration farms. Additional cost to the producer to implement these odor control measures should be weighed against the expenses incurred in trying to find an alternative site.

Table 5. Summary of the information in example 1.

Column A Odor source	Column B Odor Emission Number/ft.^{2}	Column C Area (sq. ft.)	Column D Odor Control Factor	Column E Odor Emission Factor (B x C X D/10000)
1. Gestation barn	*30*	*24,500*	*1*	*73.5*
2. Farrowing barn	*14*	*16,100*	*1*	**22.5**
3. Basin	*13*	*40,000*	*1*	*52.0*
Total Odor Emission Factor (sum of Column E)				*148.0*

Table 6. Summary of the information of MODIFIED example.

Column A Odor source	Column B Odor Emission Number/ft.^{2}	Column C Area (sq. ft.)	Column D Odor Control Factor	Column E Odor Emission Factor (B x C X D/10000)
1. Gestation barn	*30*	*24,500*	*0.1*	*7.4*
2. Farrowing barn	*14*	*16,100*	*0.1*	**2.2**
3. Basin	*13*	*40,000*	*0.5*	*26*
Total Odor Emission Factor (sum of Column E)				*35.7*

Find more information on manure and odor at www.bae.umn.edu/extens/manure

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Appendix E

APPENDIX E
SPECIAL STATUS SPECIES

Special Status Species Reported by the California Natural Diversity Database, Inventory of Rare and Endangered Plants, and Listed Species from the unofficial USFWS list of Federal and Threatened Species that may be affected by projects in Glenn County:

Species	Habitat	Status
Amphibians		
Ambystoma californiense (California tiger salamander)	Vernal pools, playas, and ponds in grasslands and low foothill (under 1,500 foot) regions; requires burrows constructed by small mammals for estivation during the dry months.	FPT
Rana aurora draytonii (California red-legged frog)	Marshes, quiet pools of streams, and occasionally ponds, offering a permanent water source.	FT
Rana boylii (Foothill yellow-legged frog)	Rocky streams in valley-foothill hardwood, valley-foothill hardwood-conifer, valley foothill riparian, ponderosa pine, mixed conifer, coastal scrub, mixed chaparral, and wet meadow habitats that offer a permanent source of water.	FSC, SC
Spea hammondii (Western spadefoot)	Vernal pools and other wet areas within grasslands.	FSC, SC
Birds		
Accipiter gentilis (Northern goshawk)	Coniferous and deciduous forests, and forest edges.	FSC, SC, MBTA
Agelaius tricolor (Tricolored blackbird)	Emergent wetland with dense cattail or tules, and thickets of blackberry, wild rose, willow, or tall herbs.	FSC, SC, MBTA
Ardea alba (Great egret)	Shallow water along the shores of lakes, esturaries, streams, ditches, other wet areas, grasslands, nests in large trees along waterways.	SC, MBTA
Ardea herodius (Great blue heron)	Shallow estuaries and fresh and saline emergent wetlands, nests in secluded large trees or snags.	SC, MBTA
Athene cunicularia (Burrowing owl)	Occurs in open, dry grasslands, deserts, and sometimes ruderal areas along ditch levees. Requires burrows.	FSC, SC, MBTA
Buteo swainsoni (Swainson's hawk)	Stands with few trees in juniper-sage flats, riparian, and oak savannah habitats. Requires adjacent suitable foraging areas such as grasslands, grain fields, or alfalfa that support rodent populations.	FSC, CT, MBTA
Coccyzus americanus occidentalis (Western yellow-billed cuckoo)	Cottonwood – tree willow riparian forest, or deciduous riparian thickets with dense understory foliage, also utilizes adjacent walnut and almond orchards for nesting.	FC, CE, MBTA
Haliaeetus leucocephalus (Bald eagle)	Dense conifer stands utilized for winter roosting, and large bodies of water, or free flowing rivers with abundant fish, and adjacent snags or other perches are required for feeding. Large, old-growth, or live tree with open branch work, preferred for nesting, especially ponderosa pine.	FT, CE, MBTA

Species	Habitat	Status
Pandion haliaetus (Osprey)	Inland lakes and reservoirs, and other northwest river systems, associated strictly with large, fish-bearing waters, primarily in ponderosa pine through mixed conifer habitats.	SC, MBTA
Riparia riparia (Bank swallow)	Riparian and other lowland habitats in California including brushland, grassland, and cropland; vertical banks or cliffs with fine-textured or sandy soils near streams, rivers, ponds, lakes, and the ocean are required for nesting.	FSC, CT, MBTA
Strix nebulosa (Great gray owl)	Mixed conifer, lodgepole pine, or old-growth red fir forests, usually in the vicinity of wet meadows.	CE, MBTA
Strix occidentalis caurina (Northern spotted owl)	Dense, old-growth, multi-layered mixed conifer, redwood, and Douglas-fir.	FT, MBTA
Invertebrates		
Branchinecta conservatio (Conservancy fairy shrimp)	Vernal pools, most commonly in grass or mud bottomed swales, or basalt flow depression pools in unplowed grasslands.	FE
Branchinecta lynchi (Vernal pool fairy shrimp)	Large vernal pools with cool, moderately turbid water that persists until June.	FT
Desmocerus californicus dimorphus (Valley elderberry longhorn beetle)	Elderberry shrubs in the Sacramento and San Joaquin Valleys.	FT
Lepidurus packardi (Vernal pool tadpole shrimp)	Vernal pools.	FE
Fish		
Hypomesus transpacificus (Delta smelt)	Native to the lower and middle reaches of Sacramento and San Joaquin Delta. Delta smelt are tolerant of a wide salinity range with most of the populations living at salinities less than 2 ppt for the majority of the year. They are seldom found at salinities greater than 10 ppt.	FT
Onchorhynchus kisutch (Coho salmon)	Natural populations occur in river basins between Cape Blanco in Curry County, OR and Punta Gorda in Humboldt Co., CA. Spawning streams are typically moderate sized coastal stream, or stream tributaries to large river with summer temperatures that seldom exceed 21 °C. The head of a riffle in small to medium sized gravel is the preferred location for redd sites.	FT, NMFS
Onchorhynchus mykiss (Central Valley steelhead)	Occur Sacramento and San Joaquin Rivers and their tributaries. When in fresh water they occur in cool, clear, fast-flowing permanent streams and rivers where riffles are predominate over pools. This fish will survive temperatures from 0 to 28°C. Most steelhead will migrate upstream in the fall months before spawning and will spawn in the same stream, which they had lived as fry. Riffles with gravel are the preferred locations for redd sites.	FT, NMFS
Onchorhynchus tshawytscha (Central Valley spring-run chinook salmon)	Spawning populations occur in the Sacramento River and its tributaries. Spawning age varies from one to seven years. Spawning usually occurs in large streams with coarse gravelly riffles but may also occur in small tributaries to the larger streams.	FT, NMFS

Species	Habitat	Status
Mammals		
Martes pennanti pacifica (Pacific fisher)	Extensive mixed hardwood forests, cutover wilderness areas.	FSC, SC
Reptiles		
Emys (=Clemmys) marmorata marmorata (Northwestern pond turtle)	Open slow-moving water of rivers, creeks, and sloughs with basking sites present.	FSC, SC
Thamnophis gigas (Giant garter snake)	Herbaceous wetland and riparian habitats, freshwater marsh, low-gradient streams with emergent vegetation, sloughs, drainage canals and irrigation ditches, ponds, and small lakes with mud bottoms.	FT, CT
Plants		
Androsace elongata ssp. *acuta* (California androsace)	Chaparral, cismontane woodland, coastal scrub, and valley and foothill grasslands.	4
Anisocarpus scabridus (Scabrid alpine tarplant)	Metamorphic rocky soils in upper montane coniferous forest.	1B
Antirrhinum subcordatum (Dimorphic snapdragon)	Chaparral, and serpentinite soils in lower montane coniferous forest.	4
Arctostaphylos manzanita ssp. *elegans* (Konocti manzanita)	Volcanic soils in chaparral, cismontane woodland, and lower montane coniferous forest in Colusa, Glenn, Lake, Mendocino, Napa and Sonoma Counties.	1B
Asclepias solanoana (Serpentine milkweed)	Chaparral, cismontane woodland, and serpentinite soils in lower montane coniferous forest.	4
Astragalus rattanii var. *jepsonianus* (Jepson's milk-vetch)	Often occurs in serpentinite soils in chaparral, cismontane woodland, and valley and foothill grasslands.	FSC, 1B
Astragalus rattanii var. *rattanii* (Rattan's milk-vetch)	Chaparral, cismontane woodland, and gravelly streambanks in lower montane coniferous forests.	4
Astragalus tener var. *ferrisiae* (Ferris's milk-vetch)	Adobe soil in dry, subalkaline flats on overflow land in the Central Valley, often associated with meadows, and valley and foothill grassland habitats.	FSC, 1B
Atriplex cordulata (Heartscale)	Chenopod scrub, sandy valley and foothill grasslands, and alkaline flats and scalds in the Central Valley.	FSC, 1B
Atriplex coronata var. coronata (Crownscale)	Chenopod scrub, meadows and seeps, and on saline or alkaline soils in valley and foothill grasslands.	4
Atriplex depressa (Brittlescale)	Chenopod scrub, vernal pools, meadows, playas, grasslands with clay soils.	FSC, 1B
Atriplex joaquiniana (San Joaquin saltbush)	Chenopod scrub, meadows and seeps, playas, and grasslands.	FSC, 1B
Atriplex persistens (Vernal pool smallscale)	Vernal pools.	FSC, 1B
Brodiaea coronaria ssp. *rosea* (Indian Valley brodiaea)	Serpentinite soils in closed cone coniferous forest, chaparral, cismontane woodland, and valley and foothill grasslands.	FSC, CE, 1B
Calyptridium quadripetalum (Four-petaled pussypaws)	Chaparral and on sandy, gravelly, serpentinite soils in lower montane coniferous forests.	4
Cardamine pachystigma var. *dissectifolia* (Dissected-leaved toothwort)	Chaparral, lower montane coniferous forest, usually on serpentinite, rocky substrates.	3
Carex buxbaumii	Bogs and fens, mesic meadows and seeps, and marshes	4

Species	Habitat	Status
(Buxbaum's sedge)	and swamps.	
Castilleja rubicundula ssp. *rubicundula* (Pink creamsacs)	Serpentinite soils in chaparral with openings, cismontane woodland, meadows and seeps, valley and foothill grasslands.	FSC, 1B
Chamaesyce hooveri (Hoover's spurge)	Vernal pools.	FT, 1B
Chamaesyce ocellata ssp. *rattanii* (Stony Creek spurge)	Sandy or rocky soils in chaparral and valley and foothill grassland.	1B
Collomia diversifolia (Serpentine collomia)	Chaparral, cismontane woodland on serpentinite, rocky or gravelly substrates.	4
Cordylanthus palmatus (Palmate bracted bird's-beak)	Alkaline soils in valley and foothill grasslands, and chenopod scrub.	FE, CE, 1B
Cypripedium montanum (Mountain lady's-slipper)	Broadleafed upland forest, cismontane woodland, lower montane and North Coast coniferous forests.	4
Delphinium recurvatum (Recurved larkspur)	Alkaline soils in chenopod scrub, cismontane woodlands, and grasslands.	FSC, 1B
Eleocharis parvula (Small spikerush)	Marshes and swamps.	4
Epilobium nivium (Snow Mountain willowherb)	Rocky soils in chaparral and upper montane coniferous forests.	FSC, 1B
Epilobium oreganum (Oregon fireweed)	Mesic soils in bogs, fens, lower montane coniferous forest, and upper montane coniferous forests.	FSC, 1B
Eriastrum brandegeeae (Brandegee's eriastrum)	Volcanic soils in chaparral and cismontane woodlands.	FSC, 1B
Eriastrum tracyi (Tracy's eriastrum)	Chaparral and cismontane woodlands.	CR, 1B
Eriogonum nervulosum (Snow Mountain buckwheat)	Serpentinite soils in chaparral.	1B
Eriogonum umbellatum var. bahiiforme (Bay buckwheat)	Cismontane woodland, and lower montane coniferous forest, on rocky, often serpentinite soils.	4
Erodium macrophyllum (Round-leaved filaree)	Cismontane woodland, and clay soils within valley and foothill grasslands.	2
Fritillaria pluriflora (Adobe-lily)	Clay or serpentine soils in chaparral, cismontane woodland, and foothill grasslands.	FSC, 1B
Fritillaria purdyi (Purdy's fritillary)	Chaparral, cismontane woodland, and on serpentinite soils in lower montane coniferous forests.	4
Gilia sinistra ssp. *pinnatisecta* (Pinnate-leaved gilia)	Chaparral, and ower montane coniferous forest on serpentinite or volcanic soils.	4
Hackelia amethystine (Amethyst stickseed)	Lower montane coniferous forest, meadows and seeps, and openings or disturbed areas within upper montane coniferous forests.	4
Helianthus exilis (Hogwallow starfish)	Mesic or clay substrates in valley and foothill grasslands.	4
Hesperolinon drymarioides (Drymaria-like western flax)	Serpentinite soils in closed cone coniferous forest, chaparral, cismontane woodland, and valley and foothill grasslands.	FSC, 1B
Hesperolinon tehamense (Tehama County western flax)	Serpentinite soils in chaparral and cismontane woodlands.	FSC, 1B

Species	Habitat	Status
Hibiscus lasiocarpus (Rose-mallow)	Freshwater marshes and swamps.	2
Layia septentrionalis (Colusa layia)	Sandy or serpentinite soils in chaparral, cismontane woodland, and valley and foothill grasslands.	FSC, 1B
Lepidium latipes var. *heckardii* (Heckard's pepper grass)	Alkaline flats and beds of winter pools below 2,000 feet, largely in grasslands from San Diego north to Humboldt, CA.	FSC, 1B
Linanthus latisectus (Broad-lobed linanthus)	Broadleafed upland forest, cismontane woodland.	4
Linanthus rattanii (Rattan's linanthus)	Cismontane woodland, lower montane coniferous forest, on rocky or gravelly soils.	4
Navarretia cotulifolia (Cotula navarretia)	Chaparral, cismontane woodland, and on adobe soils within valley and foothill grasslands.	4
Navarretia jepsonii (Jepson's navarretia)	Chaparral, cismontane woodland, valley and foothill grassland, often on serpentinite soil.	4
Neostapfia colusana (Colusa grass)	Vernal pools.	FT, CE, 1B
Orcuttia pilosa (Hairy orcutt grass)	Vernal pools.	FE, CE, 1B
Orobanche valida ssp. *howellii* (Howell's broomrape)	On serpentinite or volcanic substrates in chaparral.	4
Polystichum lonchitis (Holly fern)	Subalpine coniferous forest, and on granitic or carbonate soils in upper montane coniferous forest.	3
Sedum laxum ssp. *hydrophila* (Pale yellow stonecrop)	Broadleafed upland forest, chaparral, cismontane woodland, lower montane coniferous forest, and on serpentinite or volcanic soils within upper montane coniferous forest.	4
Sidalcea oregana ssp. *hydrophila* (Marsh checkerbloom)	Mesic soils in meadows, seeps, and riparian scrub.	FSC, 1B
Stellaria obtuse (Obtuse starwort)	Lower montane coniferous forest, riparian woodland, and in mesic upper montane coniferous forest.	4
Streptanthus breweri var. *hesperidis* (Green jewel-flower)	Serpentinite or rocky soils in chaparral openings and cismontane woodlands.	FSC, 1B
Streptanthus drepanoides (Sickle-fruit jewel-flower)	Chaparral, cismontane woodland, and on serpentinite substrates in lower montane coniferous forest.	4
Streptanthus morrisonii ssp. *elatus* (Three Peaks jewel-flower)	Serpentinite soils in chaparral within Lake, Napa, and Sonoma Counties.	1B
Streptanthus morrisonii ssp. *hirtiflorus* (Dorr's Cabin jewel-flower)	Serpentinite soils in chaparral and closed cone coniferous forests within Sonoma County.	1B
Streptanthus morrisonii ssp. *kruckebergii* (Kruckeberg's jewel-flower)	Serpentinite soils in cismontane woodlands within Lake, Napa, and Sonoma Counties.	1B
Streptanthus morrisonii ssp. *morrisonii* (Morrison's jewel-flower)	Serpentinite, rocky or talus soils in chaparral within Sonoma County.	1B
Tropidocarpum capparideum (Caper-fruited tropidocarpum)	Valley and foothill grassland, occurs on alkaline hills.	FSC, 1A

Species	Habitat	Status
Tucturia greenei (Greene's tuctoria)	Claypan or hardpan soils in vernal pools within valley and foothill grasslands.	1B
Viburnum ellipticum (Oval-leaved viburnum)	Chaparral, cismontane woodland, and lower montane coniferous forest.	2
Wolffia brasiliensis (Columbian watermeal)	Marshes, swamps, and assorted freshwater.	2
Natural Vegetation Communities of Concern		
Alkali Seep		
Coastal and Valley Freshwater Marsh		
Great Valley Cottonwood Riparian Forest		
Great Valley Mixed Riparian Forest		
Great Valley Valley Oak Riparian Forest		
Great Valley Willow Scrub		
Valley Needlegrass Grassland		

Sources: California Department of Fish and Game. 2003. California Natural Diversity Data Base, California Department of Fish and Game, Sacramento, CA.

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United States Fish and Wildlife Service. 2004. County Species List. Federal Endangered and Threatened Species That may be affected by projects in Glenn County, CA. +6 pp. (online version)

Status Abbreviations:

FE Federal Endangered Species
FT Federal Threatened Species
FSC Federal Species of Concern
MBTA Species Protected Under the Auspices of the Migratory Bird treaty Act
CE California Endangered Species
CT California Threatened Species
CR California Rare Species Afforded Protection Under the Native Plant Protection Act
SC California Department of Fish and Game Species of Special Concern
1A California Native Plant Society List 1A - Plants Presumed Extinct in California
1B California Native Plant Society List 1B - Plants Rare, Threatened, or Endangered in California and Elsewhere
2 California Native Plant Society List 2 - Plants Rare, Threatened, or Endangered in California, but More Common Elsewhere
3 California Native Plant Society List 3 - Plants About Which More Information is Needed, a Review List
4 California Native Plant Society List 4 - Plants of Limited Distribution, a Watch List

Appendix F

APPENDIX F
TECHNICAL REPORT COMPONENT DESCRIPTIONS

A. General Site Information

General Site Information shall be included as part of the Technical Report documentation submitted with an application for a new or expanding confined animal facility requiring a use permit. General Site Information includes the following:

1. Descriptions of the confined animal populations to be permitted at the facility, delineating the numbers and types of animals (e.g., number of milking cows, dry cows, heifers, and calves if the confined animal facility is a dairy).

2. A facility map including: property perimeter, all existing and proposed land use (crops, grazed areas, woodlands, processing facilities, pastures, confined areas, feeding areas, etc.), topography, creeks/drainages, livestock crossings, waste collection and disposal system (waste conveyances, storage areas, ponds, pumps, pipes, irrigation/disposal areas, etc.)

B. Geotechnical Report

The Geotechnical Report is part of the Technical Report documentation prepared by a qualified professional, either a Professional Engineer or Licensed Geotechnical Engineer. The report shall, at a minimum, present the results of sufficient subsurface sampling and testing to classify and characterize the soils and groundwater conditions in areas of proposed confined animal facility structures, corrals, feed and manure storage areas, lagoon, and cropland where process water and manure are spread. If the preliminary soils report indicates the presence of critically expansive soils or other soil problems, which if not corrected, could lead to structural defects or leakage of contaminants into the groundwater, a soil investigation shall be prepared by a Civil Engineer registered in the State of California and shall recommend design requirements that are likely to prevent possible structural damage to structures or lagoons proposed to be constructed within the production facility. The report shall include recommendations for foundation design, cut and fill slope design, berm or embankment design, and site grading.

C. Drainage Analysis

The Drainage Analysis should identify any Flood Insurance Rate Map (FIRM) flood zones in or near the project site. Please be advised that not all flood-prone areas appear on the FIRMs. The analysis should note and locate all flood protection facilities. Such facilities shall not decrease the capacity of any floodways. Note and locate drainage facilities, on and off-site that will carry storm water runoff from the project site. Estimate the capacity of these facilities and calculate approximate pre and post development flows to be carried by these facilities. Note and locate all water quality treatment facilities. Summarize, briefly, their

capacities and how they will work. In general terms, qualitatively describe where the water will go if these facilities fail.

D. Groundwater Evaluation

This evaluation may be done in conjunction with the Geotechnical Report described above. The Groundwater Evaluation shall address the following:

1. Groundwater and surface water: Minimum separation from bottom of (lined and unlined) lagoons, manure and feed storage areas, and corrals shall be at least five (5) feet to the highest recorded groundwater level.

2. Depth to first useable groundwater for human consumption: The source of potable water for the confined animal facility and nearby properties, and the safeguards to protect that water source must be identified.

3. Proximity to watercourses: Adjacent watercourses and improvements to protect watercourses from discharges from a confined animal facility into watercourses or water bodies must be identified.

4. Baseline groundwater quality: The applicant shall also prepare a plan for monitoring groundwater quality, including sampling of background water quality prior to the construction of confined animal facilities. The plan must provide a way to determine the rate and direction of groundwater flow and monitor groundwater quality immediately upgradient and downgradient from the waste management area, and also locate background monitoring points, detection monitoring points, and groundwater quality compliance points.

E. Nutrient Management Plan

A Nutrient Management Plan (NMP) is a conservation plan that is unique to animal feeding operations. It is a grouping of conservation practices and management activities which, when implemented as part of a conservation system, will help to ensure that both production and natural resource protection goals are achieved. An NMP incorporates practices to utilize animal manure and by-products as a beneficial resource. An NMP addresses natural resource concerns dealing with soil erosion, manure, and by-products and their potential impacts on water quality, which may derive from an animal feeding operation.

An NMP is developed to assist an owner/operator in meeting all applicable local, tribal, State, and Federal water quality goals or regulations. For nutrient impaired stream segments or water bodies, additional management activities or conservation practices may be required to meet local, tribal, State, or Federal water quality goals or regulations. For the purposes of the Glenn County Confined Animal Facilities Element, the NMP must include those descriptions, figures, calculations, and management practices sufficient to meet the national pollutant elimination discharge requirements of the Central Valley Regional Water Quality Control Board.

F. Dead Animal Management Plan

The Dead Animal Management Plan is a part of the Technical Report submitted with each application for a new or expanding confined animal facility requiring a use permit. The plan shall include a program of removing dead animals from the site within 7 days. Burial or otherwise disposing of the carcasses on site shall not be allowed unless by order of the Department of Environmental Health, Agricultural Commissioner, or other authority authorized to make such an order. Records shall be kept at the confined animal facility site documenting dead animal removal and shall be made available to Glenn County Environmental Health Services Department personnel upon their request.

G. Pest and Vector Control Plan

The Pest and Vector Control Plan (PVCP) is a part of the Technical Report submitted with each application for a new or expanding confined animal facility requiring a use permit. The PVCP shall include methods of controlling flies, mosquitoes, and rodents under various conditions. The plan shall be designed to use good housekeeping practices as the primary tool to combat vector infestation. It shall include, but not be limited to, measures that ensure good drainage of manured areas, frequent lane flushing, clean-up and maintenance along fence lines, and prompt repair of all leaking pipes and fixtures. Secondary measures to be included in the PVCP are biological controls, including, but not limited to, the use of parasitic beetles and mites (to control egg and larvae populations) and parasitic wasps (to control fly pupae populations). When housekeeping and biological controls prove ineffective (or have provided limited effectiveness), chemicals (i.e., pesticides) may supplement the program. When chemicals are used, special care shall be taken to select and apply chemicals that are compatible with existing biological controls that may be in use (i.e., those that do not kill the parasitic wasps). Other measures that may be considered in the PVCP are biological controls, including, but not limited to, the use of parasitic beetles and mites (to control egg and larvae populations) and parasitic wasps (to control fly pupae populations).

The PVCP shall be distributed to the Mosquito and Vector Control District, Glenn County Agricultural Commissioner, and the Glenn County Division of Environmental Health Services for review and comment before final approval acceptance of the plan. Record keeping for the PVCP shall consist of documentation kept at the confined animal facility site that includes pest control methods used and the dates of the pest control activities.

H. Dust Control Plan

The Dust Control Plan (DCP) is a part of the Technical Report submitted with each application for a new or expanding confined animal facility requiring a use permit. The owner/operator shall prepare a DCP which shall include, but not be limited to the following components:

1. Identification of all significant off-field source of fugitive dust emissions (e.g., unpaved roads, unpaved corrals and other open or vacant areas, and bulk material stockpiles);

2. Description of Best Available Control Measures (BACMs) used for controlling of fugitive emissions from all sources identified at the confined animal facility and an estimate of control efficiency provided by BACMs;

3. Discussion of compliance of identified BACMs with the requirements of rules adopted by the Glenn County Air Pollution Control District;

4. Discussion of quality control/quality assurance procedures to ensure that BACMs are implemented and inspected;

5. Discussion of record keeping for quality control/quality assurance procedures;

6. Identification of person responsible for implementation of the DCP.

The Glenn County Planning Director shall distribute the DCP to the Glenn County Air Pollution Control District and the Glenn County Division of Environmental Health Services for review and comment before final acceptance of the plan.

I. Odor Control Plan

The purpose of the Odor Control Plan (OCP) is to reduce the potential for odor impacts to nearby receptors. The owner/operator, or his or her agent, shall prepare an OCP that specifies standard operating practices for livestock handling, and manure collection, processing, storage, and land application. The OCP shall specifically address standard operating practices for livestock handling, and manure collection, processing, storage, and land application. It shall also provide standard operating procedures/control measures to be implemented to protect receptors from potential odors that could be generated from confined animal facility operations. At a minimum, the plan shall include the following components:

1. Manure Collection Areas:

    a. Clean out manure generated at the freestall barns and corrals at a frequency that will minimize odors;
    b. Keep cattle as dry and clean as possible at all times;
    c. Scrape manure from the corrals and bedding from the freestall barns and corrals at a frequency that will minimize odors.

2. Manure Management and Application:

    a. Minimize moisture content of stockpiled manure/retained solids to a level that will reduce the potential for release of odorous compounds during storage.
    b. Minimally agitate stockpiled manure during loading for off-site transport;
    c. Mix process water with irrigation water prior to irrigation (dilution rate shall be adequate to minimize odor levels and maintain appropriate nutrient content in effluent);
    d. Apply process water containing ammonia so that it minimizes exposure to air;

e. Clean up manure spills upon occurrence;
f. Maintain and operate separation pits and process water lagoons to minimize odor levels.
g. Avoid spreading in windy conditions, especially when it blows toward populated areas, or immediately before weekends or holidays when nearby neighbors are likely to be engaged in outdoor and recreational activities.
h. If there is no storage facility, spread manure as frequently as possible during warm weather. Unload storages on schedule. To minimize the time that odor is released to the air, have machinery in good repair and labor ready before starting to unload.
i. Incorporate manure during or immediately after land application by injecting it into the soil or plowing or disking the soil.

3. General:

a. Implement dust suppression measures to prevent the release of odorous compound-carrying fugitive dust;
b. During project operations, the confined animal facility operator/owner shall respond to neighbors who are adversely affected by odors generated at the project site and take prompt corrective action.

J. Traffic Analysis

The Traffic Analysis is a part of the Technical Report submitted with each application for a new or expanding confined animal facility requiring a use permit. This component of the Technical Report shall include the following information:

1. Routes to be used by project traffic to reach major regional arterials.

2. Summary of classes of trucks traveling to and from the project site, including typical weights and numbers of axles.

3. Traffic counts, including percentage of truck traffic and volume splits at project access points and nearby impacted intersections.

4. A calculation of the estimated Level of Service at the nearby impacted intersections.

K. Biological Resources Evaluation

The Biological Resources Evaluation is a part of the Technical Report submitted with each application for a new or expanding confined animal facility requiring a use permit. The evaluation shall include an evaluation by a qualified wildlife biologist based on the results of a search of the California Natural Diversity Database in the vicinity of the project and a reconnaissance of the project site. If habitat for sensitive species are found, appropriate measures shall be taken to avoid destruction of active dens or nests. An appropriate buffer zone shall be established around any active den or nest based on consultation with representatives of the California Department of Fish and Game and/or the U.S. Fish and

Wildlife Service, depending upon jurisdiction under State and Federal laws. Construction activities shall be restricted in this zone until the qualified biologist has determined that the young animals are no longer using the dens or nests.

L. Cultural Resources Evaluation

The Technical Report shall include documentation that a review of records of known cultural resources has been completed by the California Historical Resources Information System (CHRIS) and that no significant cultural (historic or archaeological) resources would be disturbed by the proposed confined animal facility development. If CHRIS indicates that known resources are present or suspected within the construction area of the proposed confined animal facility development, the Technical Report shall include an evaluation of the resource by an archaeologist qualified under the Secretary of the Interior's Standards and Guidelines for archaeologists which includes an appropriate mitigation plan that will be implemented by the confined animal facility developer. This evaluation shall include an evaluation of paleontological and unique geologic feature resources.

M. Light/Glare Control Plan

The Light/Glare Control Plan is part of the is part of the Technical Report documentation submitted with an application for a new or expanding confined animal facility requiring a use permit. The plan shall show all exterior lights of the production facilities and describe the methods used to ensure that the lighting is so arranged to reflect light away from adjoining properties. The plan shall also address the protection of the night sky. Applicants are encouraged to apply practices and use products approved by the International Dark-Sky Association.

Appendix G

651.1080 Appendix 10D—Geotechnical, Design, and Construction Guidelines

Appendix 10D Geotechnical, Design, and Construction Guidelines

Introduction

The protection of surface and ground water and the proper utilization of wastes are the primary goals of waste storage ponds and treatment lagoons. Seepage from these structures creates potential risks of pollution of surface water and underground aquifers. The permeability of the soil in the boundaries of a constructed waste treatment lagoon or waste storage pond directly influences the potential for downward or lateral seepage of the stored wastes.

Many natural soils on the boundaries of waste treatment lagoons and waste storage ponds at least partly seal as a result of introduction of manure solids into the reservoir. Physical, chemical, and biological processes occur that reduce the permeability of the soil-liquid interface. Suspended solids settle out and physically clog the pores of the soil mass. Anaerobic bacteria produce by-products that accumulate at the soil-liquid interface and reinforce the seal. The soil structure can also be altered in the process of metabolizing organic material. Chemicals in waste, such as salts, can disperse soil, which may be beneficial in reducing seepage. Researchers have reported that, under the right conditions, the permeability of the soil can be decreased by up to several orders of magnitude in a few weeks following contact with waste in a waste storage pond or treatment lagoon. These guidelines have been developed under the premise that the permeability decrease induced by the manure should not be counted on as the sole means of ground water protection. However, the guidelines do propose recognition of sealing to the extent of one order of magnitude for soils with a clay content exceeding 5 percent for ruminant manures and 15 percent for monogastric animal manures.

General design considerations

The following guidelines[1] address the design and construction techniques needed to overcome certain soil limitations. These guidelines should be considered in the planning, design, construction, and operation of agricultural waste management components including waste treatment lagoons and waste storage ponds.

Soil and foundation characteristics are critical to design, installation, and safe operation of successful waste treatment lagoons or waste storage ponds. Waste impoundments must be located in soils with acceptable permeabilities or be lined.

[1] These guidelines are an update and augmentation of material previously published in SNTC Technical Note 716, "Design and Construction Guidelines for Considering Seepage from Agricultural Waste Storage Ponds and Treatment Lagoons." SNTC Technical Note 716 has been canceled.

Soil properties

NRCS soil mechanics laboratories have a data base of permeability tests performed on over 1,100 compacted soil samples. Experienced NRCS engineers have analyzed these data and correlated permeability rates with soil index properties and degree of compaction of the samples. Tables 10D–1 to 10D–3 are based on this analysis and provide general guidance on the probable permeability of the described soil groups. The grouping of soils in table 10D–1 is based on the percent fines and Atterberg limits of the soils. Fines are those particles finer than the No. 200 sieve. Table 10D–2 provides assistance in converting from the Unified Soil Classification to one of the four permeability groups.

Table 10D–1 Grouping of soils according to their estimated permeability

Group	Description
I	Soils that have less than 20% passing a No. 200 sieve and have a Plasticity Index (PI) less than 5.
II	Soils that have 20% or more passing a No. 200 sieve and have PI less than or equal to 15. Also included in this group are soils with less than 20 percent passing the No. 200 sieve with fines having a PI of 5 or greater.
III	Soils that have 20% or more passing a No. 200 sieve and have a PI of 16 to 30.
IV	Soils that have 20% or more passing a No. 200 sieve and have a PI of more than 30.

Table 10D–2 Unified classification versus soil permeability groups 1/

Unified classification	Permeability group 2/ I	II	III	IV
CH	N	N	S	U
MH	N	S	U	S
CL	N	S	U	S
ML	N	U	S	N
CL-ML	N	A	N	N
GC	N	S	U	S
GM	S	U	S	S
GW	A	N	N	N
SM	S	U	S	S
SC	N	S	U	S
SW	A	N	N	N
SP	A	N	N	N
GP	A	N	N	N

1/ ASTM Method D-2488 has criteria for use of index test data to classify soils by the Unified Soil Classification System.

2/ A = Always in this permeability group.
N = Never in this permeability group.
S = Sometimes in this permeability group (less than 10 percent of samples fall in this group).
U = Usually in this permeability group (more than 90 percent of samples fall in this group).

Permeability of soils

Table 10D–3 shows the percentage of each group for which a permeability test measured a k value of 0.0028 feet per day (1 x 10^{-6} cm/s) or less. The table also shows the median k value for the group in feet per day. A value of the coefficient of permeability of 0.0028 feet per day (1 x 10^{-6} cm/s) was selected for the median value studied. For typical NRCS designed structures, this value results in an acceptable seepage loss. As discussed later in this section, sealing by manure solids and biological action will most likely produce an additional order of magnitude reduction in permeability in the soils at grade.

Table 10D–3 summarizes a total of 1,161 tests. Where tests are shown at 85 to 90 percent of maximum density, over 75 percent of the tests were at 90 percent of maximum dry density. Where 95 percent degree of compaction is shown, data include both 95 and 100 percent degree of compaction tests. Over 80 percent of this group of tests was performed at 95 percent of maximum density. Based on these data, the following general statements can be made for the four soil groups:

Group I—These soils have the highest permeability and could allow unacceptably high seepage losses. Because the soils have a low clay content, permeability values may not be substantially reduced by manure sealing, and will probably exceed 10^{-6} centimeters per second.

Group II—These soils generally are less permeable than the Group I soils, but lack sufficient clay to be included in Group III.

Group III—These soils generally have a very low permeability, good structural features, and only low to moderate shrink-swell behavior.

Caution: Some soil in Group III is more permeable than indicated by the percent fines and PI value because they contain a high amount of calcium. The presence of a high amount of calcium results in a flocculated or aggregated structure in the soils. These soils often result from the weathering of high calcium parent rock, such as limestone. Soil scientists and published soil surveys are helpful in identifying these soil types. Dispersants, such as tetrasodium polyphosphate, can alter the flocculated structure of these soils by replacement of the calcium with sodium on the clay particles (See the section, *Design and construction of clay lines treated with soil dispersants*). Because manure contains salts, it can be helpful in dispersing the structure of these soils, but design should probably not rely solely on manure as the additive for these soil types.

Group IV—Normally, these soils have a very low permeability. However, because of their sometimes blocky structure, they can experience high seepage losses through cracks that can develop when the soil is allowed to dry. They possess good attenuation properties if the seepage does not move through cracks in the soil mass.

Table 10D–3 Summary of soil mechanics laboratories permeability test data

Soil group	Percent of ASTM D698 dry density	Number of observations	Median K (cm/s)	Median K (ft/d)	Percent of tests where k < 0.0028 (ft/d)
I	85-90	27	7.2 x 10^{-4}	2.0	0
I	95	16	3.5 x 10^{-4}	1.0	0
II	85-90	376	4.8 x 10^{-6}	0.014	30
II	95	244	1.5 x 10^{-6}	0.004	45
III	85-90	226	8.8 x 10^{-7}	0.0025	59
III	95	177	2.1 x 10^{-7}	0.0006	75
IV	85-90	41	4.9 x 10^{-7}	0.0014	72
IV	95	54	3.5 x 10^{-8}	0.0001	69

In situ soils with acceptable permeability

Natural soils that are classified in permeability Groups III or IV generally have permeability characteristics that result in acceptable seepage losses. NRCS permeability data bases show these soils usually have coefficients of permeability of 1 x 10^{-6} centimeters per second (0.0028 ft/d) or less if the soils are at dry densities equivalent to at least 90 percent of their Standard Proctor (ASTM D698) maximum dry densities. Based on the literature reviewed, introduction of manure provides a further decrease in the permeability rate of at least 1 order of magnitude. Such sealing is thought to be a result of physical, chemical, and biological processes. Suspended solids settle or filter out of solution and physically clog the pores of the soil mass. Anaerobic bacteria produce by-products that accumulate at the soil-water interface and reinforce the seal, and in the process of metabolizing organic material can alter the soil structure. Chemicals in animal waste, such as salts, can disperse soil, which may be beneficial in reducing seepage. Special design measures generally are not necessary where agricultural waste storage ponds or treatment lagoons are constructed in these soils, provided that the satisfactory soil type is at least 2 feet thick below the deepest excavation limits and sound construction procedures are used. This also assumes that no highly unfavorable geologic conditions, such as limestone formations with extensive caves or solution channels, occur at the site.

Soils in Groups III and IV that have a blocky structure or desiccation cracks should be disked, watered, and recompacted to destroy the structure in the soils and provide an acceptable permeability. The depth of the treatment required should be based on design guidance given in the section, *Construction considerations for compacted clay liners*. High calcium clays should be modified with soil dispersants to achieve the target permeability goals based on the guidance given in the section, *Design and construction of clay liners treated with soil dispersants*.

Definition of pond liner

Liners are relatively impervious barriers used to reduce seepage losses to an acceptable level. A liner for a waste impoundment can be constructed in several ways. When soil is used as a liner, it is often called a clay blanket or impervious blanket. A simple method of providing a liner for a waste storage structure is to improve the soils at the excavated grade by disking, watering, and compacting them to a thickness indicated by guidelines in following sections. Soils with suitable properties can make excellent liners, but the liners must be designed and installed correctly. Soil has an added benefit in that it provides an attenuation medium for many types of pollutants.

The three options when the soil at the excavated grade is unsuitable to serve as a liner for a waste impoundment are:

- Treat the soil at grade with bentonite or a soil dispersant.
- Construct the soil liner by compacting imported clay from a nearby borrow source onto the bottom and sides of the waste impoundment.
- Use concrete or synthetic materials, such as geosynthetic clay liners (GCL's) and geomembranes.

Treat the soil at grade with bentonite or a soil dispersant. Problem soils in Group III may be treated with dispersants to attain a satisfactory soil liner. (See the section, *Design and construction of clay liners treated with soil dispersants.*) Soils in Groups I and II that are unsuitable in their natural state for use as liners can often be treated with bentonite to produce a satisfactory soil liner. Bentonite or soil dispersants should be added and mixed well into a soil prior to compaction. Brown (1991) describes techniques for constructing bentonite treated liners.

High quality sodium bentonite with good swell properties should be used for construction of clay liners using Group I and II soils. The highest quality bentonite is mined in Wyoming and Montana. NRCS soil mechanics laboratories have found it important to use the same type and quality of bentonite that will be used for construction in the laboratory permeability tests used to design the soil-bentonite mixture. Both

the quality of the bentonite and how finely ground the product is before mixing with the soil affect the final permeability rate of the mixture. It is important to work closely with both the bentonite supplier and the soil testing facility when designing treated soil liners.

Construct the soil liner by compacting imported clay from a nearby borrow source onto the bottom and sides of the waste impoundment—Compaction is often the most economical method for constructing liners if suitable soils are available nearby.

Use concrete or synthetic materials, such as geosynthetic clay liners (GCL's) and geomembranes—Concrete has advantages and disadvantages for use as a liner. It will not flex to conform to settlement or shifting of the earth. In addition, some concrete aggregates may be susceptible to attack by continued exposure to chemicals contained in or generated by the waste. Concrete serves as an excellent floor from which to scrape solids. It also provides a solid support for equipment, such as tractors or loaders. Some bedrock may contain large openings caused by solutioning and dissolving of the bedrock by ground water. Common types of solutionized bedrock are limestone and gypsum. When existence of sinks or openings is known or identified during the site investigation, these areas should be avoided and proposed facility located elsewhere. However, when these conditions are discovered during construction or alternate sites are not available, concrete liners may be required to bridge the openings, but only after the openings have been properly treated and backfilled.

Geomembranes and GCL's are the most impervious types of liners if designed and installed correctly. Care must be exercised both during construction and operation of the waste impoundment to prevent punctures and tears. Forming seams in the field for geomembranes can require special expertise. GCL's have the advantage of not requiring field seaming, but the overlap required to provide a seal at seams is an extra expense. Geomembranes and GCL's must contain ultraviolet inhibitors if they will be exposed. Designs should include provision for their protection from damage during cleaning operations.

Four conditions where a liner should be considered

Four conditions for which a designer should consider seepage reduction beyond that provided by the natural soil at the excavation boundary are listed below.

Proposed site is located where any underlying aquifer is at a shallow depth and not confined and/or the underlying aquifer is a domestic or ecologically vital water supply. State or local regulations may prevent locating a waste storage structure within a given distance from such features.

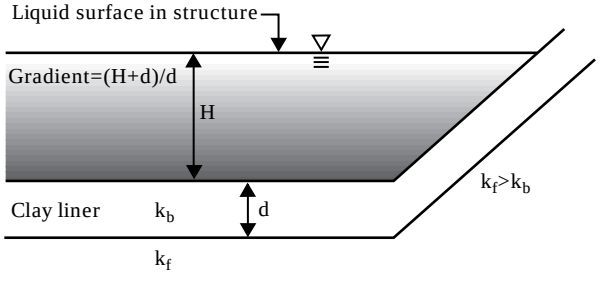
Excavation boundary of a site is underlain by less than 2 feet of soil over bedrock. Bedrock that is near the soil surface is often fractured or jointed because of weathering and stress relief. Many rural domestic and stock water wells are developed in fractured rock at a depth of less than 300 feet. Some rock types, such as limestone and gypsum, may have wide, open solution channels caused by chemical action of the ground water. Soil liners may not be adequate to protect against excessive leakage in these bedrock types. Concrete or geomembrane liners may be appropriate for these sites. However, even hairline openings in rock can provide avenues for seepage to move downward and contaminate subsurface water supplies. Thus, a site that is shallow to bedrock can pose a potential problem and merits the consideration of a liner. Bedrock at a shallow depth may not pose a hazard if it has a very low permeability and has no unfavorable structural features. An example is massive siltstone.

Excavation boundary of a site is underlain by soils in Group I—Coarse grained soils with less than 20 percent low plasticity fines generally have higher permeability and have the potential to allow rapid movement of polluted water. The soils are also deficient in adsorptive properties because of their lack of clay. Relying solely on the sealing resulting from manure solids when Group I soils are encountered is not advisable. While the reduction in permeability from manure sealing may be 1 to 3 orders of magnitude, the final resultant seepage losses are still likely to be excessive, and a liner should be used.

Excavation boundary of a site is underlain by some soils in Group II or problem soils in Group III (flocculated clays) and Group IV (highly plastic clays that have a blocky structure)—Soils in Group II may or may not require a liner. Documentation through laboratory or field permeability testing or by other acceptable alternatives is advised. An acceptable alternative would be correlation to similar soils in the same geologic or physiographic areas for which test data are available. Higher than normal permeability for flocculated clays and clays that have a blocky structure has been discussed. These are special cases, and most soils in Groups III and IV will not need a liner. Note that a liner may be constructed by treating a determined required thickness of unfavorable soils occurring at grade.

The above conditions do not always dictate a need for a liner. Specific site conditions can reduce the potential risks otherwise indicated by the presence of one of these conditions. For example, a thin layer of soil over high quality rock, such as an intact shale, is less risky than if the thin layer is over fractured or fissured rock.

Figure 10D–1 Definition of terms for clay liner and seepage calculations



where:

H = Head of waste liquid in waste impoundment
k_f = Permeability of foundation
d = Thickness of liner
k_b = Permeability of liner

Specific discharge

(a) Introduction

No soil or artificial liner, even concrete or a geomembrane liner, can be considered impermeable. To limit seepage to an acceptable level, regulatory agencies may specify a maximum allowable permeability value in liners. A criterion often used for clay liners is that the soils at grade in the structure, or the clay liner if one is used, must have a permeability of 1×10^{-7} centimeters per second or less. However, using only permeability as a criterion ignores other factors defining the seepage from an impoundment. Seepage is calculated from Darcy's Law (covered in the following section), and seepage calculations consider the permeability of the soil and the hydraulic gradient for a liner at a site.

(b) Definition of specific discharge

The term *specific discharge*, or unit seepage, is the seepage rate for a unit cross-sectional area of a pond. It is defined as follows from Darcy's Law. The hydraulic gradient for a clay liner is defined in figure 10D–1.

Given:

$$Q = k\left(\frac{(H+d)}{d}\right)A \quad \text{(Darcy's Law)}$$

Where:

Q = Total seepage through area A (L^3/T)
k = Coefficient of permeability (hydraulic conductivity) ($L^3/L^2/T$)
$\frac{(H+d)}{d}$ = Hydraulic gradient (L/L)
H = Vertical distance measured between the top of the liner and required volume of the waste impoundment (figs. 10D–1, 10D–14, 10D–15, and 10D–21) (L)
d = Thickness of the soil liner (fig. 10D–1) (L)
A = Cross-sectional area of flow (L^2)
L = Length
T = Time

Rearrange terms:

$$\frac{Q}{A} = \frac{k\left(H + d\right)}{d} \qquad (L/T)$$

By definition, unit seepage or specific discharge, ν, is Q/A:

$$\nu = \frac{k\left(H + d\right)}{d} \qquad (L^3/L^2/T)$$

The units for specific discharge are $L^3/L^2/T$. However, these units are commonly reduced to L/T.

If a coefficient of permeability of 1 x 10^{-7} centimeters per second is regarded as acceptable, then an allowable specific discharge value can be calculated. Typical NRCS waste impoundments have a depth of waste liquid of about 9 feet and a liner thickness of 1 foot. Then, a typical hydraulic gradient of (9+1)/1 = 10 is a reasonable assumption. To solve for an allowable specific discharge, using previous assumptions that an acceptable permeability value is 1 x 10^{-7} centimeters per second, and a hydraulic gradient of 10, substituting in the equation for ν:

$$\begin{aligned} \nu_{allowable} &= k\frac{\left(H + d\right)}{d} \\ &= 1\times10^{-7}\ cm/s \times 10 \\ &= 1\times10^{-6}\ cm/s \\ &= 0.0028\ ft/d \end{aligned}$$

However, if one assumes at least one order of magnitude of reduction in permeability will occur, the initial permeability can be 10 times greater (1 x 10^{-6} centimeters per second) and the final value for permeability will approach 1 x 10^{-7} centimeters per second after sealing. Then, an allowable initial specific discharge of will be:

$$\begin{aligned} \nu_{initial\ allowable} &= k\frac{\left(H + d\right)}{d} \\ &= 1\times10^{-6}\ cm/s \times 10 \\ &= 1\times10^{-5}\ cm/s \\ &= 0.028\ ft/d \end{aligned}$$

As noted previously, allowable specific discharge actually has units of cubic feet per square foot per day, but for convenience the units are often stated as foot per day. Note that some State or local regulations may not permit taking credit for an order of magnitude reduction in permeability resulting from manure sealing. The State or local regulations should be used in design for a specific site.

Specific discharge or unit seepage is the quantity of water that flows through a unit cross-sectional area composed of pores and solids per unit of time. It has units of $L^3/L^2/T$ and is often simplified to L/T. Because specific discharge expressed as L/T has the same units as velocity, specific discharge is often misunderstood as representing the average rate or velocity of water moving through a soil body rather than a quantity rate flowing through the soil. Because the water flows only through the soil pores, the cross sectional area of flow is computed by multiplying the soil cross section (A) by the porosity (n). The seepage velocity is then equal to the unit seepage or specific discharge, v, divided by the porosity of the soil, n. Seepage velocity = (v / n). In compacted liners, the porosity usually ranges from 0.3 to 0.5. The result is that the average linear velocity of the seepage flow is two to three times the specific discharge value. The units of seepage velocity are L/T.

(c) Design of compacted clay liners

To determine the required thickness of clay liner, rearrange the above equation for specific discharge using test values for permeability and the depth of waste liquid in the waste impoundment. Alternatively, a given value for the thickness of liner to be constructed may be assumed, and the minimum permeability required to meet a target specific discharge for the depth of waste liquid in the facility can be determined. Detailed design examples and equation derivations are shown later in this section.

Detailed design steps for clay liners

The suggested steps for design of a compacted soil liner are:

Step 1—Size the structure to achieve the desired storage requirements within the available construction limits and determine this depth or the height, H, of storage needed.

Step 2—Either estimate the permeability from the previous information showing estimated permeability values for Groups III and IV, or use the value attained in laboratory permeability tests. Field tests on compacted liners could also supply permeability design information. Use a value for allowable discharge of $v = 1 \times 10^{-5}$ centimeters per second (0.028 ft/d) if manure sealing can be credited, or 1×10^{-6} centimeters per second (0.0028 ft/d) if it is not credited. Calculate a preliminary liner thickness (d) to meet the allowable specific discharge criterion using the following equation. Derivation of the equation is shown later in this section. Terms are defined in figure 10D–1.

$$d = \frac{k \times H}{v - k}$$

Step 3—If the k value used for the liner is equal to or greater than the assumed allowable specific discharge, meaningless results are attained for d, the calculated thickness of the liner in the equation above. The allowable specific discharge goal cannot be met if the liner soils have k values equal to or larger than the assumed allowable specific discharge.

Step 4—The calculated thickness of liner required is very sensitive to the value of permeability used and the assumed allowable specific discharge value. Often, the required liner thickness can be reduced most economically by decreasing the soil permeability. Small changes in the soil liner specifications, including degree of compaction, rate of bentonite addition, and water content at compaction, can drastically affect the permeability of the clay liner soil.

Step 5—An alternative design approach is to use a predetermined desirable thickness for the liner; for example, 1 foot, and then calculate what permeability is required to meet the specific discharge target. The equation used is derived later in this section, and is as follows:

$$k = \frac{v \times d}{H + d}$$

This design approach requires that measures, such as special compaction or addition of bentonite or other soil additives, be then taken to ensure the calculated allowable permeability or a lesser value is attained.

Step 6—Cautions

The liner soil must be filter-compatible with the natural foundation upon which it is compacted. Filter compatibility is determined by criteria in NEH Part 633 (chapter 26). As long as the liner soil will not pipe into the foundation, no limit need be placed on the hydraulic gradient across the liner. Filter compatibility is most likely to be a significant problem when very coarse soil, such as poorly graded gravels and sands, occurs at a site and a liner is being placed directly on this soil.

The minimum recommended thickness of a compacted natural clay liner is 1 foot. Clay liners constructed by mixing soil dispersants or bentonite with the natural soils at a site are recommended to have a minimum thickness of 6 inches. These minimum thicknesses are based on construction considerations rather than calculated values for liner thickness requirement from the specific discharge equations. In other words, if the specific discharge equations indicate only a 7-inch thickness of compacted natural clay is needed to meet suggested seepage criteria, a 1-foot-thick blanket would still be recommended because constructing a 7-inch natural clay blanket with integrity would be difficult.

Natural and constructed liners must be protected. Natural and constructed liners must be protected against damage by mechanical agitators or other equipment used for cleaning accumulated solids from the bottoms of the structures. Liners should also be protected from the erosive forces of waste liquid flowing from pipes during filling operations.

Soil liners may not provide adequate confidence against ground water contamination if foundation bedrock relatively near the pond waste impoundment bottom contains large, connected openings, where collapse of overlying soils into the openings could occur. These bedrock conditions were discussed in detail previously. Structural liners of reinforced concrete or geomembranes should be considered because the potential hazard of direct contamination of ground water is significant.

Liners should be protected against puncture from animal traffic and roots from trees and large shrubs. The subgrade must be cleared of stumps and large angular rocks before construction of the liner.

If a clay liner is allowed to dry, it may develop drying cracks or a blocky structure and will then have a much higher permeability. Desiccation can occur during the initial filling of the waste impoundment and later when the impoundment is emptied for cleaning or routine pumping. Disking, adding water, and compaction are required to destroy this structure. A protective insulating blanket of less plastic soil may be effective in protecting underlying more plastic soil from desiccation during these exposure periods.

State and Federal regulations may be more stringent than the design guidelines given, and they must be considered in the design. Examples later in this section address consideration of alternative guidelines.

Construction considerations for compacted clay liners

(a) Thickness of loose lifts

The permissible loose lift thickness of clay liners depends on the type of compaction roller used. If a tamping or sheepsfoot roller is used, the roller teeth should fully penetrate through the lift being compacted into the previously compacted lift to achieve bonding of the lifts. A loose lift thickness of 9 inches is commonly used by NRCS specifications. If the feet on rollers cannot penetrate the entire lift during compaction, longer feet or a thinner lift should be specified. A loose layer thickness of 6 inches may be needed for some tamping rollers that have larger pad type feet that do not penetrate as well. Thinner lifts could significantly affect construction costs.

(b) Method of construction

(1) Bathtub

This method of construction consists of a continuous thickness of soil compacted up and down or across the slopes (fig. 10D–2). This construction is clearly preferable to the stair step method because inter-lift seepage flow through the sides of the excavation is less. This method also lends itself well to the thinner lifts used by NRCS. Side slopes should be 3H:1V or flatter to use this method. Shearing of the soil by the equipment on steeper slopes is a problem. To prevent shearing of the compacted soil, the slope used must be 3H:1V or flatter so that equipment will exert more normal pressure on the slope than downslope pressure.

(2) Stair step

This method of construction is illustrated in figure 10D–2. It would probably be needed for side slopes steeper than about 3H:1V. A much thicker blanket, measured normal to the slope, will result compared to the bathtub method of construction. This is a positive factor in seepage reduction, but it will probably be more expensive because of the larger volume of soil required. Another advantage of this method is that the thicker blanket reduces the impact of shrinkage

cracks, erosive forces, and potential mechanical damage to the liner. If the main concern is leakage through the bottom of the lagoon rather than the sides, the method has fewer advantages over the bathtub method. Another disadvantage of this method is that a larger volume of excavation is required to accommodate the thicker blanket.

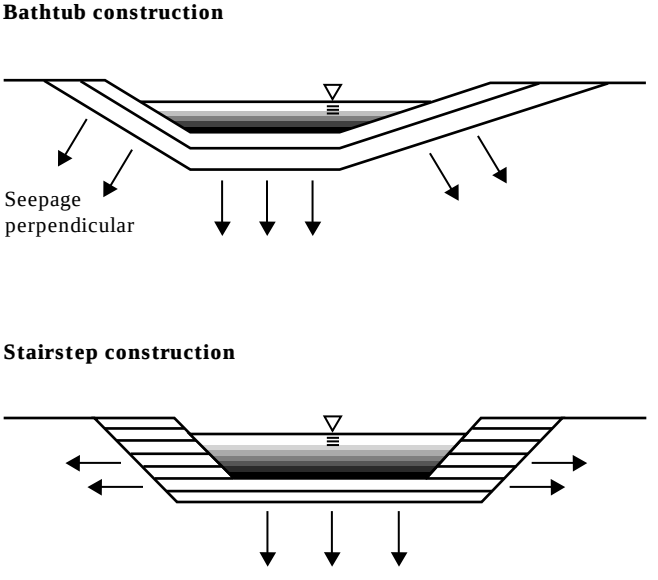
(c) Soil type

(1) Classification

Group IV soil has a plasticity index (PI) greater than 30 and is usually considered desirable. However, soil that has a PI value greater than 40 is not desirable for several reasons. Although more highly plastic clays may have very low laboratory test permeability values, these clays can develop severe shrinkage cracks. Preferential flow through the desiccated soil often results in a higher than expected permeability. Figure 10D–3 illustrates the structure that can occur with plastic clays where clods are present.

Highly plastic clays are also difficult to compact properly. Special effort should be directed to processing the fill and degrading any clods in high plasticity clays to prevent the problems illustrated with figure 10D-3.

Figure 10D–2 Methods of liner construction (After Boutwell, 1990)

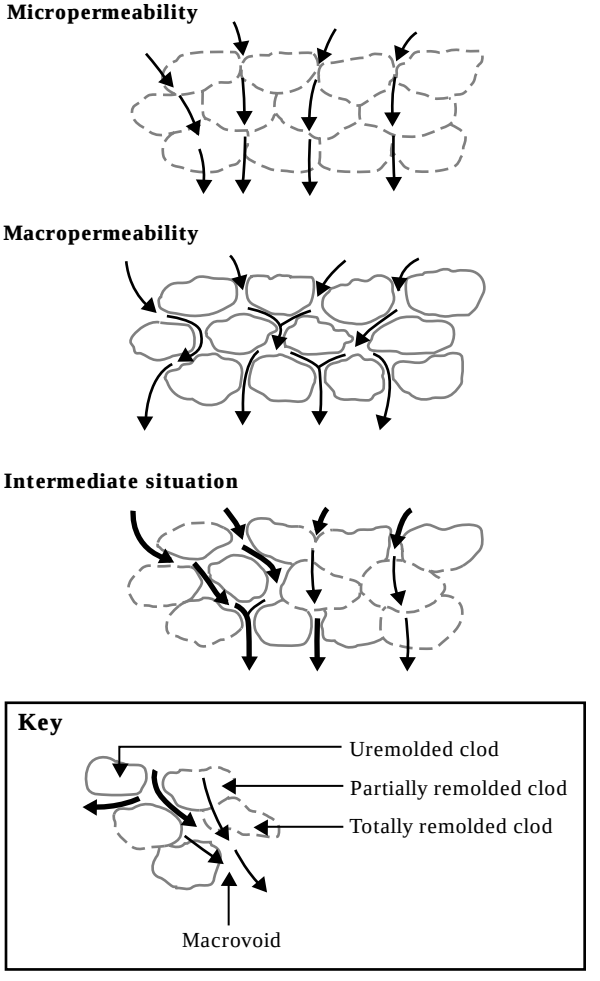


High plasticity clays may be covered with a blanket of insulating soil, such as an SM soil, to protect the liner from desiccation while the waste impoundment is being filled, particularly if filling will occur during hot, dry months.

(2) Size of clods

The size and dry strength of clay clods in soil prior to compaction have a significant effect on the final quality of a clay liner. Large, dry clods of plastic clays are extremely difficult to degrade and moisten thoroughly. High speed rotary pulverizers are sometimes needed if conditions are especially unfavorable. Adding water to the soil is difficult because water penetrates the clods slowly.

Figure 10D–3 Macrostructure in highly plastic clays with poor construction techniques (from Hermann 1987)



(d) Natural water content of borrow

(1) Dry conditions in the borrow

Dry, highly plastic clays are most likely extremely cloddy. Time must be allowed for added water to penetrate larger clods before processing. Prewetting the borrow area may reduce the severity of this problem. Because water slowly penetrates any clods, adding significant amounts of water to a plastic clay is difficult if this addition is delayed until processing on the compacted fill.

(2) Wet conditions in the borrow

If the natural water content of the borrow soil is significantly higher than optimum water content, achieving the required degree of compaction may be difficult. A good rule-of-thumb is that a soil will be difficult to compact if its natural water content exceeds about 90 percent of the theoretical saturated water content at the dry density to be attained. The following procedure can help to determine if a wet condition may be present.

Step 1—Measure the natural water content of the soil to be used as a borrow source for the clay liner being compacted.

Step 2—Measure the maximum dry density and optimum water content of the soil by the appropriate Proctor test (generally ASTM D 698, method A).

Step 3—Determine from suggestions in this guidance document, or from laboratory permeability tests, to what degree of compaction are the clay soils to be compacted (generally 90, 95, or 100 percent of maximum dry density).

Step 4—Calculate the theoretical saturated water content at the design dry density of the liner:

$$w_{sat}(\%) = \left(\frac{\gamma_{water}}{\gamma_d} - \frac{1}{G_s} \right) \times 100$$

Step 5—Calculate 90 percent of the theoretical saturated water content.

Step 6—If the natural water content of the soil is more than 1 or 2 percent wet of this calculated upper feasible water content, the clays will be difficult to compact to the design density without drying. In most cases drying clay soils simply by disking is somewhat ineffective. It would be more practical to delay construction to a drier part of the year when the borrow source is at a lower water content. In some cases the borrow area can be drained several months before construction. This would allow gravity drainage to decrease the water content to an acceptable level.

(e) Method of excavation and methods of processing

(1) Clods in borrow soil

If borrow soil is plastic clays at a low water content, it will probably have large, durable clods. Disking may be effective for some soils at the proper water content, but pulverizer machines may be required. To attain the highest quality liner, the transported fill should be processed with either a disk or a pulverizer before using a tamping roller. Equipment requirements depend on the severity of the clodiness and the water content of the soil.

(2) Placement of lifts

Preferential flow paths can be created if lifts of the clay liner are not staggered or placed in alternating directions. Continuous processing in one direction without adequate disking and bonding can also result in flow paths between lifts. Careful planning of the liner construction will avoid these problems.

(f) Macro-structure in plastic clay soils

Clods can create a macro-structure in a soil that results in higher than expected permeability because of preferential flow along the interfaces between clods. Figure 10D–3 illustrates a structure that can result from inadequate wetting and processing of plastic clay. The permeability of intact clay particles may be quite low, but the overall permeability of the mass is high because of flow between the intact particles.

(g) Dry density and optimum water content

(1) Introduction

Compaction specifications normally require a minimum dry density (usually referenced to a specified compaction test procedure) and an accompanying range of acceptable water contents (referenced to the same compaction test procedure). This method of fill specification may not be as applicable to design of clay liners. A given permeability value can be attained for many combinations of compacted density and water contents (Daniels 1990). Dry density/water combinations that result in compaction at a relatively high degree of saturation are most effective in minimizing permeability for a given soil.

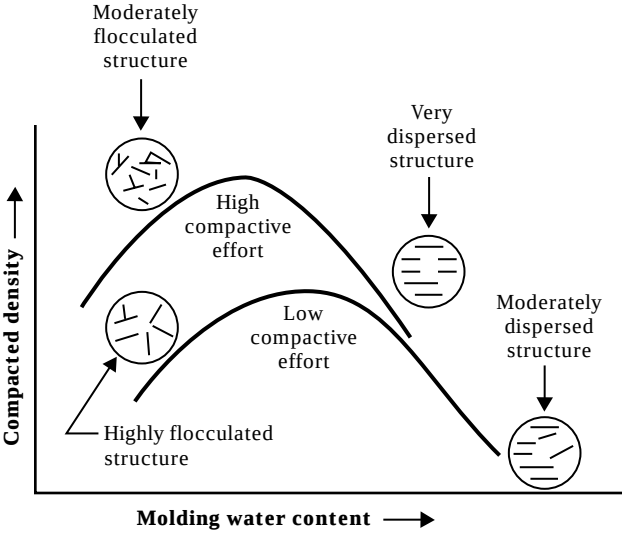
(2) Percent saturation criteria

A given value of permeability may be attained at any number of combinations of dry density and molding water content. Generally, for any given value of dry density, a lower permeability is attained if soils are compacted wet of optimum. However, many combinations of dry density and molding water content result in acceptably low permeability if the degree of saturation is high enough and a certain lower bound dry density value is met. For instance, a soil compacted at 90 percent of maximum Standard Proctor dry density at a water content 2 percent wet of optimum may have about the same permeability as a soil compacted to 95 percent of maximum Standard Proctor dry density at a water content equal to optimum water content.

Daniels (1990) describes a method of specifying combinations of dry density and water content to meet a certain permeability goal. Extensive testing may be required to establish the range of acceptable dry density and molding water content for a particular sample or site using this method. To limit soil mechanics testing complexity, generally no more than three combinations of dry density and placement water content are investigated to arrive at a design recommendation. More detailed analyses are usually reserved for large sanitary landfills or hazardous waste sites.

Figure 10D–4 shows how a different structure results between soils compacted wet of optimum and those compacted dry of optimum water content. It also illustrates that soils compacted with a higher compactive effort or energy have a different structure than those compacted with low energy.

Figure 10D–4 Effect of water content and compactive effort on remolding of soil structure in clays (from Lambe 1958)



(h) Energy level of compaction

The relationship of maximum dry density and optimum water content varies with the compactive energy used to compact a soil. Higher compactive energy results in higher values of maximum dry unit weight and lower values of optimum water content. Lower compactive energy results in lower values of maximum dry unit weight and higher values of optimum water content. Because optimum water content varies with the energy used in compaction, its nomenclature can be misleading. The optimum water content of a soil is actually for the particular energy used in the test to measure it.

Compactive energy is a function of the weight of the roller used, the thickness of the lift, and the number of passes of the roller over each lift. Rollers must be heavy enough to cause the teeth on the roller to penetrate or almost penetrate the compacted lift. Enough passes must be used to attain coverage and break up any clods. As such, additional passes cannot be used to compensate for rollers that are too light for the job.

Roller size is often specified in terms of contact pressure exerted by the feet on tamping rollers. Light rollers have contact pressures less than 200 pounds per square inch, while heavy rollers have contact pressures greater than 400 pounds per square inch.

Limited data are available for various sizes of equipment to correlate the number of passes required to attain different degrees of compaction. Typically, from 4 to 8 passes of a tamping roller with feet contact pressures of 200 to 400 pounds per square inch are required to attain degrees of compaction of from 90 to 100 percent of maximum Standard Proctor dry density. However, this may vary widely with the soil type and weight of roller used. Specific site testing should be used when possible.

(i) Equipment considerations

(1) Size and shape of teeth on roller

Tamping rollers should have teeth that protrude an appreciable distance from the drum surface, as the older style sheepsfoot rollers do. The newer types of tamping rollers have square pads that do not protrude far from the drum surface. They appear less desirable than the older style rollers because less bonding and destruction of clay clods probably result.

(2) Total weight of roller

To attain penetration of the specified loose lift, the roller weight must be appropriate to the specified thickness and the shape of the roller teeth. Many modern rollers have contact pressures that are too great to compact soils appreciably wet of optimum water content. When the specified compaction water content is approaching 90 percent theoretical saturation at the specified dry density, lighter rollers are essential. Permeability of clays is minimized by compaction at water contents wet of optimum.

(3) Speed of operation

Heavy rollers operated at excessive speed can shear the soil lifts being compacted. This can result in higher permeability. Close inspection of construction operations should indicate when this problem occurs, and adjustments to equipment or the mode of operation should then be made.

(4) Vibratory versus nonvibratory

Vibratory type tamping rollers appear to have few advantages in constructing clay liners. These rollers may be counterproductive when the base soil is saturated and lower in plasticity because the vibration can induce pore pressures in the underlying base soil and create free water. Smooth-wheeled vibratory rollers should never be used in compacting clay liners. They are suitable only for relatively clean, coarse-grained soil.

Design and construction of bentonite clay liners

Some waste impoundment sites may not have soils within a practical distance that are suitable to serve as a clay liner. When this is the situation, there are generally two alternatives:

- Construct a synthetic liner.
- Import bentonite for treating the in situ soil on the sides and bottom of the impoundment.

(a) Bentonite type and quality

Bentonite is a volcanic clay that swells to about 15 times its original volume when placed in water. There are a number of bentonite suppliers, primarily located in the Western States. A sodium type bentonite should be used for constructing bentonite treated liners for waste impoundments. Another type of bentonite, calcium bentonite, should not be used. For bentonite to be suitable for use in constructing a liner for a waste impoundment, it must have two important qualities. One quality is that it possess a minimum level of activity or the ability to swell. The other quality bentonite must possess is an appropriate fineness.

The two primary ways of determining if a bentonite under consideration has an adequate level of activity are:

- Determine its level of activity based on its Atterberg limit values as determined in a soil testing laboratory. High quality sodium Wyoming bentonite has LL values greater than 600 and PI values greater than 550.
- Determine its level of activity based on a test of its free swell. Bentonite should have a free swell of at least 22 mL as measured by ASTM Standard Test Method D 5890. A brief summary of the free swell test follows. However, the ASTM Standard Test Method should be reviewed for detailed instructions on performing the test.
  - — Prepare a sample for testing that consists of material from the total sample that is finer than a #100 sieve with at least 65 percent finer than a #200 sieve.
  - — Add 90 mL of distilled water to a 100 mL graduated cylinder.
  - — Add 2 grams of bentonite in small increments to the cylinder. The bentonite will sink to the bottom of the cylinder and swell as it hydrates.
  - — Rinse any particles adhering to the sides of the cylinder into water while raising the water volume to the 100 mL mark.
  - — After 2 hours, inspect the hydrating bentonite column for trapped air or water separation in the column. If present, gently tip the cylinder at a 45 degree angle and roll slowly to homogenize the settled bentonite mass.
  - — After 16 hours from the time the last of sample was added to the cylinder, record the volume level in milliliters at the top of the settled bentonite. Record the volume of free swell, for example, 22 milliliters free swell in 16 hours.

Bentonite is furnished in a wide range of particle sizes for different uses including clarification of wine. Fineness provided by the bentonite industry ranges from very finely ground, almost like face powder, to a granular form, with particles about the size of a #40 sieve. Laboratory permeability tests have shown that even though the same quality of bentonite is applied at the same volumetric rate to a sample, a dramatic difference in the resulting permeability can occur between a fine and a coarse bentonite. It is important to specify the same quality and fineness as was used by the soils laboratory for the permeability tests to arrive at recommendations. An appropriate fineness for use in treating liners for waste impoundment can be obtained specifying an acceptable bentonite by supplier and designation. An example specification is Wyo Ben type Envirogel 200, CETCO type BS-1, or equivalent.

(b) Design details for bentonite liner

The criteria given in NRCS Practice Standard, 521C, Pond Sealing or Lining, Bentonite Sealant, requires a 4-inch-thick bentonite treated layer for water depths in the impoundment of 8 feet or less. The criteria infers that a thicker liner should be used for deeper impoundments. Although not directly stated in the standard, the thickness of the liner should be proportional to the head of water in the impoundment for depths of

more than 8 feet. For waste impoundment liners, a minimum thickness liner of 6 inches is recommended for constructibility.

The design procedure using the laboratory permeability k value of treated samples is the preferred method to arrive at a required liner thickness. This procedure uses the depth of liquid in the impoundment, the k value of the treated soil, and an allowable seepage rate. The procedure is covered in the examples in this appendix. The calculated thickness is recommended unless it is less than 6 inches; then, the minimum thickness liner would be used regardless.

Consideration should be given to providing a soil cover over the bentonite treated compacted liner in waste impoundments. There are several reasons why a soil cover should be provided:

- The potential for desiccation cracking of the liner on the side slopes may occur during periods when the impoundment is drawn down for waste utilization or sludge removal. Desiccation cracking would significantly change the permeability of the liner. Rewetting generally does not completely heal the cracks.
- The potential for erosion of the thin bentonite treated liner that could occur during periods when the impoundment has been drawn down. Rilling due to rainfall on the exposed slopes can also seriously impair the water tightness of the liner.
- Over excavation by mechanical equipment during sludge removal. A minimum thickness of 6 inches measured normal to the slope and bottom is recommended for a protective cover. The protective cover should be compacted to reduce its erodibility.

(c) Construction specifications for bentonite liner

The best equipment for compacting bentonite treated liners is rubber-tired or smooth wheeled steel rollers, or crawler tractor treads. Practice Standard 521-C specifies that for mixed layers, the material shall be thoroughly mixed to the specified depth with disk, rototiller, or similar equipment. In addition, intimate mixing of the bentonite is essential to constructing an effective liner. If a standard disk is used, several passes should be specified. A high speed rototiller as is used on lime treated earthfills is the best method of obtaining the desired mix. A minimum of two passes of the equipment is recommended to assure good mixing.

Another construction consideration is the moisture condition of the subgrade into which the bentonite is to be mixed. Unless the subgrade is somewhat dry, the bentonite will most likely ball up and be difficult to thoroughly mix with the underlying soils. Ideally, bentonite should be spread on a relatively dry subbase, mixed thoroughly with the native soil, then watered and compacted.

A sheepsfoot or tamping type of roller should not be used for compacting a bentonite treated liner. Dimples in the surface developed by these rollers cause the effective liner thickness to be significantly less than planned.

Other construction considerations are also important. For some equipment, tearing of the liner during compaction can occur on slopes even as flat as 3:1. On the other hand, compacting along rather than up and down the slopes could be difficult on slopes as steep as 3:1. For some sites, slopes as flat as 3.5:1 or 4:1 should¸' considered for this factor alone.

A design may occasionally call for a liner thickness of more than 6 inches. A 6-inch-thick liner can probably be satisfactorily constructed in one lift, mixing in the required amount of bentonite to a 9-inch-thick loose depth, and then compacting it to the suggested 6 inches. Thicker liners should be constructed in multiple lifts, with the final compacted thickness of each lift being no greater than 6 inches. For instance, to construct an 8-inch-thick liner, use two 4-inch-thick compacted lifts.

Design and construction of clay liners treated with soil dispersants

The *Permeability of soils* section cautions that soils in Group III containing high amounts of calcium may be more permeable than indicated by the percent fines and PI values. Group III soils predominated by calcium require some type of treatment to serve as an acceptable liner. The most prevalent method of treatment to reduce the permeability of these soils is use of a soil dispersant additive containing sodium in some form.

(a) Types of dispersants

The dispersants most commonly used to treat high calcium clays are soda ash (Na_2CO_3), TSPP (tetrasodium pyrophosphate), and STPP (sodium tetra phosphate). Common salt (NaCl) has been used, but it is considered less long-lasting than the other chemicals. All these dispersants may be obtained from commercial suppliers. NRCS experience has shown that usually about twice as much soda ash is required to effectively treat a given clay than the polyphosphates. However, because soda ash may be less than half as expensive, it may be the most economical choice in many applications.

(b) Design details for dispersant treated clay liner

The criteria given in NRCS Practice Standard, 521B, Pond Sealing or Lining, Soil Dispersant, requires a 6-inch-thick dispersant treated layer for water depths in the impoundment of 8 feet or less. The criteria infers that a thicker liner should be used for deeper impoundments. Although not directly stated in the standard, the thickness of the liner should be proportional to the head of water in the impoundment for depths of more than 8 feet. To illustrate, for a liquid depth of 12 feet, a minimum liner thickness of one and one-half the minimum thickness should be used. For waste impoundment liners, a minimum thickness liner of 6 inches is recommended for constructibility.

Design procedures using the laboratory permeability k value of treated samples are the preferred method to arrive at a required liner thickness, using the depth of liquid in the impoundment, the k value of the treated soil, and an allowable seepage rate. Laboratories should be requested to perform trials with various amounts of a given additive to determine the most economical design. This procedure is covered in the examples in this appendix. The calculated thickness is recommended unless it is less than 6 inches, then the minimum thickness liner would be used regardless.

For planning purposes, the information given in NRCS Practice Standard, 521B, Pond Sealing or Lining, Soil Dispersant, may be used to determine approximate amounts of dispersants that will be required. Preliminary estimates given for soda ash are 10 to 20 pounds per 100 square feet (mixed into a compacted 6-inch layer). For STPP or TSPP, 5 to 10 pounds per 100 square feet is recommended.

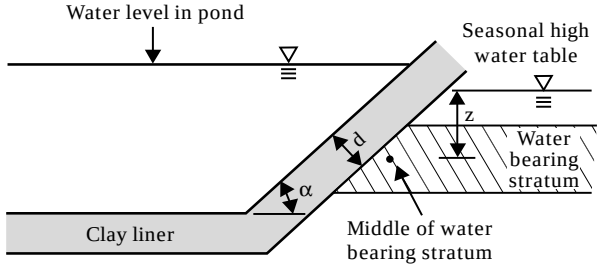
(c) Construction specifications for dispersant treated clay liner

The best equipment for compacting clays treated with dispersants is a sheepsfoot or tamping type of roller. Practice Standard 521-B specifies that the material shall be thoroughly mixed to the specified depth with disk, rototiller, or similar equipment. Because small quantities of soil dispersants are commonly used, intimate mixing of the dispersants is essential to constructing an effective liner. If a standard disk is used, several passes should be specified. A high speed rototiller as is used on lime treated earthfills is the best method of obtaining the desired mix. A minimum of two passes of the equipment is recommended to assure good mixing.

Other construction considerations are also important. For some equipment, tearing of the liner during compaction can occur on slopes even as flat as 3:1. On the other hand, compacting along rather than up and down the slopes could be difficult on slopes as steep as 3:1. For some sites, slopes as flat as 3.5:1 or 4:1 should be considered for this factor alone.

A design may occasionally call for a liner thickness greater than 6 inches. A 6-inch-thick liner generally can be satisfactorily constructed in one lift by mixing in the required amount of soil dispersant to a 9-inch-thick loose depth and then compacting it to the 6 inches. Thicker liners should be constructed in multiple lifts, with the final compacted thickness of each lift being no greater than 6 inches. For instance, to construct an 8-inch-thick liner, use two 4-inch thick compacted lifts.

Figure 10D–5 Uplift calculations for high water table (from Oakley 1987)



Uplift pressures beneath clay blankets

In some situations a clay blanket is subject to uplift pressure from a seasonal high water table in the foundation soil behind or beneath the clay liner. The uplift pressure in some cases can exceed the weight of the clay liner, and failure in the clay blanket can occur. This problem can occur particularly during the period before the waste impoundment is filled and during periods when the impoundment may be emptied for maintenance and cleaning. Figure 10D–5 illustrates the parameters involved in calculating uplift pressures for a clay blanket. The most critical condition for analysis typically occurs when the pond is emptied. Thicker blankets may be needed to attain satisfactory safety factors.

The safety factor against uplift is the ratio of the pressure exerted by a column of soil to the pressure of the ground water under the liner. It is given by the equation:

$$FS = \frac{\gamma_{sat} \times d \times \cos(\alpha)}{z \times \gamma_{water}}$$

where:

- d = Thickness of liner, measured normal to the slope
- α = Slope angle
- γ_w = Unit weight or density of water
- γ_{sat} = Saturated unit weight of clay liner
- z = Vertical distance from middle of water bearing stratum to the seasonal high water table

A safety factor of at least 1.1 should be attained. The safety factor can be increased by using a thicker blanket or providing some means of intercepting the ground water gradient and lowering the potential head behind the blanket.

Soil mechanics testing

(a) Sample size needed for testing

Laboratory soil testing may be required by regulations for design, or a designer may not be comfortable relying on correlated permeability test values. The NRCS National Soil Mechanics Center Laboratories have equipment and the ability to perform the necessary tests. Similar testing is also available at many commercial labs. Allow 3 to 4 weeks for obtaining gradation and Atterberg limits, and 6 to 8 weeks for permeability and sealing tests results. Contact the labs for more detailed information on documentation needed and for procedures for submitting samples.

Sample size based on percent gravel content for gradation analysis and Atterberg Limit only should be as follows:

Estimated gravel content of the sample 1/ (%)	Sample moist weight (lb)
0 – 10	5
10 – 50	20
> 50	40

1/ The sample includes the gravel plus the soil material that passes the No. 4 sieve (approx. 1/4 inch mesh).

Sample size based on percent gravel content for gradation analysis, Atterberg Limits, and for compaction and permeability testing should be as follows:

Estimated gravel content of the sample 1/ (%)	Sample moist weight (lb)
0 – 10	50
10 – 50	75
> 50	100

1/ The sample includes the gravel plus the soil material that passes the No. 4 sieve (approx. 1/4 inch mesh).

If designs rely on a minimum degree of compaction and water content to achieve stated permeability goals in a clay liner, testing of the clay liner during construction may be advisable to verify that design goals have been achieved. Field density and water content measurements are routinely made using procedures shown in NEH Part 646 (section 19), Construction Inspection.

(b) Factors in laboratory permeability testing for clay liners

Laboratory permeability testing is often used for design of compacted clay liners. The following sections describe factors that are important in laboratory testing and in writing construction specifications. However, the clay liner must be constructed properly for these laboratory tests to reflect accurately the actual permeability of the completed liner. Previous sections discuss many additional construction considerations.

(1) Placement dry density or degree of compaction

For a given soil, many different combinations of dry density and molding water content can result in an acceptable permeability value. For a given value of molding water content, increasing the degree of compaction will usually reduce the permeability. Degree of compaction is the percentage of the soil's maximum Standard Proctor dry density. Specimens remolded to a higher density, at the same water content, will have a lower permeability than specimens remolded to a lower density. The following table summarizes test data from an NRCS laboratory that illustrates this:

Percent maximum γ_d	Water content referenced to optimum	k value (cm/s)
90.1	Optimum + 1.7 %	9.6×10^{-6}
95.1	Optimum + 1.7 %	3.4×10^{-6}
100.1	Optimum + 1.7 %	6.0×10^{-8}

Compacting a soil to a higher degree is usually more economical than including additives, if compaction achieves the required permeability. However, some soils cannot be compacted sufficiently to create a satisfactorily low permeability. Then, additives are the only choice. Both the cost of additives and the cost of application must be considered in comparisons. One must also include the cost of quality control in verifying a higher degree of compaction when comparing this alternative.

The minimum degree of compaction that one should consider for clay liners is 90 percent. Usually, this degree of compaction is easily obtained if thin lifts are used and the water content is in the proper range. This degree of compaction may not require specialized compaction equipment for many soils.

The maximum degree of compaction that one should usually consider for clay liners in NRCS designs is 100 percent of Standard Proctor dry density. This degree of compaction is achievable, but for clay soils, probably only by using sheepsfoot or tamping rollers. For a bentonite treated liner, pneumatic rollers may be preferable. While achieving a degree of compaction higher than 100 percent of Standard Proctor dry density is possible, specifying higher values is not common. An intermediate degree of compaction that is commonly specified is 95 percent of maximum Standard Proctor dry density.

(2) Molding water content

Usually, for a given value of dry density or degree of compaction, increasing the molding water content will reduce the permeability. The following summary of tests performed at an NRCS Laboratory illustrates this point:

Percent maximum γ_d	Water content + or - optimum	k value cm/s
95	Optimum - 2 %	4.0×10^{-4}
95	Optimum	5.0×10^{-5}
95	Optimum + 2 %	9.0×10^{-6}

The in situ water content of borrow soils should be carefully considered in a preliminary design for a compacted clay liner. One should know what construction equipment is commonly available. If the in situ water content of borrow soils is high, compacting soils to a high degree may be impractical. If the in situ water content of borrow soils is low, it may be easier to compact the soils to a higher degree and require less water to be added during construction.

A previous section of appendix 10D includes steps for determining the upper water content at which a given dry density is achievable. The highest placement water content that one should consider for a given degree of compaction, or dry density, corresponds to 90 to 95 percent of theoretical saturated water content. Compaction of soils results primarily from expulsion of air from the soil voids. Expelling the last 5 to 10 percent of air in soils with significant fines content by compaction is difficult. Even repeated applications of energy seldom result in increased degrees of saturation when soils are very wet. Example 10D-6 illustrates calculations.

Most clay liners should be compacted at optimum water content or wetter to minimize permeability. However, for high degrees of compaction, allowing placement at 1 to 2 percent dry of optimum may be necessary to allow some range in placement water contents and give flexibility to contractors' operations. Laboratory tests should usually consider the least favorable conditions in evaluating permeability for conservatism.

It must be possible to attain the required degree of compaction over a range of placement water contents. If the specified minimum placement water content is near 90 percent saturation at the required dry density, there will be little flexibility in obtaining the required dry density during construction. Specifications should enable the desired densification to be obtained within a range of 2 to 4 percent in placement water contents. Specifications cannot require both a high degree of compaction and a high placement water content and be practical. Example 10D-5 illustrates calculations.

(3) Soil Additives - Bentonite

It may be obvious for a given soil that an acceptably low permeability cannot be obtained by compaction alone. An example is a sand with relatively low fines content. For other soils, usually clays with a high calcium content, it may not be immediately obvious that compaction alone will be inadequate. For either case, if soil additives are needed, the following guidelines should be considered.

- Sodium bentonite should be the additive selected to be investigated if the soil has a low percentage of fines, less than 50 percent, or, if the soil has low plasticity fines (PI less than about 7). NRCS Conservation Practice Standard 521C suggests that bentonite should be used for soils with less than 50 percent fines. The Standard shows preliminary application rates, as follows:

Soil type	Application rate, lb/ft^2
Silty sand	1.5 - 2.0
Clean sand	2.0 - 2.5

The rate given is based on the bentonite being mixed and compacted into a finished layer that is 4 inches thick. Then, a volumetric rate, in pounds per cubic feet, would be triple the rate given in the table.

- The quality and fineness of bentonite used for laboratory permeability testing is important. Previous sections of appendix 10D also discuss quality of bentonite. The bentonite used for laboratory tests should be comparable to that which will be used in construction. Bentonite processors furnish bentonite in a range of particle sizes, ranging from very finely ground, with most of the particles finer than the #200 sieve, to granular bentonite, with most of the particles larger than about the #40 sieve. NRCS laboratories have found a significant difference in permeability between specimens prepared using the same application rate of the fine compared to the coarse bentonites, for some soils.
- Each grade of bentonite has its advantages. The very finely ground bentonite usually is more effective in reducing permeability. However, the material is prone to dusty conditions during construction, and may ball up when applied to a wet sub-grade. The coarsely ground bentonite is easier to spread and mix, but may require a higher application rate to achieve a given target permeability.
- Permeability tests to evaluate bentonite should assumine a relatively low degree of compaction, usually no more than 95 percent of maximum Standard Proctor dry density. At least 2 or 3 tests should be requested, to determine the minimum quantity of bentonite required to obtain the desired permeability. A range of bentonite application rates of from 0.5 to 2.5 pounds per square foot (mixed into a compacted 4 inch layer), equivalent to1.5 to 7.5 pounds per compacted cubic foot, should be considered.
- The following example test results were obtained in a test on a relatively clean sand in an NRCS laboratory

Test γ_d % max	Test w % ref. to opt.	Additive type	Additive rate lb/ft^2	k cm/s
90	Opt + 1.5 %	Fine Bentonite	0.5	3.5×10^{-4}
90	Opt. + 1.8 %	"	1.0	5.5×10^{-7}
90.1	Opt. + 2.0 %	"	1.5	9.6×10^{-8}

(4) Soil additives - dispersants.

A soil dispersant should be selected for the additive to be investigated if the soil has more than about 50 percent fines, if the soil has at least 15 percent clay content (percent finer than 2 microns), and has a PI value of 7 or higher. Soil dispersants are usually considered when previous tests or experience in an area show that compaction alone will not produce a satisfactorily low permeability. The two preferred types of soil dispersant chemicals are soda ash (Na_2CO_3) and sodium polyphosphate (STPP or TSPP). Recommended preliminary application rates are as follows:

Dispersant type	Application rate, lb/100 ft^2
Soda ash	10–20
Polyphosphates	5–10

- The stated application rate is based on the given amount of dispersant being mixed and compacted into a finished layer that is 6 inches thick. Then, a rate, in pounds per cubic feet, would be double the rate given in the above table.
- Either soda ash or polyphosphates are most commonly used. About twice as much soda ash is required to produce a given permeability, other factors being equal, than polyphosphates. However, if the product cost of soda ash is less than half that of polyphosphates, or it is more readily available, then soda ash should be selected. The cost of application and incorporating the additive into the soil should be the same for both chemicals. NRCS laboratories have supplies of either of these soil dispersants, and it is not necessary to provide supplies for testing when this option is being explored.
- Permeability tests using soil dispersants should be performed for a range of assumed degrees of compaction, probably in the range of 90 to 100 percent of maximum Standard Proctor dry density. At least two or three tests should be requested, to determine the minimum quantity of dispersant required to obtain the desired permeability. A range of dispersant application rates of from 5 to 20 pounds per 100 square feet (mixed into a compacted 6-inch layer), or from 0.1 to 0.4 pounds per compacted cubic foot, should be considered.

- The following example test results were obtained in a test on a CL soil in an NRCS laboratory

Test γ_d % max	Test w % ref. to opt.	Additive type	Additive rate lb/100 ft^2	k cm/s
94.8	Opt. + 2.0 %	None	**	4.9 x 10^{-6}
99.9	Opt. + 2.0 %	None	**	1.6 x 10^{-6}
95.0	Opt. + 2.0 %	Soda Ash	10	2.5 x 10^{-6}
95.0	Opt. + 2.0 %	Soda Ash	15	9.5 x 10^{-8}

(5) Construction quality control and procedures

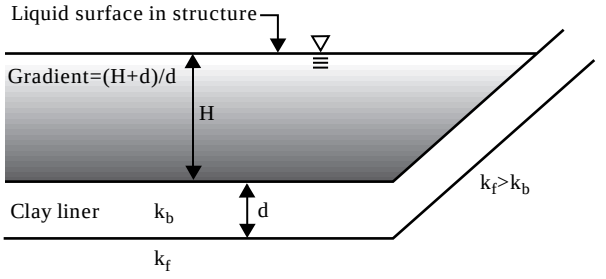
One should consider which construction equipment and methods are commonly available when selecting combinations of dry density and molding water in the design of clay liners. Some of these considerations are summarized as follows. The discussion specifically applies to Standard Proctor compaction (ASTM D698). Different guidelines would apply to designs using Modified Proctor (ASTM D1557) compaction tests.

- It may be difficult to obtain a degree of compaction greater than about 90 percent for many clay soils unless a sheepsfoot or tamping type roller, together with thin lifts is employed. If laboratory tests show that 95 or 100 percent of Proctor dry density is required to obtain a satisfactorily low permeability, plans should require this equipment for the clay liner construction.
- It will usually be more economical to specify a lower degree of compaction and a higher water content, unless the in situ water content of borrow soils is low, and water must be incorporated prior to compaction. If the in situ water content of borrow soils is excessive, it may be impossible to achieve higher degrees of compaction, as detailed in previous sections.
- The field quality control testing effort required to verify that soils are compacted to a higher degree must be considered. Achieving 90 percent of maximum Standard Proctor dry density is relatively easily accomplished, and observations of construction operations may be sufficient verification. Using thin lifts and thorough coverage of the equipment usually results in this degree of compaction. Higher degrees of compaction, greater than 90 percent, are more difficult to achieve, and field quality control testing probably should be a part of documentation. Qualified personnel and appropriate testing equipment are necessary for this effort.
- In the absence of previous experience in an area, the following initial trials are suggested for laboratory permeability tests. Some of these trials may not be necessary, or other trials should be assigned if factors dictate.

Degree of compaction	Placement water content ref. to opt.
90	Opt. + 3
95	Opt. + 2
100	Opt. or Opt. + 1

Exhibit 10D–1 Derivation of equations

Definition sketch for clay liner in waste storage pond or treatment lagoon



where:

H = Head of waste liquid in waste impoundment
k_f = Permeability of foundation
d = Thickness of liner
k_b = Permeability of liner

Derivation of equation for calculating required thickness of liner

Using the equation for specific discharge, ν

$$\nu = \frac{\left[k \times \left(H + d\right)\right]}{d} \qquad [8a]$$

The units for specific discharge in the English system are cubic feet per square foot per day. The coefficient of permeability, k, also has units of cubic feet per square foot per day. These units are usually simplified to units of feet per day. Using metric units, specific discharge and the coefficient of permeability are generally expressed in cubic centimeters per square centimeter per second, simplified to centimeters per second. Units for H and d cancel, but the same basic units should be used as used for permeability to reduce confusion (either feet or centimeters).

Then:

$$\nu = \frac{\left[\left(k \times H\right) + \left(k \times d\right)\right]}{d} \qquad [8b]$$

$$\nu \times d = \left(k \times H\right) + \left(k \times d\right) \qquad [8c]$$

$$\left(\nu \times d\right) - \left(k \times d\right) = k \times H \qquad [8d]$$

$$d \times \left(\nu - k\right) = k \times H \qquad [8e]$$

$$d = \frac{\left(k \times H\right)}{\left(\nu - k\right)} \qquad [8f]$$

Exhibit 10D–1 Derivation of equations—Continued

Derivation of equation for calculating required permeability of liner

To solve for the required k value, given an allowable specific discharge, a liner thickness, and a height of waste liquid in the impoundment, begin with equation 8d:

$$(v \times d) - (k \times d) = k \times H \qquad [8d]$$

$$(v \times d) = (k \times H) + (k \times d) \qquad [9b]$$

$$v \times d = k(H + d) \qquad [9c]$$

$$k = \frac{v \times d}{(H + d)} \qquad [9d]$$

Example 10D–1 Example calculations for required minimum thickness of compacted soil liner

Given: Site design has resulted in a required depth of waste liquid, H, in the constructed waste impoundment of 12 feet. A soil sample was obtained and submitted to a soil mechanics laboratory for testing. A permeability test on a sample of proposed clay liner soil resulted in a permeability value of 3.0×10^{-7} centimeters per second (0.00085 ft/d) for soils compacted to 95 percent of maximum Standard Proctor dry density. Another test on a sample compacted to 90 percent of maximum density resulted in a measured k value of 6×10^{-6} centimeters per second (0.017 ft/d).

Assume: Allowable specific discharge of 1×10^{-5} centimeters per second (0.028 ft/d) is satisfactory because manure sealing will produce an order of magnitude reduction in permeability.

Solution:

Step 1: Design a liner assuming soils are to be compacted to 95 percent of maximum Standard Proctor dry density. It is given that the k value at this density is 0.00085 foot per day. Calculate the required minimum thickness of compacted liner as follows:

The equation for required d is:

$$d = \frac{k \times H}{v - k}$$

Using English system units, substituting the given values for H and k, assuming an allowable specific discharge, v, of 0.028 foot per day, then

$$d = \frac{0.00085 \times 12}{0.028 - 0.00085}$$

$$d = 0.38 \text{ ft.}$$

A 1-foot-thick minimum thickness is suggested for a soil liner because thinner clay liners are difficult to construct with confidence.

Step 2: For the case of the liner being compacted to about 90 percent of maximum density, the calculated required d, using a given value for k at this density of 0.017 foot per day and the given value of H of 12 feet, is:

$$d = \frac{k \times H}{v - k}$$

$$d = \frac{0.017 \times 12}{0.028 - 0.017}$$

$$d = 18.5 \text{ ft}$$

Conclusion: The final calculation shows that the design based on 90 percent degree of compaction results in a liner thickness that is impractical. Other options could be explored for reducing the permeability including compaction at higher water contents. Including provisions for extra effort in attaining the required 95 percent of maximum density or adding extra water in compaction generally is far more economical than using thick liners. Sheepsfoot rollers would probably be required to attain 95 percent of maximum Standard Proctor dry density for a clay soil.

Example 10D–2 Example calculations for required minimum thickness of compacted soil liner

Given: Site design has resulted in a required depth of waste liquid, H, in the constructed waste impoundment of 10 feet. A soil sample was obtained and submitted to a soil mechanics laboratory for testing. Based on Atterberg limits and gradation analyses, the soil to be used for a liner is in Group III. Based on guidance following table 10D–2, a soil in Group III if compacted to at least 90 percent of maximum dry density will probably have a permeability value of 0.0028 foot per day or less. Assume that an allowable specific discharge of 0.028 foot per day is satisfactory.

Solution: Calculate the required minimum thickness of compacted liner assuming that the above information is accurate. The equation for required d is:

$$d = \frac{k \times H}{v - k}$$

Using English system units, then

$$d = \frac{0.0028 \times 10}{0.028 - 0.0028}$$

$$d = 1.2\,\text{ft}$$

A 1.2-foot minimum thickness would be used for this liner.

Example 10D–3 Example calculations for required minimum thickness of compacted soil liner

Given: Site design has resulted in a required depth of waste liquid, H, in the constructed waste storage pond impoundment of 9 feet. A soil sample was obtained and submitted to a soil mechanics laboratory for testing. Based on Atterberg limits and gradation analyses, the soil to be used for a liner is in Group I. Laboratory tests show that if bentonite is added to the soil at the rate of 3 pounds per square foot, mixed into a 4-inch-thick compacted layer, that a coefficient of permeability of 5.0 x 10^{-7} centimeters per second is achievable.

Determine: Minimum required thickness of the bentonite treated liner assuming that an allowable specific discharge of 0.028 foot per day is satisfactory.

Solution: Calculate the required minimum thickness of compacted liner.
Convert the stated coefficient of permeability of the liner to feet per day. The conversion from centimeters per second to feet per day is:

$$\frac{1\,\text{cm}}{\text{s}} \times \frac{86,400}{1\,\text{d}} \times \frac{1\,\text{ft}}{30.48\,\text{cm}} = 2,835\,\text{ft/d}$$

$$5 \times 10^{-7}\,\text{cm/s} \times 2,835 = 0.0014\,\text{ft/d}$$

The equation for required d is:

$$d = \frac{k \times H}{\nu - k}$$

Using English system units, then

$$d = \frac{0.0014 \times 9}{0.028 - 0.0014}$$

$$d = 0.47\,\text{ft}$$

Based on previous material, a 6-inch minimum thickness would be used for this liner, but only because it is a bentonite treated material. Otherwise, a compacted soil liner would require a minimum thickness of 1 foot.

Example 10D–4 Example calculations for required permeability of compacted soil liner

Given: The information is the same as that for example 10D–3 except it is given that a particular policy or regulation does not permit taking credit for a 1 order of magnitude reduction in permeability for manure sealing. The assumed value for allowable specific discharge then becomes 1×10^{-6} centimeter per second, or 0.0028 foot per day. Assume the same permeability value as that in example 10D–3.

Solution: The equation for required d is:

$$d = \frac{k \times H}{v - k}$$

Using English system units, then

$$d = \frac{0.0014 \times 9}{0.0028 - 0.0014}$$

$$d = 9\,\text{ft}$$

Because this is an impractical design, the value of permeability that would be required to attain a more realistic design would be of interest. The above equation can be rearranged to solve for k, given values for specific discharge, H, and an assumed liner thickness. The rearranged equation is show as follows:

$$k = \frac{v \times d}{H + d}$$

If a realistic liner thickness of 1 foot is assumed, use this equation to determine the required coefficient of permeability for a bentonite/soil mixture.

$$k = \frac{1 \times 0.0028}{1 + 9}$$

$$k = 0.00028$$

A designer could then work with a soil testing laboratory to determine the amount of bentonite and the degree of compaction required to attain this k value

Example 10D-5 Example calculations for upper placement water content of compacted soil liner

This example assumes that a soil to be used for constructing a clay liner has a maximum dry density of 113.0 pcf and an optimum water content of 14.5 percent. The specific gravity of the soil solids, Gs, is 2.68. Assume that the soil will be compacted to 90 percent of maximum Standard Proctor dry density. Determine the following:

(a) The minimum acceptable dry density

$$\gamma_{d\,min} = 0.9 \times 113.0 \text{ pcf} = 101.7 \text{ pcf}$$

(b) The upper limit of water content at which a soil can be compacted to this dry density.

(1) First, calculate the saturated water content at this dry density:

$$w_{sat} = \left(\frac{\gamma_{water}}{\gamma_d} - \frac{1}{G_s} \right) \times 100$$

$$w_{sat} = \left(\frac{62.4}{101.7} - \frac{1}{2.68} \right) \times 100 = 24.0\%$$

(2) A good rule of thumb is that soils are difficult to compact if the water content exceeds 90 percent of the theoretical saturated water content. Determine the water content that is 90 percent of the saturated water content is 0.9 x 24.0 % = 21.6%.

(3) Then if soils in the borrow are much wetter than 21.6 % water content, it will be difficult to obtain the required compaction.

(c) Assume that permeability tests show the soil should be compacted at least at a water content 3 percent wet of optimum. Then, what is the minimum water content permissible, and, given the solution above, what is the range in practical placement water content for this situation.

(1) The minimum water content is 3 percent wet of optimum, and optimum water content is 14.5 percent, so the minimum acceptable water content is 17.5 percent. The wettest the soil can be compacted to the required degree is 21.6 percent from the previous step. Then, the range of water content within which the specifications can be met is from 17.5 to 21.6 percent, a range of about 4 percent. This gives adequate flexibility during construction. Similar computations for considering placement of the soil to 100 percent of maximum Standard Proctor dry density are as follows:

(2) The minimum required dry density is 100 percent of maximum dry density, which is 113.0 pcf, and the saturated water content, calculated with the equation above, at this density is 17.9 percent. The upper feasible placement water content is 90 percent of saturation, or 16.1 percent. If one is to allow a 3 percent spread in attainable placement water contents, the lowest water content would be about 13 percent, which is 1.5 percent dry of optimum. A lab permeability test should be performed at this dry density/water content to verify that an acceptably low permeability is attainable.

Example 10D-6 Example calculations for placement water content of compacted soil liner

Given: The in situ water content of soils in the borrow is 22.0 percent. The soil has a maximum dry density of 113.0 pcf and an optimum water content of 14.5 percent. The specific gravity of soil solids, G_s, is 2.68. Determine whether it is feasible to compact the soils to at least 95 percent of maximum Standard Proctor dry density.

Solution: (a) Given the maximum Standard Proctor dry density of the soil is 113.0 pcf, the minimum acceptable dry density is then 0.95 x 113.0 pcf, or 107.4 pcf. To determine the upper feasible placement water content, use the rule of thumb that 90 percent degree of saturation is the wettest a soil can be reasonably compacted. The saturated water content of a soil is calculated from the following equation, using the given values of dry density and specific gravity of solids.

$$w_{sat}(\%) = \left(\frac{\gamma_{water}}{\gamma_d} - \frac{1}{G_s} \right) \times 100$$

$$w_{sat}(\%) = \left(\frac{62.4}{107.4} - \frac{1}{2.68} \right) \times 100 = 20.8\%$$

(b) The wettest you should consider compacting the soil is 90 percent of theoretical saturated water content, or 0.9 x 20.8, or 18.7 percent.

(c) Then, the in situ water content of the soils in the borrow area, given as 22.0 percent, is greater than the highest water content at which the required density can be obtained. To achieve the required compaction, the soils will probably have to be dried by about 22.0–18.7, or 3.3 percent.

(d) This amount of drying may be attainable by disking repeatedly during hot, dry weather for some soils, but, highly plastic soils may be more difficult to dry. In some cases, a site should be constructed only during dry weather or the borrow area should be drained several months prior to construction.

Summary

The reduction in soil permeability by manure sealing in waste storage ponds and treatment lagoons is well documented. However, for this phenomenon to produce acceptable low permeability requires the soils at grade to have a minimum clay content (percent finer than 2 microns). A minimum clay content of 15 percent is required for sealing to occur if manures are from monogastric animals, and a minimum clay content of 5 percent is required for sealing if manures are from ruminant animals.

Soils can be divided into four permeability groups based on their percent fines (minus #200 sieve) and plasticity index (PI). Soils in Group III and IV generally do not require a liner. Group I soils will generally require a liner. Soils in Group II will need permeability tests or other documentation to determine whether or not a liner is advisable.

Guidance is given on when to consider a liner. Four conditions are listed in which a liner should definitely be considered.

Recommended values for allowable specific discharge and minimum liner thickness are given. A methodology is presented to calculate a minimum blanket thickness based on design parameters.

Flexibility is built into the design process. The depth of the liquid, the permeability, and thickness of the soil liner can be varied to provide an acceptable specific discharge.

A method of documenting the design rationale for inclusion in the design file is provided.

A practical means for evaluating, in quantitative terms, the level of ground water protection that can be achieved with a soil liner is also provided.

The guidelines provided in this chapter result in a somewhat conservative, but reasonable level of protection to important ground water resources. This guidance covers an area where uncertainties may exist. Additional research may produce better information, and practice standards will be updated to reflect this state-of-the-art knowledge.

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Appendix H

CALIFORNIA DAIRY
Quality Assurance
PROGRAM

502 Mace Blvd, Ste. 12 - Davis, CA 95616
1-866-66CDQAP / 1-866-662-3727 / info@CDQA.org

CDQA
Environmental Stewardship Certification
How do I Certify?

Any dairy producer in California may certify in Environmental Stewardship. These certification requirements will assist the producer to comply with the federal, state, and local laws and water quality regulations. Participation in the program by a dairy producer is strictly voluntary. The requirements are:

Complete the Environmental Stewardship Short Course 1 (ESSC 1) for dairy producers

_____ Certificates of participation are provided to the producer who attends all three sessions of the ESSC 1. Contact your local University of California Cooperative Extension Dairy Advisor or field representative if you have questions related to attendance.

Develop and implement an Environmental Stewardship Farm Management Plan (ESFMP). These written plans are the property of the producer and will remain in their possession (at the dairy).

These plans will include (but are not necessarily limited to):

_____ Do the four Risk Assessment documents in section 3 of the ESSC1 binder.

_____ List all categories with a Risk Ranking of 1 from Section 3 of the ESSC1.

_____ Identify appropriate alternatives for implementation at your facility to reduce risk for items listed.

_____ Estimated liquid manure storage needs for winter months (printout from the *UCCE software)

_____ Calculate existing water storage capacity (printout from the *UCCE software)

_____ Develop a Storm Water Pollution Prevention Plan (SWPPP) homework from ESSC 1

_____ Develop a Manure Management Emergency Plan (homework from ESSC 1).

_____ Copies of: conditional use permits (County), Waste Discharge Requirements (WDR) or waiver of WDR (Regional Water Quality Control Board), the Notice of Intent for National Pollutant Discharge Elimination System Stormwater Permit, and annual reports submitted as a result of a government issued permit.

_____ Documentation if available to indicate pond has 10% clay.

* A computer program was developed by UCCE to standardize necessary calculations to estimate storage requirements. Producers are encouraged to use this standardized program to expedite the third party evaluation.

Successfully complete an on-site evaluation by an independent, third party evaluator

_____ Call CDQA evaluation hot-line (530) 574-0524 to request the third party evaluation.

_____ Schedule your third party evaluation

_____ Complete the "Do Ahead" part of the checklist before the evaluator arrives

_____ Work with people (*dairy advisors, trade associations fieldmen*, or consultants) who have been trained by University of California Cooperative Extension (UCCE) and California Dairy Quality Assurance Program (CDQAP) to prepare you for the evaluation

_____ The individual who completed the ESSC 1 will work with the evaluator during the evaluation

All information collected during the evaluation remains on the dairy. All documents, including the completed checklist, remains on the dairy.

The evaluation includes a visual assessment of the waste containment and runoff control facilities. The on-site evaluation is non-regulatory in nature. Following successful completion of an evaluation, the certification process is complete.

In the event that the on-site evaluation reveals circumstances which need to be corrected the evaluator will leave the checklist and discuss with the producer items needing corrections and will schedule a subsequent re-evaluation. Upon successful completion of the re-evaluation, the certification process is complete.

If a producer owns more than one facility, an employee representing each facility will only have to attend the Environmental Stewardship Short course once. A separate Environmental Stewardship Farm

Management Plan and associated documents will have to be completed for each facility where livestock are kept.

The cost to cover up to two evaluations per dairy through 2002 was paid through a grant from U.S. EPA.

Questions

my exposure to enforcement?
allows producers to identify any
nforcement action occurs.

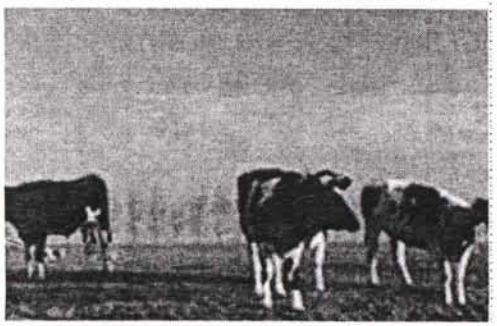
records? *Information generated*
n remains on the dairy and cannot be
ction.

? *Nothing. Dairy producers may*
hip Short Course free of charge. After
for a free, on-site evaluation by a

ter being evaluated? *If the*
ed improvement, the producer can
e on-site evaluation at a later date.

s? *CDQAP increases compliance*
plex state, federal and local laws and
complying with them—is a challenge.
tion, CDQAP provides a fast, simple
nderstand his or her obligations, and
out of compliance, allowing regulators
rces.

d? *Participation in CDQAP is*
ho choose to certify their dairies may
r quality permitting fees and peace of
is in compliance.



Program Benefits

CDQAP benefits communities, regulatory agencies and the dairy industry.

Dairy Producers:

- Greater confidence and peace of mind for producers that their facilities are in compliance
- Improved nutrient management
- Enhanced neighbor and community relations
- Lowered risk of potential fines from violations
- Reduced permit fees and streamlined reporting
- Takes guesswork out of compliance, resulting in savings of time and money

Community:

- Peace of mind for neighbors of dairies
- Public confidence that local dairies are complying with public health and environmental safety requirements
- Improved opportunities for sustainable growth, jobs and employment

Regulatory:

- Increased producer cooperation and dedication to compliance and environmental stewardship
- Enhanced efficiency of regulators in the field
- Improved allocation of regulatory resources

CDQAP Partners

California Environmental Protection Agency • California Department of Food and Agriculture
The California Resources Agency • U.S. Environmental Protection Agency
State Water Resources Control Board • California Department of Fish and Game
U.S. Department of Agriculture • University of California
California Manufacturing Milk Advisory Board • California Farm Bureau Federation
Western United Dairymen • Milk Producers Council

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or

More Questions? Visit www.CDQA.org or call
CDQAP Information Center at 1-866-66CDQAP (1-866-662-3727)

Environmental Stewar

CALIFOR
Quality

Compliance T

"It's truly a remarka
in helping industry p

ıce Program (CDQAP) is
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s in the following areas:

Preparedness *(under development)*

nent)

mental Stewardship module of
nent is done in two basic steps:

rse

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nment and industry funding.
ensure they are in compliance
ent of both the producer and

A DAIRY

surance
OGRAM

Dairy Producers Talk About CDQAP

Joe Silva, *Los Banos*—*"I was apprehensive at first about inviting a CDQAP evaluator to my dairy. But I decided it would be better to be proactive than reactive. I reviewed the notes from my CDQAP class, and filled out a simple checklist. I identified a couple of things I needed to do, and took care of them. Then I set up an appointment for a CDQAP evaluation.* ***Thanks to the classroom prep I knew exactly what to expect and the evaluation went smoothly.***"

John Draxler, *Hanford*—*"After taking the class, I decided to seek certification. After the free evaluation, I found out I needed to address a couple of issues on my dairy if I wanted to be certified.* ***I was able to fit the repairs into my schedule and at my own pace, without worrying about a fine or deadline.*** *Then I scheduled a second evaluation–also free–and now my dairy is certified."*

Bill Hoekstra, *Oakdale*—*"Even before CDQAP was formed, our dairy invested in more lagoon capacity and better water management. We wanted to do the right thing—and getting certified through the third-party evaluation was a way of earning recognition for the work we'd done. We also were able to identify a few other minor alterations that needed to be worked on.* ***The solutions were surprisingly practical and straightforward. We saved money by knowing what really needed to be fixed, and what was fine.*** *Now we're really confident that our dairy is in compliance. The investment has paid for itself in peace of mind."*

Sharon Doughty, *Point Reyes Station*—*"Sometimes it's helpful to have fresh eyes look at your operation. The third-party evaluation of the CDQAP was very useful to us.* ***The regulatory agencies in our area respect the fact that we have participated in the CDQAP.*** *They seem to have a greater appreciation and trust for our stewardship efforts since we became certified."*

Stepping Up to Ce

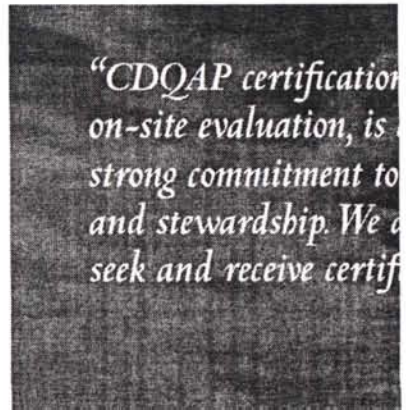
The California Dairy Quality
classroom instruction on environm
management. But taking the classe:

Dairy certification means going fr
the classroom to practical applicati
develops a plan for environmental
covering issues from proper draina
and emergency plans. An independ
then evaluates the operation to ens
state and local environmental laws.
can schedule repairs and a second

For producers who have been cons
New federal and state regulations
growing scrutiny of dairies. Certifi
to understand and comply with re

Additionally, awareness and recogn
nation's leading environmental stew
California regulators are now offer
to CDQAP-certified dairies, and o
are being aggressively pursued. Ad
through your dairy trade associatio
California Cooperative Extension

Interested in Certification
at 1-866-66C



Appendix I

APPENDIX I
LIST OF REFERENCES

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Appendix J

APPENDIX J
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