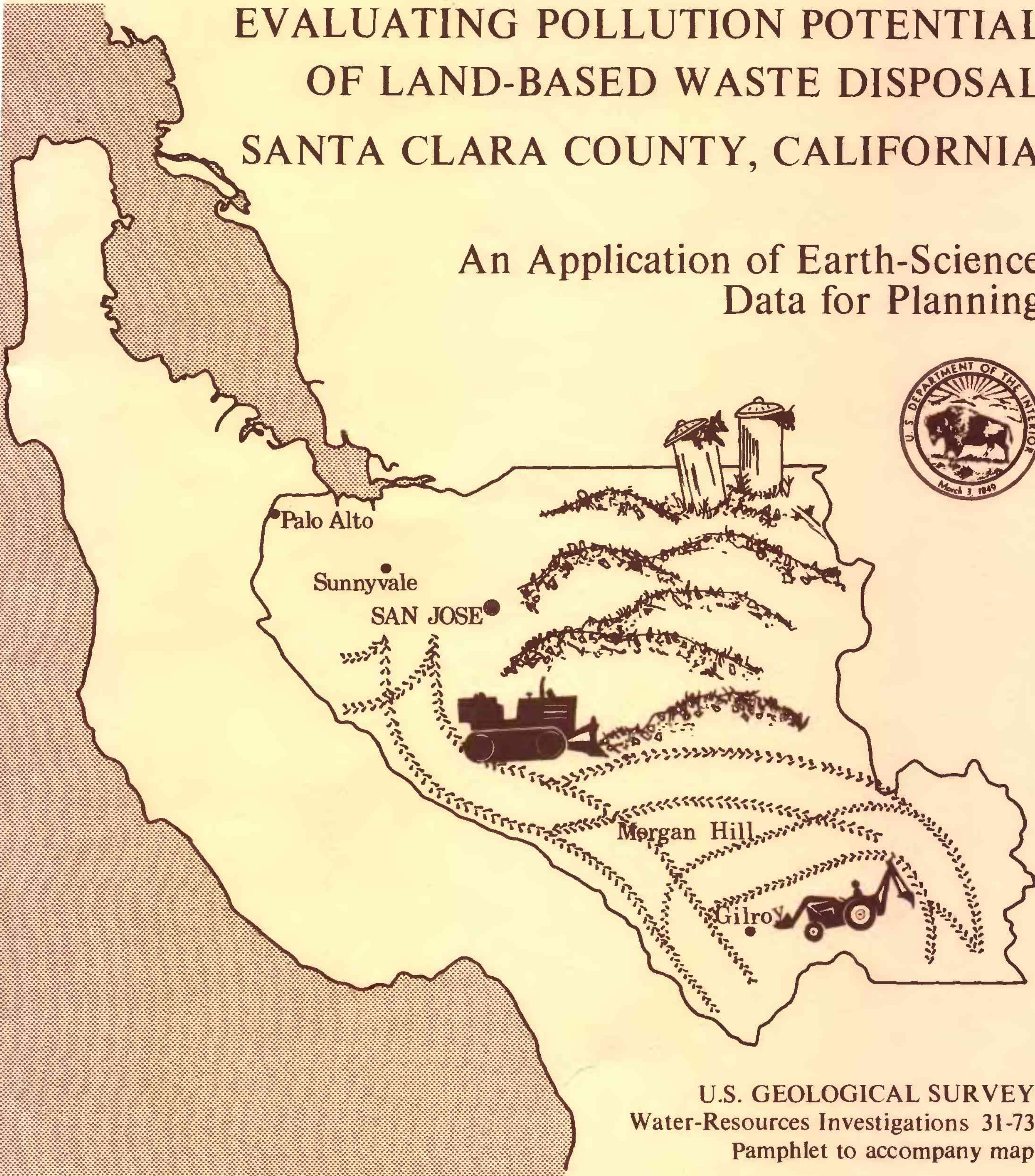
EVALUATING POLLUTION POTENTIAL OF LAND-BASED WASTE DISPOSAL SANTA CLARA COUNTY, CALIFORNIA

An Application of Earth-Science Data for Planning



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SANTA CLARA COUNTY, CALIFORNIA

An Application of Earth-Science Data for Planning

By W. G. Hines

INTRODUCTION

As a result of recently initiated programs such as the San Francisco Bay Region Environment and Resources Planning Study, planners in the San Francisco Bay region are becoming increasingly aware of the types and possible uses of earth-science data. These data encompass a wide spectrum of disciplines including hydrology, topography, geology, geomorphology, and seismology. If properly integrated with the planner's competence in demography, sociology, economics, and other fields, earth-science data can be invaluable for evaluating and controlling many critical environmental problems in urban areas.

In a rapidly developing area such as the San Francisco Bay region (fig. 1), vital land and water resources can be seriously endangered if planners make land-use decisions that fail to adequately account for the existence of certain pollution hazards. These pollution hazards are basically a function of several interacting factors: (1) The type, location, and emission characteristics of pollution sources, (2) the proximity and sensitivity of land and water resources to these pollution sources, and (3) the existence of one or several critical physical conditions that may affect the generation, transport, and distribution of pollutants in the environment. An understanding of these factors and their interactions is a prerequisite for evaluating and controlling many of the pollution and waste-disposal problems encountered in the San Francisco Bay region.

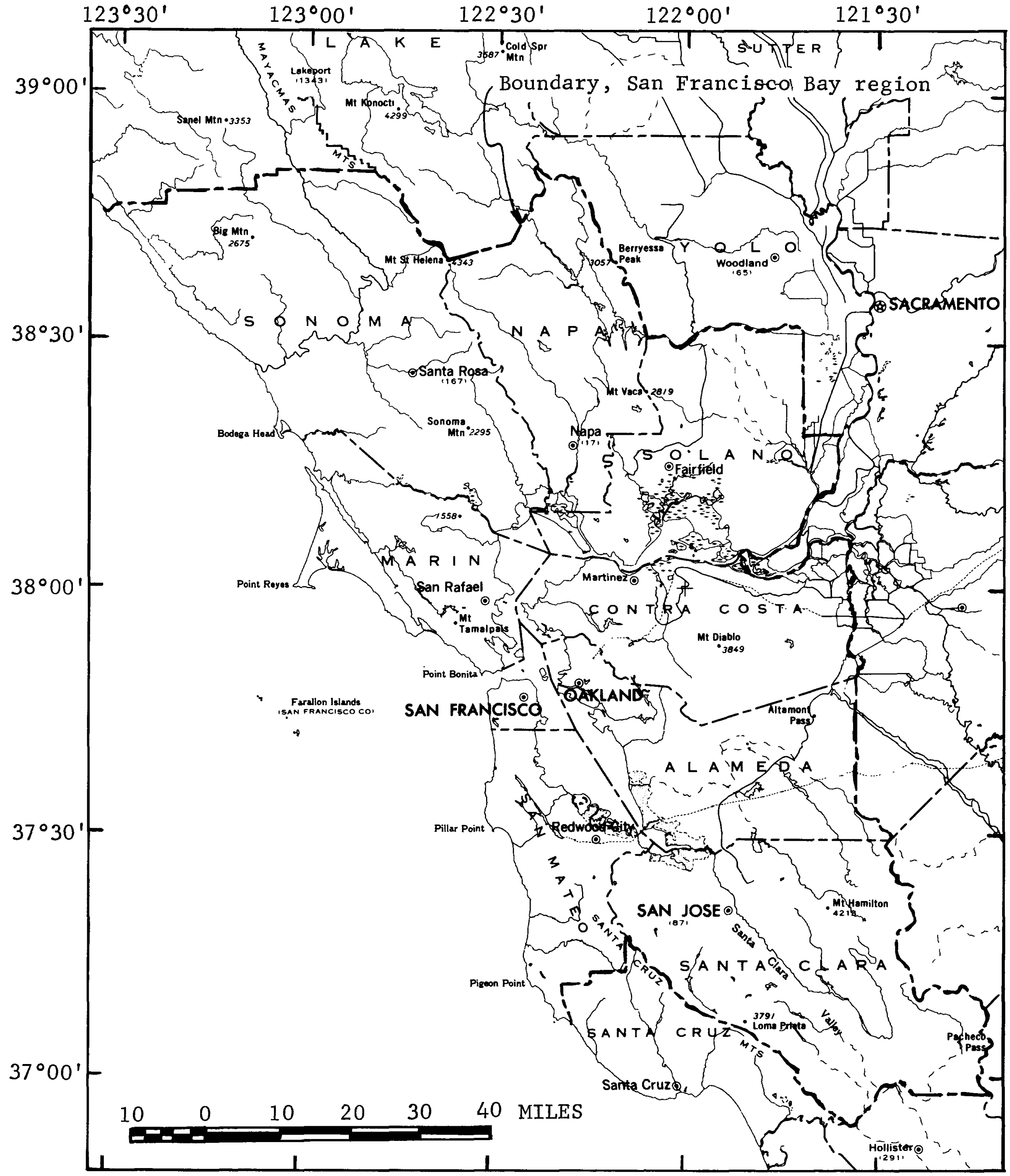

FIGURE 1.--Outline map of San Francisco Bay region.

PURPOSE AND SCOPE

The purpose of this report is to acquaint planners with the utility of earth-science information for analyzing pollution and waste-disposal problems in relation to land-use planning and the protection of land and water resources. The following topics are emphasized:

(1) An identification and description of factors that interact to form pollution hazards.

(2) A presentation of selected examples of, and possible control measures for, pollution hazards typically encountered in the bay-region environment.

(3) Criteria and methodology needed for the preliminary evaluation of the suitability of land areas intended for waste-disposal sites.

Much of the discussion is keyed to the accompanying map (sheets 1 and 2) of Santa Clara County, a typical rapidly developing county in the San Francisco Bay region, for which selected physical information has been compiled. Methods used in the preparation of the map are described on sheet 1 of the map. The map is utilized as a means of relating physical conditions described in the text to actual conditions found in the county. In addition to the map and text, several tables and a glossary of selected technical terms are included.

This report was prepared by the U.S. Geological Survey in cooperation with the U.S. Department of Housing and Urban Development as part of the San Francisco Bay Region Environment and Resources Planning Study. The author wishes to acknowledge D. A. Rickert, hydrologist, U.S. Geological Survey, for many of the concepts included in this report and to give special thanks to R. L. Rodgers for the final preparation of the map. Eduardo Agado, G. D. Myren, Karen Van Dine, and Perry Wood are also cited for their aid in compiling the maps and other parts of this report.

INTERACTING FACTORS THAT FORM POLLUTION HAZARDS

Major Sources of Pollution

Many sources of pollution have the potential for detrimental impact on the bay-region environment. Table 1 lists the major sources and types of pollutants that are most common in the bay region. The significance of each of the sources and types of pollutants varies considerably within specific locales. For example, a planner in San Jose might be most concerned with the effects of a new solid-waste landfill on a shallow ground-water reservoir whereas a planner in Marin County might be more concerned about how drainage from a dairy feedlot may affect the quality or usability of water from an adjacent stream. Thus, planners in different geographical areas may find it necessary to rank sources and types of pollutants in order of local importance.

TABLE 1.--*Major sources and types of pollutants*

Major types of pollutant emissions:

a. Noxious or toxic chemicals, acids, caustics, pesticides
b. Toxic metallic substances
c. Soluble and particulate organic substances
d. Nutrients, particularly compounds of nitrogen and phosphorus
e. Pathogenic microbes
f. Mineralized water
g. Airborne noxious or toxic gases, and particulate matter
h. Suspended sediment and turbity
i. Debris (paper, rags, cans, trash)
j. Grease and oil

Source of pollutants	Type of pollutant	Possible additional sources of information
1. Agricultural wastes and irrigation return flows[1].	a,c,d,f	U.S. Department of Agriculture; California Department of Agriculture.
2. Animal wastes	c-e	U.S. Department of Agriculture; California Department of Agriculture.
3. Dredge spoils	a-d,h	U.S. Army Corps of Engineers, Bay Conservation and Development Commission.
4. Heavy construction or landscape alteration[1].	h,i	County planning and public works departments
5. Incinerators; open burning	b,g	Bay Area Air Pollution Control District
6. Industrial stack gases	b,g	Bay Area Air Pollution Control District
7. Junkyards	b,i,j	County planning departments
8. Mining and mine wastes	a,b,f,h	California Division of Mines and Geology
9. Motor vehicles	b,g,j	California Division of Highways; Bay Area Air Pollution Control District.
10. Pesticide spraying	a	U.S. Department of Agriculture; California Department of Agriculture.
11. Septic tanks[1]	a,c-e,j	County public health or environmental engineering departments.
12. Solid-waste disposal sites[1]	a-j	California Department of Public Health
13. Storm-water runoff[1]	a-e,h-j	County public works departments
14. Toxic-chemical storage areas	a,b	California Department of Industrial Relations; California Regional Water Quality Control Board, San Francisco Bay Region.
15. Municipal and industrial wastewater-treatment plants and outfalls[1].	a-j	California Regional Water Quality Control Board, San Francisco Bay Region.
16. Wastewater-injection wells	a,b,f	California Regional Water Quality Control Board, San Francisco Bay Region.
17. Watercraft	e,i,j	U.S. Coast Guard

[1]Most important source of pollutants.

After preparation of a list of the most important local pollution sources, the location of these sources can be mapped separately or identified on an existing map. Such a map can be helpful for evaluating potential pollution hazards, particularly if utilized in conjunction with resource information such as depicted on the accompanying Santa Clara County map. Regionwide information necessary for preparation of pollution-source maps has been compiled by Limerinos and Van Dine (1970), California Water Resources Control Board (1971), and Goss (1972). These publications include information on the location of municipal and industrial wastewater outfalls, descriptions of wastewater characteristics, and summaries of data on solid-waste disposal sites. Specific information on types and sources of pollutants within county or municipal jurisdictions usually can be obtained from sources identified in table 1.

Critical Land and Water Resources

In order to evaluate the overall significance of sources of pollution in an area, planners need to assess the sensitivity of major land and water resources to various types of pollution. Major land and water resources that are sensitive to pollution can be classified as critical resources that require special consideration with regard to land-use planning.

In a general sense, *critical land resources*[1] could be described as (1) land that is primarily used for man's living, working, and recreational habitat; and (2) biologically-productive land essential for the well-being of important plant and animal life and for a pleasing habitat for man's enjoyment. *Critical water resources* could be described as (1) those that supply man with water for drinking, hygienic, industrial, recreational, and agricultural purposes; and (2) those that support important aquatic and wildlife habitats.

Table 2 includes a list of critical land and water resources commonly found in the bay region. An example of each critical land or water resource listed in the first column of table 2 is given in the second column and each example can be identified on the large map showing physical information (sheets 1 and 2) or on the small maps showing precipitation and estimated depth to the water table (sheet 1). Table 2 also includes a list of information sources that should be useful to planners wishing to gather data or prepare a map of critical land and water resources.

[1]The description of critical land resources implies the importance of existing or proposed land use in assessing the critical nature of a particular land resource. Land use has often been classified in the context of sociopolitical considerations, but for convenience in this report certain land uses shown in table 2 have been classified with natural physical considerations.

TABLE 2.--*Critical land and water resources*

Critical resources	Example on map showing physical information	Information sources
Land resources		
1. Urban land[1]	San Jose area	U.S. Geological Survey, Washington, D.C.; state and county planning departments.
2. Parks, campgrounds, game preserves, and large recreational areas.	Henry W. Coe State Park.	California Department of Parks and Recreation; county parks departments.
3. Marshlands	Areas identified by "marshlands pattern."	Bay Conservation and Development Commission
Water resources		
1. Shallow tidal reaches of the San Francisco Bay estuary.	Tidal sloughs near top of sheet 1.	Bay Conservation and Development Commission; U.S. Army Corps of Engineers; California Regional Water Quality Control Board, San Francisco Bay Region.
2. Major water-storage reservoirs,[2] lakes, and their immediate peripheral watershed[3] areas.	Lake Elsman	California Water Resources Control Board; California Regional Water Quality Control Board, San Francisco Bay Region; county water departments.
3. Major recreational reservoirs, lakes, and their immediate peripheral watershed areas.	Anderson Reservoir	Do.
4. Major streams, rivers, and their immediate peripheral watershed areas.	Guadalupe River	Do.
5. Major ground-water reservoirs	See map showing estimated depth to water table for extent of principal aquifer system.	Webster (1972a,b,; 1973); county water departments
6. Major ground-water-recharge areas	Percolation ponds near Vasona Reservoir.	California Department of Water Resources; U.S. Geological Survey, Menlo Park, Calif; county water departments.

[1]See glossary for a description of the urban-land classification.

[2]Many water-storage reservoirs are of multipurpose design. Planners should consider the most sensitive beneficial uses (drinking-water supply and fish propagation) when evaluating land-use plans.

[3]See description of watershed in glossary.

Critical Physical Conditions

Certain naturally occurring physical conditions can accentuate pollution problems by facilitating the excessive generation, transport, or distribution of pollutants in the environment. These critical conditions are particularly important in the dynamic and physically diverse environment of the bay region. Table 3 lists eight critical conditions commonly encountered in the bay region, gives example pollution problems that may be caused by the various conditions, and shows possible sources of information for each critical condition.

Several of the physical phenomena described in table 3 have been recognized by planners and have, in fact, had a limited effect on land-use practices in the bay region. For example, local and county governments have ordinances requiring that septic-tank systems meet criteria relative to depth to ground water and soil permeability. In some places, flood-prone areas have been zoned to preclude intensive development. Road construction is restricted in certain areas where land slopes are steep and erosion problems are prevalent. In most places, however, such physical conditions have not been sufficiently recognized or evaluated with regard to their interactions with various types of land-use practices.

EVALUATION AND CONTROL OF POLLUTION HAZARDS

In previous discussion it was shown that the existence of a major pollution hazard is dependent upon the presence of at least two conditions: (1) A pollutable land or water resource within the sphere of influence of (2) a source of pollution. The pollution hazard is significantly increased when geologic and hydrologic conditions are such that they allow excessive generation, rapid transport, or distribution of pollutants. By utilizing information given in tables 1-3 and on a map showing appropriate physical information, planners have the initial tools needed for the identification and preliminary evaluation and control of many of the pollution hazards encountered in the bay region.

From information contained in tables 1-3, one could identify hundreds of unique pollution hazards. A description of a selected number of types of these pollution hazards and possible control measures is compiled in table 4 as a guide to planners for relating various land-use practices and planning activities to pollution hazards.

TABLE 3.--*Critical conditions, example pollution problems, and information sources*

Critical condition	Example pollution problems caused by the critical condition	Example on map showing physical information	Information source
Flood-prone areas	Inundation of pollution sources; rapid transport and distribution of pollutants; damage to waste-treatment and waste-disposal facilities.	Area bordering Guadalupe River	Limerinos, Lee, and Lugo (1973), U.S. Geological Survey, Menlo Park, Calif., U.S. Army Corps of Engineers, San Francisco, Calif.
Severe land slopes	Rapid transport and distribution of discharged pollutants.	Area identified as having land slopes greater than 15 percent.	U.S. Geological Survey, Menlo Park, Calif.
Heavy precipitation	Dissolution and leaching of stored chemicals and other potentially polluting materials; increased production of polluted leachate and drainage at solid-waste landfills.	Areas on precipitation map where rainfall exceeds 50 in/yr.	Rantz (1971)
Shallow ground-water reservoir.	Pollution of ground-water system from septic tanks, solid-waste landfills, and other pollution sources.	Areas on map where depth-to-water is less than 10 feet.	Webster (1973), U.S. Geological Survey Menlo Park, Calif.
Highly permeable soil	Easy movement of pollutants to the ground-water system.	Areas where soil permeability is greater than 2.0 in/hr.	U.S. Soil Conservation Service (1968).
Susceptibility to erosion, gullying, or landsliding.	Excessive production of debris, sediment, and turbid water; damage to waste-treatment and waste-disposal facilities.	None. See information source	Brown and Jackson (1973)
Susceptibility to severe movement during earthquakes.	Damage to waste-treatment and waste-disposal facilities.	None. See information source	Brown (1970); Brown and Lee (1971) and U.S. Geological Survey, Menlo Park, Calif.
Bedrock or impermeable deposit near land surface.	Rapid transport and distribution of discharged pollutants in sloped areas; ponding of discharged pollutants in flat areas.	None. See information source	U.S. Geological Survey, Menlo Park, Calif. U.S. Soil Conservation Service.

PRELIMINARY EVALUATION OF SITES FOR WASTE DISPOSAL ON LAND

The information and methodology required for the evaluation and control of pollution hazards are directly applicable to the preliminary evaluation of the suitability of land for several types of onland waste-disposal systems, hereafter referred to as land-based waste-disposal systems. The following four general types (see glossary for descriptions) probably are of most interest to planners in the bay region:

1. Septic tanks
2. Solid-waste landfills
3. Wastewater-spray irrigation
4. Waste-containment ponds

Preliminary evaluation of potential land-based waste-disposal sites is perhaps best accomplished by placing potential sites on a map (such as the map showing physical information) and identifying obvious constraints related to proximate land or water resources and the presence of critical earth-related conditions. For example, urban land is, with rare exception, preempted for use as a solid-waste landfill site. Similarly, it is not advisable to locate an evaporation pond for a toxic industrial wastewater on land that is subject to flooding. An area with land slopes greater than 15 percent will not, without drastic alteration, be suited for septic tanks. By identifying these types of obvious constraints at an early stage of evaluation, large areas of land can be eliminated from unnecessary consideration. Areas not eliminated by obvious constraints than can be evaluated in more detail from the standpoint of hydrologic and geologic suitability in conjunction with the planner's concurrent evaluation of social, economic, and esthetic considerations.

Criteria for Evaluating Land-Based Waste-Disposal Sites

The following publications were reviewed during the compilation of this report and aided in the formulation of land-based waste-disposal site criteria: Franks (1972); Schneider (1970); California Water Pollution Control Board (1961); Hughes, Landon, and Farvolden (1971); Geological Survey of Alabama (1971); U.S. Soil Conservation Service (1968); American Society of Civil Engineers (1959); Born and Stephenson (1969); Hughes and Cartwright (1972); Williams and Wallace (1970); California Department of Public Health (1968); and McGauhey, Krone, and Winneberger (1966).

TABLE 4.--*Examples of pollution hazards with possible impacts and control measures*

Description of possible pollution hazard	Possible impact of hazard	Possible control measures for minimizing the existing hazard or for avoiding a similar hazard in the future
1. Irrigation return flows from an agricultural area enter a stream which is utilized for a drinking water supply farther downstream.	The concentration of salts and pesticides in the stream is increased making it unsuitable for a drinking water supply.	a. Change to spray irrigation technique to preclude irrigation return flows. b. Divert return flows to a collection drain for discharge below the point of drinking water-supply usage. c. Zone upper watersheds of water-supply streams to preclude intensive irrigated agricultural development.
2. A dairy-cattle feedlot is located on permeable land above a shallow ground-water reservoir.	The ground-water reservoir becomes contaminated with fecal bacteria and nitrate.	a. Move the feedlot to less permeable land that does not overlie a shallow ground-water reservoir. b. Construct an impermeable liner under the feedlot and install a wastewater collection and treatment system. c. Require future feedlot sites to meet waste containment pond criteria (table 5) or to be carefully engineered to control pollutant emissions.
3. Navigation dredge spoils are placed on a tidal mudflat in the marshlands.	A waterfowl feeding area is ruined	a. Prohibit the disposition of dredge spoils in the marshlands. b. Allow future disposition of dredge spoils only in areas specified by the U.S. Army Corps of Engineers.
4. Massive earthmoving, road work, and vegetation removal begin during September as the preliminary phase of subdivision construction.	Heavy erosion, gullying, and sediment transport commence with the first rains in November. A downstream watershed is choked with debris.	a. Install temporary drainage facilities and sediment entrapment basins around construction areas. b. Schedule heavy construction projects to avoid landscape disturbance during the rainy season. c. Limit vegetation removal to a minimum in all projects. d. Prohibit heavy construction, particularly extensive road networks, in highly erodable areas. Zone these areas for limited development whenever possible.
5. A large incinerator is operated near a ground-water-recharge basin.	Soot and noxious particulate matter are deposited in the recharge basin. Water quality is degraded and the bottom of the recharge basin is clogged.	a. Increase incineration efficiency and treatment of emissions. b. Close or move the incinerator. c. Locate future incinerator sites in remote areas, downwind of critical land and water resources.
6. Noxious sulfur and nitrous oxides are emitted in the stack gases of an industrial plant located adjacent to an urban residential area.	Air pollution endangers public health and damages residential structures.	a. Provide increased treatment for stack gases. b. Zone land so as to prohibit conflicts between industrial and residential land use. Allow only light, nonpolluting industries to locate in areas adjacent to residential developments.
7. A large automobile salvage yard is located on the marshlands.	Drainage (water, oil, and grease) from the salvage yard enters a tidal slough and endangers shellfish.	a. Incorporate grease traps in drainage facilities. b. Divert drainage to the municipal storm-sewer system. c. Zone marshlands to prohibit the location of automobile salvage yards.
8. A remote county park becomes crowded with motor vehicles during summer weekends.	Obnoxious fumes, dust, and noise threaten the esthetic appeal and enjoyment of the park.	a. Discourage vehicular traffic in the park by using shuttle buses and by encouraging more pedestrian and bicycle traffic. b. Plan future remote parks to accomodate large crowds without reliance on motor vehicles for transportation.
9. Herbicides are heavily applied in a flood-control channel to eradicate dense growths of weeds. The channel leads to a tidal slough.	Herbicides concentrate in the bottom sediment of the slough and endanger aquatic life.	a. Replace herbicide applications with mechanical weed-control methods. b. Reduce the quantity of herbicide application and use short-lived biodegradable types. c. Design flood-control channels and zone surrounding flood plains to accommodate a reasonable amount of seasonal weed growth (that is, expect weeds and other debris to cause somewhat increased water levels during floods).

10. A village septic tank drainage field located on steeply sloped, impermeable land erodes and overflows during a rainstorm.	A downstream watershed is polluted with nutrients and fecal bacteria.	a. Move the drainage field to flatter, more permeable land less susceptible to erosion. b. Install a wastewater-collection system and a simple, efficient treatment facility such as a multistage oxidation pond. c. Plan future septic-tank systems to meet site criteria similar to those shown in table 5 or to be engineered to preclude pollution problems.
11. A solid-waste landfill is located on permeable land overlying a shallow ground-water reservoir. A heavy rain produces a large quantity of leachate.	The ground-water reservoir is polluted with organic compounds, hydrogen sulfide, toxic trace metals, and other noxious material.	a. Seal the landfill with an impermeable layer of clay and close. b. Move the landfill to a new site located on less permeable land where ground water is at greater depth. c. Plan future landfills to meet site criteria similar to that shown in table 5 or to be engineered to control pollution problems.
12. Storm-water runoff from a parking lot at an urban shopping center enters a pond at a nearby recreational park.	Floatable debris, greases and oils, and toxic materials such as lead are deposited in the pond.	a. Clean the parking lot thoroughly and often--especially just before and during the seasonal runoff period. b. Construct grease and debris traps in the parking-lot-drainage system. c. Divert drainage to the municipal storm-sewer system. d. Design future recreational ponds and lakes to include provision for periodic dredging and flushing with high quality water. e. Plan future recreational ponds to exclude runoff from areas contaminated by motor vehicles.
13. Liquid chlorine is stored in containers adjacent to an industrial plant in an area prone to flooding.	A large flood inundates the area, damages the storage containers, and causes the release of toxic chlorine gas.	a. Build flood protection levees and spillage-containment structures around toxic chemical-storage facilities. b. Move the storage facilities to an area not prone to flood damage. c. Zone flood-prone areas to prohibit the storage of toxic chemical materials.
14. A municipal sewage-treatment plant is located on poorly-consolidated land on the periphery of San Francisco Bay.	An earthquake damages the plant and causes raw sewage to be discharged to the bay.	a. Install emergency wastewater-holding and treatment facilities to preclude discharge of raw sewage. b. Incorporate earthquake protection considerations into all future plant and pipeline designs.
15. Brine wastes from an industrial process are injected into a well for underground disposal.	The quality of water in the ground-water reservoir is degraded by salt-water encroachment.	a. Close the injection well and construct another facility, such as an evaporation pond, for disposal of the brine waste. b. Prohibit the future use of wastewater-injection wells unless a comprehensive geologic investigation is undertaken to insure that brines can be injected safely.
16. Powerboats are allowed to operate on a small reservoir used for a drinking water supply.	Gas and oil spillage from boats pollute the reservoir.	a. Prohibit the use of powerboats
17. A large pile of waste ore from an abandoned mercury mine is located near a major stream.	A flood transports the waste ore into a downstream recreation reservoir. High mercury concentrations are detected in fish which inhabit the reservoir.	a. Require that waste ore from mining operations not be placed in areas prone to flooding. b. Contact State or Federal envirnomental regulatory agencies to investigate the contamination problem and make recommendations for control measures.

Table 5 contains suggested criteria to assess the suitability of land for four types of land-based waste-disposal systems. The table includes criteria on land and water resources (criteria 1, 4, and 5); geologic and hydrologic phenomena (criteria 2, 3, and 6 through 10); numerical suitability ratings (on a scale of 0-3) for evaluating each of four types of land-based waste-disposal systems. Table 5 is intended as a guide for making site selections and assessments of areas under consideration for use in land-based waste-disposal systems. The criteria are not intended to preempt or replace local, State, or Federal standards or regulations for land-based waste-disposal practices. Those wishing to obtain specific standards or regulations should contact county or State public health agencies, the California Regional Water Quality Control Board, San Francisco Bay Region, or the Environmental Protection Agency.

To use table 5 most effectively the following steps are suggested:

1. Compile and examine available data and information relative to the 10 criteria listed in the table.

2. Prepare a map, or maps, to summarize as much of this information as possible. (For example, the map sheets in this report show information on land resources and land uses, land slopes, floods, surface-water resources, and soil permeabilities. Supplemental maps at a less detailed scale show information on precipitation and ground-water resources.)

3. Locate the proposed site of the land-based waste-disposal system on the map.

4. Evaluate the suitability of the proposed site on the basis of criteria and numerical ratings given in table 5. Sites receiving several "0's" or a mix of "0's" and "1's" usually can be eliminated from consideration. Sites receiving "3's" and "2's" and no "0's" or "1's" should be noted and reserved for further evaluation relative to remaining criteria not adequately defined by available information.

Criteria not evaluated in steps 1-4 above usually can be evaluated by aerial-photograph interpretation, site visitations, and field measurements. Criteria for erosion, geology, soil permeability, and ground-water resources commonly will have to be evaluated in this manner. For information on earthquakes and floods (in places where flood-prone areas have not been mapped), consultation with geologists and hydrologists may be necessary.

If the preliminary evaluation indicates that the site may be suitable, comprehensive field investigations can be undertaken to insure that no critical considerations were overlooked. Final design of a particular land-based waste-disposal facility should be made on the basis of data obtained from the field investigation. The nature and detail of the field investigation will depend upon several factors including size and type of facility, the quality of the preliminary evaluation, and the requirement for engineering modifications where potential pollution hazards are present. Generally, solid-waste landfills and wastewater-spray irrigation systems will require the most comprehensive field investigation.

DISCUSSION AND CONCLUSIONS

The evaluation and control of pollution hazards and preliminary evaluation of sites for land-based waste-disposal systems are but two of the many potential uses of earth-sciences information. Planners in most urban areas are increasingly being called upon to provide more sophisticated means of predicting and controlling environmental impacts associated with urbanization, resource development, and land-use practice. This need can be best met if planners are able to formulate land-use plans that are compatible with the types of constraints described in this report. These constraints and the nature of hydrologic and geologic information needed to evaluate them vary depending upon the particular type of land use intended. However, the compilation of available earth-science information on a map is often sufficient to form a basis for a preliminary impact assessment of alternative land-use plans.

As planners gain knowledge about an area's unique physical conditions and other factors such as pollution sources, land-use planning can be conducted on the basis of a rational environmental analysis. Hazards can be identified in advance of development and avoided or effectively controlled. Economic, social, and esthetic benefits will accrue as land-use practices are tailored to conform with the land's developmental capacities.

TABLE 5.--*Preliminary suitability evaluation of proposed land-based waste-disposal sites*
[0, unsuitable; 1, poor suitability; 2, moderate to good suitability, 3, most suitable]

Criteria for consideration	Numerical suitability ratings for land-based waste-disposal site				Comment
	Septic tanks	Solid-waste landfills	Wastewater-spray irrigation	Waste-containment ponds	
1. Land resources and land use[1]					Septic tanks may be the only possible method of domestic wastewater treatment in isolated recreational areas. In some locations parks and recreational areas can be reclaimed from land previously used as a landfill. Small-scale spray irrigation systems may be feasible under controlled conditions for parks, golf courses, and other vegetated areas.
a. Urban	0-1	0	0	0	
b. Parks, campgrounds, game preserves, and large recreational areas.	*1	*0	*1	0	
c. Marshlands	0	0	0	0	
d. Agricultural	1-3	1	3	1-2	
e. Open space	3	3	3	3	
2. Land slope[1]					Slopes greater than 15 percent can be built upon only with great precaution.
a. 0 to 5 percent	3	3	3	3	
b. 5 to 15 percent	1-2	1-2	1-2	1-2	
c. Greater than 15 percent	0	0	0	0	
3. Floods[1]					Normally, flood-prone-area mapping for the bay region is based upon a flood with a theoretical recurrence interval of 100 years corrected for present-day flood-control facilities.
Within flood-prone areas (100-year flood).	0	0	0	0	
4. Surface-water resources[1]					Land-based waste-disposal systems should be located as far away from and as far downstream of surface-water resources as possible. It may be possible in many cases to locate land-based waste-disposal sites closer to surface-water resources provided that engineering safeguards are included in the design of facilities.
a. Within 1,000 ft of major domestic water-supply reservoir, lake, or stream.	0	0	0	0	
b. Within 500 ft of major tidal water or reservoir, lake, or stream utilized for recreation or non-domestic water supply.	0	0	0	0	
c. Within immediate peripheral watershed[2] of major water-supply or recreational reservoir, lake, or stream.	0-1	0-1	0-1	0-1	
5. Precipitation[1] (mean annual)					Precipitation criteria presented here applies to the San Fancisco Bay region. For detailed evaluation, a proposed site should be studied to determine expected monthly or weekly rainfall and evaporation rates. The difference between rainfall and evaporation can be used to estimate possible quantities of leachate production in landfills or overloading of septic tank fields.
a. Greater than 50 inches	0	0	0	0	
b. 30 to 50 inches	1	1	1	1	
c. 20 to 30 inches	2	2	2	2	
d. 0 to 20 inches	3	3	3	3	

6. Ground-water resources[3]					Depth-to-ground-water criteria should be based upon the depth-to-the-seasonal high level of the saturated zone (water table). In much of the bay region, the water table is not accurately defined by the level at which water stands in wells. In many cases, the water level in wells is either above or below the water table because of upward or downward components of ground-water flow. Planners involved in site evaluations should consult with ground-water geologists or hydrologists who have knowledge of the area in question.
a. Within 1,000 ft of major ground-water recharge basin.	0	0	0	0	
Depth to ground water from land surface.*					
b. 0 to 10 ft	0	0	0	0	
c. 10 to 50 ft	1	1	1	1	
d. 50 to 100 ft	2	2	2	2	
e. Greater than 100 feet	3	3	3	3	
7. Soil permeability[3,4]					Desired permeability range for wastewater spray irrigation depends upon whether the system is designed for infiltration or overland runoff. Permeability data always should be examined in conjunction with depth-to-water data to preclude ground-water pollution in areas where wastes are applied to high permeability soils.
a. 0 to 0.2 in/hr	0	3	*	3	
b. 0.2 to 0.63 in/hr	1-2	1-2	*	1-2	
c. 0.63 to 2.0 in/hr	2-3	0-1	*	0-1	
d. Greater than 2.0 in/hr	3	0	*	0	
8. Erosion[3] Within area of active landsliding, gullying or obvious surface instability	0	0	0	0	Planners should be aware that even limited vegetation removal or construction in the bay region can initiate erosion problems.
9. Geology[3] Bedrock or impermeable deposits exposed or near land surface.	0	*0	0	*0	Solid-waste landfills and waste-containment ponds can be located on level impermeable bedrock if diked and properly designed for collection and treatment of leachate.
10. Earthquakes[3] Areas peripheral to active faults and areas underlain by unconsolidated deposits susceptible to severe shaking.	0	0	0	0	Any part of a land-based waste-disposal facility requiring pipelines, holding ponds, or treatment works should be examined with regard to earthquake susceptibility.

[1]Criteria for land resources and land use, land slope, floods, surface-water resources, and precipitation usually can be evaluated first because data normally are available.

[2]See glossary.

[3]Criteria for ground-water resources, soil permeability, erosion, geology, and earthquakes usually are not adequately described by available data. These criteria usually need be evaluated only for sites not eliminated on the basis of criteria in footnote 1.

[4]Soils are often not homogeneous in character with respect to depth or horizontal extent. Therefore, soil permeability rates obtained from existing soils maps should be verified with field data before final site selection.

*See comment column.

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GLOSSARY

Agricultural land.--In broad terms agricultural land commonly is described as that utilized for soil cultivation and crop and livestock production. Agricultural land identified on the map sheets is either of three general types: (1) Field crop, (2) vineyard and orchard, and (3) pasture. This classification, and the classification for urban land and open space also presented in this glossary, was taken directly from a joint NASA-Geological Survey aerial photographic land-use mapping program supervised by the Geological Survey, Washington, D.C.

Demography.--The science of population and the factors affecting its dynamics (that is, growth, decline, distribution, changes).

Geology.--The study of the origin, history, and structure of the earth, as recorded in the rocks, together with the forces and processes that modify the rocks.

Geomorphology.--The study of the surface features of the earth and the way in which they have been and are being produced.

Hydrology.--The science encompassing the behavior of water as it occurs in the atmosphere, on the land surface, and underground.

Land slope.--The gradient of land as measured from a horizontal surface. This gradient or slope usually is expressed as a percentage, such as 5 percent, indicating a 1-unit vertical rise in 20 units of horizontal distance.

Marshlands.--Marshlands include those areas closely associated with fresh or saline water, either surface or ground water. These areas are highly productive biologically and are characterized by saturated soil, ponded water, thick vegetation, and abundant animal life. Marshlands also find extensive use as recreational areas for man. In the bay region, marshlands usually are found on the periphery of San Francisco Bay (commonly referred to as bay lands) and major reservoirs and lakes or in naturally low lying areas where the water table is at, or near, land surface.

Open space.--The open space land-use classification is a modification of that used by the Geological Survey (see "*Agricultural land*" in this glossary for a description of land-use data). Generally, open-space areas shown on the map sheets have one or several of the following identifying characteristics:

1. Meadowland
2. Brush or trees associated with riparian vegetation
3. Native brush or timber
4. Forest
5. Barren
6. Salt flats
7. Sand dunes

Saturated zone.--That part of a water-bearing material in which all voids, large and small, are filled with water.

Seismology.--The science concerned with the study of earthquakes and measurement of the elastic properties of the earth.

Septic tank.--A settling tank in which settled sludge is in immediate contact with wastewater flowing through the tank. The organic solids in the settled sludge on the bottom of the tank are decomposed by anaerobic (oxygenless conditions) bacterial action, while the overflowing wastewater is dispersed into the soil through a lateral, subsurface drainage field.

Soil permeability.--The capacity of a soil for transmitting a fluid. The common permeability measurement is performed by measuring the rate at which a fluid, usually water, moves a given distance during a given time interval.

Solid-waste landfill.--A facility for disposal of waste materials, usually domestic garbage and trash which involves burial, compaction, and natural decomposition under the land surface. The types of solid-waste landfills vary in the sophistication from poorly managed dumps to well managed sanitary landfills. In the bay region future landfill facilities will almost all be of the sanitary-landfill type.

Topography.--The science of surveying the physical features of a district or region and the art of delineating them on maps.

Urban land.--In a broad sense, urban land could be defined as that land that constitutes or comprises a city or town. A heterogeneous mix of land uses is implied, and as a result urban land-use classifications may differ somewhat among the various bay region land-use planning communities. The classification used for the map sheets is shown below. (See "*Agricultural land*" in this glossary for a description of the source of land-use data.)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
San Francisco Bay Region Study
345 Middlefield Road
Menlo Park, CA 94025

July 12, 1974

To: Friends of the San Francisco Bay Region

From: Virgil Frizzell
Staff Geologist

Subject: Interpretive Report 6

Enclosed is a copy of "Evaluating Pollution Potential of Land-Based Waste Disposal, Santa Clara County, California" by Walt Hines. This report is the sixth in the San Francisco Bay Region Study Interpretive Report Series and is subtitled "An Application of Earth-Science Data for Planning." It is intended to acquaint planners and other decision makers with the usefulness of earth-science data when analyzing pollution and waste-disposal problems in relation to land-use planning. In the report the author emphasizes the following topics: 1) an identification and description of factors that interact to form pollution hazards; 2) a presentation of selected examples of, and possible control measures for, pollution hazards typically encountered in the bay region environment; and 3) criteria and methodology needed for the preliminary evaluation of the suitability of land areas intended for waste-disposal sites.

Although the text is keyed to an accompanying map of Santa Clara County, the report is topical in nature and the methodology used is applicable in other areas where the necessary physical information is available.

If you would like additional copies of the map, they are available through:

Public Inquiries Office
504 Custom House
555 Battery Street
San Francisco, CA 94111

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

Prepared in cooperation with the
DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

(200)
R29o
no. 73-111

WATER-RESOURCES INVESTIGATION 31-73
OPEN FILE REPORT (SHEET 2 OF 2)

Base from U.S. Geological Survey
San Francisco Bay Region 1:125,000, 1970,
sheet 3

SCALE 1:62 500

1 ½ 0 1 2 3 4 5 MILES

1 .5 0 1 2 3 4 5 6 7 KILOMETERS

CONTOUR INTERVAL 200 FEET
DOTTED LINES REPRESENT 40-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

MAP SHOWING SELECTED PHYSICAL INFORMATION FOR SANTA CLARA COUNTY, CALIFORNIA

Prepared in cooperation with the
DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

EVALUATING POLLUTION POTENTIAL OF LAND-BASED WASTE DISPOSAL, SANTA CLARA COUNTY, CALIFORNIA

AN APPLICATION OF EARTH-SCIENCE DATA FOR PLANNING

BY
W. G. HINES
Graphics by R. L. Rodgers

PREPARATION OF THE MAP

The discussion below summarizes the selection and preparation of the map and should aid planners who may wish to prepare a similar map for areas other than Santa Clara County.

The original base map chosen for the resources map was a 1:62,500 scale (about 1 inch = 1 mile) map compiled from Geological Survey 7½-minute topographic maps. The 1:62,500 scale offered the dual advantage of detail and compatibility with land-use and land-surface maps which were already available. For final preparation in this report, however, a photo-enlarged 1:62,500 scale section of the recently compiled 1:125,000 scale map of the San Francisco Bay region was used as the base map. This photo-enlarged map was registered to the original base map to facilitate the accurate transfer of information.

Users can consider boundaries for units showing land-use, land-slope, and flood-prone areas as accurate to within ±350 feet. Boundaries for other features are taken directly from the base map with little loss in accuracy. The reasons for possible inaccuracies are based upon the multiple-step process necessary for transfer of information to the base map and upon the preliminary and experimental nature of several of the source products.

Compilation of physical information on the base map, including the location of all major fresh and tidal surface water, marshlands, parks, campgrounds, recreational areas, and other cultural features, were already included on the base map and, except for accentuation, did not require any compilation. For the remaining earth-related information, separate compilation and transfer to the base map was accomplished as described below.

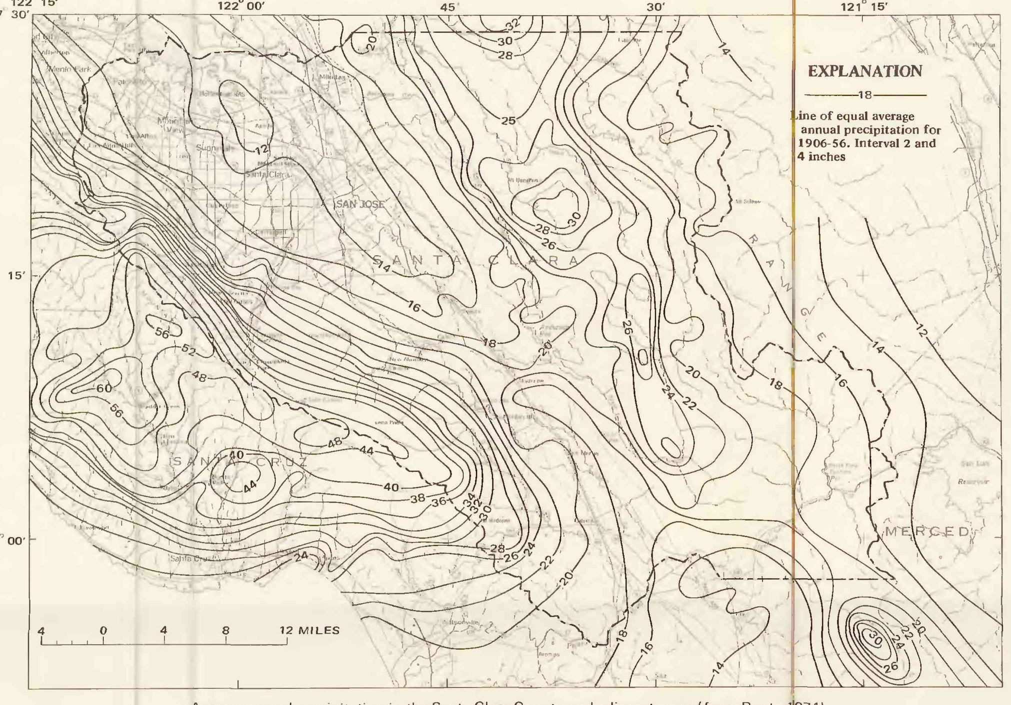
Land use.–Land-use information was transferred directly to the base map from land-use maps (scale 1:62,500) prepared by the Geological Survey, Washington, D.C., from 1970 NASA aerial photographs of the bay region. These land-use maps showed all distinct land-use types. For this report however, the classification was simplified for identification of three general types–urban, agricultural, and open space (see glossary in accompanying text for land-use descriptions).

Floods.–Information on flood-prone areas was compiled from flood maps prepared by the Santa Clara County Flood Control and Water Conservation District (1970) and Limerinos, Lee, and Lugo (1973). Flood-prone areas appearing on the resources map are based upon the statistical occurrence of a once-in-100-year flood with 1970 flood-control facilities in place. Put another way, a flood of magnitude illustrated has a 1 percent chance of occuring in any given year.

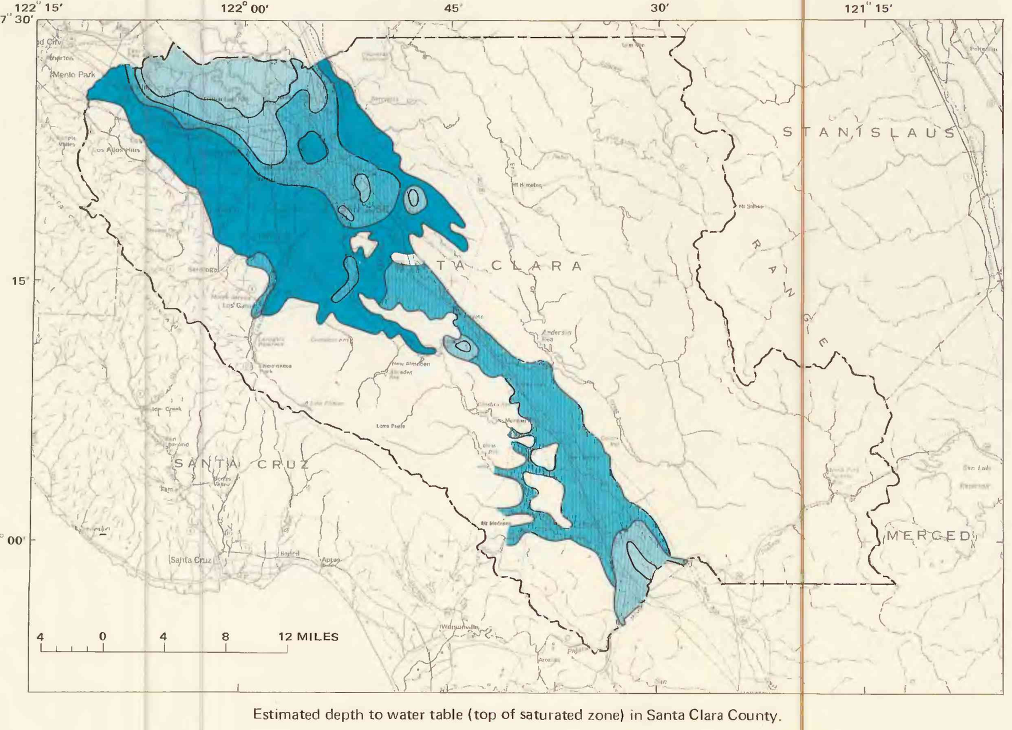
Land slope.–Information on slope was transferred directly onto the map from a slope map (scale 1:62,500) of Santa Clara County prepared by the Geological Survey in Menlo Park, Calif. This slope map identified land slopes in intervals of 0-5, 5-15, 15-30, 30-50, 50-70, and more than 70 percent. For the present map, slope intervals 0-5, 5-15, and more than 15 percent were identified in all areas except those mapped as urban or flood-prone areas.

Soil permeability.–Soil-permeability information for Santa Clara County was obtained from the U.S. Soil Conservation Service (1968) and manually transferred to the base map. Besides soil-permeability information, the Soil Conservation Service publication includes detailed soil maps (scale 1:12,000), a description of physical and chemical soils properties, and general land-use suitability interpretations. Similar publications of the Soil Conservation Service are available for most other areas in the bay region.

Base from U.S. Geological Survey San Francisco Bay Region 1:125,000, 1970, sheet 3



Average annual precipitation in the Santa Clara County and adjacent areas (from Rantz, 1971).



Estimated depth to water table (top of saturated zone) in Santa Clara County.

EXPLANATION

Less than 5 feet to water table (top of saturated zone)

5 to 10 feet to water table (top of saturated zone)

10 to 20 feet to water table (top of saturated zone)

More than 20 feet to water table (top of saturated zone)

Depth to water table little known. Depending on location, character of rocks, and sources of recharge, depth to water table may range from a few feet to more than 100 feet.

Boundary of Santa Clara County

MAP EXPLANATION

Information shown on the map can be identified by the symbols shown below. Note that in many cases symbols overlie one another to show two or more features simultaneously. For example, [2] depicts an area with agricultural land use [ ], a land-surface slope of 5-15 percent [ ], and a soil permeability of 0.2 to 0.63 inch per hour [2].

Classification	Map symbol	Remarks
Land use		
Urban		All land-use units, except urban, which are in areas of 0 to 5 and 5 to 15 percent land-surface slope also have soil permeability and land-surface slope symbols. Some open space will have slope and soil-permeability symbols (see below) and will thus not always appear blank as the symbol opposite indicates.
Agricultural		
County and State parks, campgrounds recreational areas, and game preserves	MT. MADERA STATE PARK	
Open space		
Municipal parks, golf courses, athletic fields, cemeteries	▲	
Soil permeability		Soil-permeability symbols appear either in or adjacent to areas identified as having land-surface slope of 0 to 5 or 5 to 15 percent. No soil-permeability symbols are shown for urban land, flood-prone land, or where land-surface slope in greater than 15 percent. Users should consider soil-permeability information depicted on this map as representative of average local conditions. Permeability often varies considerably with depth and with horizontal location, particularly where soils grade into extremely permeable alluvial deposits along stream channels.
0.0 to 0.2 inch per hour	1	
0.2 to 0.63 inch per hour	2	
0.63 to 2.0 inches per hour	3	
>2.0 inches per hour	4	
Land-surface slope		Land-surface slope colors are shown for all agricultural, recreational, and open-space land. No symbols are given for urban or flood-prone land. The large, central part of Santa Clara County where land-surface slope is within the 0 to 5 percent range is largely enclosed by the symbol
0 to 5 percent		
5 to 15 percent		
>15 percent		
Flood-prone area		Physical conditions within flood-prone areas are not shown on the map.
Stream and other water bodies	Lake Elsman Coyote Creek	Major streams, lakes, reservoirs, and tidal sloughs are shown on map by name.
Ground-water-recharge basin	R	
Marshlands		Marshlands occur along the margins of San Francisco Bay. Some marshlands cannot be identified on the map because they are within flood-prone areas.

SCALE 1:62 500

1 ½ 0 1 2 3 4 5 MILES

1 .5 0 1 2 3 4 5 6 7 KILOMETERS

CONTOUR INTERVAL 200 FEET
DOTTED LINES REPRESENT 40-FOOT CONTOURS
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