EVALUATION OF SOIL EROSION IMPACTS OF THE WEST AND SOUTH COUNTY RECLAMATION ALTERNATIVES

SANTA ROSA SUBREGIONAL LONG-TERM WASTEWATER PROJECT

Prepared for

City of Santa Rosa
and
U.S. Army Corps of Engineers

February 1996

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1. INTRODUCTION

The availability of reclaimed water for irrigation may change agricultural land-uses and consequently agricultural management practices in the West and South County project areas. Many of these areas are currently utilized for the production of dry-farmed oat hay and for beef and dairy cattle grazing. More intensive agricultural uses are generally precluded by the limited availability of a dependable irrigation water supply. Furthermore, there is strong motivation by farmers to produce more animal feeds locally, since the dairy industry currently imports more than 80 or 85 percent of its feeds at a significant cost.

With a dependable source of water supplied by the Santa Rosa project, some of the gently sloping lands may be converted from winter produced oat hay, silage, and grazing to such irrigated forage crops as summer hay, silage, sudan grass and field corn. Other gently to moderately sloping lands may be planted to improved pasture grasses and be more intensively grazed. Within the constraints of the IMP, cultivated crops, particularly cool season vegetables such as lettuce, broccoli, and cauliflower, may be grown utilizing sprinkler or drip irrigation on the flatter areas of the valley bottoms, while drip irrigated specialty corps, such as raspberries, strawberries and artichokes may be grown on gentle valley side slopes. Existing vineyards and orchards may be spray or drip irrigated in the Sebastopol and South County areas, as well as some new plantings established in these areas. Most of the intensively grown cultivated crops would utilize a winter grass cover for soil stabilization. The winter cover crops could be cut for hay or silage prior to seeding the vegetable crops in the spring. The use of protective cover crops is much more difficult in fields grown with perennial drip irrigated crops such as artichokes.

There is a concern that extensive land conversion from dry-farmed hay, silage and rangeland to cultivated vegetable crops, specialty crops, forage, and irrigated pasture will result in increased rates of soil erosion. This increase would be associated with the need for more frequent cultivation practices such as discing, plowing, harrowing and seeding. There is also a concern that when more feeds are produced locally, beef livestock and dairy herd sizes could increase. In turn, a larger number of animals in a small area could compact soils and increase rainfall runoff, nutrient discharge and soil erosion. Increased rates of runoff, nutrient discharge, and soil erosion are more likely to occur when agricultural practices disturb and expose soil to intensive rainfall events, particularly on sloping ground. The eroded soil particles and animal wastes could be transported to stream courses, and portions ultimately to the coastal estuaries or the Petaluma River or Laguna de Santa Rosa.

The concern over potential impacts is particularly high in the Stemple and Americano Creek watersheds. Historically accelerated rates of soil erosion from farming and ranching practices before the turn of the century have had serious environmental impacts on Estero de San Antonio and Estero Americano. Sediment deposition within the lower tidal reaches of these esteros has significantly altered their character, impacting water quality and aquatic biota, as well as emergent marsh and terrestrial vegetation.

Runoff containing elevated concentrations of nutrients from dairy and livestock operations are also impacting the coastal estuaries and the Petaluma River. These impacts, as well as a plan to enhance the watershed and improve the water quality and biologic attributes of the esteros, are presented in the Stemple Creek/Estero de San Antonio Watershed Enhancement Plan (Prunuske Chatham Inc., July 1994). The plan also provides recommendations for controlling existing sheet and rill erosion from hay land and rangeland areas, as well as for gully and streambank stabilization.

Expected hydrologic changes from intensive irrigated agriculture and associated nutrient and water quality effects are addressed in two separate technical reports, entitled:

1. Water Quality Evaluations on Wastewater Irrigation in West and South County Alternatives by Kenneth Tanji.

2. Baseline Hydrology and Irrigation Drainage Evaluation for West and South County Reclamation Alternatives, by Norman Hantzsche and Sydney Temple, Questa Engineering (July 1995).

In addition to concerns over potential increases of soil erosion from agricultural land conversion, construction activities associated with building the reclaimed water distribution system pipelines, stations and the storage reservoir(s) could result in substantial soil disturbance causing extensive localized soil erosion. Failure of pressurized pipelines and rupture of the proposed Geyser's pipeline could also result in substantial localized gullying and scouring of soils, especially on steep slopes immediately above stream crossings.

The U.S. Department of Agriculture's soil erosion prediction model, the Universal Soil Loss Equation (USLE), was used to estimate soil loss on farmed land in the West and South County project areas. The objective of the analysis was to determine if conversion of large areas of dry-farmed oat hay and native rangeland to more intensively cultivated irrigated crops would result in increased rates of soil erosion and subsequently increased sedimentation to South County and West County streams and estuaries.

The rate of soil erosion is dependent upon numerous factors including soil characteristics and their associated aggregate strength and ability to withstand detachment forces from rainfall and overland flow. Other important factors affecting soil erosion rates are rainfall intensity, slope steepness, slope length, water velocity and factors that determine if runoff water is directed and concentrated. Vegetative cover, particularly the establishment of a permanent dense cover crop that can absorb rainfall impact, disperse and retard surface flow and filter the water, is an important factor that is different among various land-uses and agricultural practices. Perhaps most important in the erosion equation is the effect that soil conservation and erosion control can have on reducing soil erosion rates.

In addition, the transport of eroded particles and their delivery to stream courses is equally complex. Such factors as particle size, the gradient of the flow path of water, and variables influencing the velocity and velocity changes in the water course must be considered.

2. SOIL CONSERVATION AND EROSION CONTROL PRACTICES

Water management, soil conservation and erosion control measures have been developed by the University of California Cooperative Extension Service (U.C. Extension) and the USDA Natural Resources Conservation Services (NRCS) for all of the major crop, dairy and ranching activities that may be considered for irrigation agriculture in Sonoma County. Nearly all of these measures are described in the NRCS *Field Engineering Handbook of Conservation Practices*. They include such items as: the correct design and installation of water intake and outlet structures and surface drainages; proper systems for tillage and seeding; irrigation management for dairy, pasture and range; selection, use and management of protective vegetative cover crops; streambank and gully stabilization methods, and, the use of temporary erosion control devices and sediment detention structures.

Provided that restrictions are placed on inappropriate planting of steep, erosive soils, the array of conservation practices and erosion control measures that can be assembled in a conservation plan are capable of significantly controlling erosion on irrigated and non-irrigated lands. In almost all instances, application of the appropriate erosion control technology and management practices will result in a net decrease in soil loss over existing conditions.

As outlined in the Irrigation Management Plan (IMP)[1] (Questa Engineering Corporation, July 1995), the development and implementation of a detailed farm-specific Irrigation and Conservation Plan (ICP) will be required for all farming and ranching operations electing to participate in the City's reclaimed wastewater irrigation project. The IMP has been developed as part of the project description, and following CEQA certification and project selection will be incorporated into the legally enforceable project Mitigation and Monitoring Plan. New conservation practices will be needed to be developed and field tested before drip/sprinkler irrigated specialty crops can be grown on sloping lands in the West County. These plans will be prepared in cooperation with the NRCS and the appropriate Resource Conservation District (RCD).

Soil erosion and sediment control measures will be an extremely important element in the ICPs. The ICPs will include irrigation system design and water application management techniques to avoid over-irrigation and greatly reduce the incidence of irrigation runoff and erosion, as well as subsurface flow and groundwater mounding problems. Eroding streambanks and head-cutting gullies will be stabilized where they occur adjacent to irrigation areas. This gully repair and streambank will be prioritized and accomplished over time in coordination with other State and Federal watershed

[1] The IMP has been developed and will considered for inclusion in the project description by the BPU.

enhancement projects. In addition to the ICPs, the Irrigation Management Plan provides for ongoing consultation and management assistance, as well as maintenance, and monitoring of plan implementation and success.

3. ESTIMATING SOIL LOSS WITH THE UNIVERSAL SOIL LOSS EQUATION, USLE

Accurately predicting actual soil loss rates is difficult and requires extensive long-term monitoring data. Erosion rates can vary radically annually in response to rainfall frequency and intensity, total precipitation amounts, cultivation practices, and many other factors.

The Universal Soil Loss Equation is an empirical model developed by the U.S. Department of Agricultural to estimate sheet and rill erosion from agricultural lands. A revised computer software version (RUSLE) was released by the Soil and Water Conservation Society of America (SWCSA) in 1994. It is extensively used by the Natural Resources Conservation Service (NRCS) to estimate soil erosion on an on-farm basis for conservation planning and verification of compliance with Food Security Act (FSA) conservation provisions. Provisions of the FSA generally prohibit cultivation of highly erodible lands or wetland areas, and deny eligibility to various USDA commodity support and conservation assistance programs to farmers who do not adhere to conservation plans prepared by the NRCS for their farms and ranches. The USLE has also been applied on a small watershed basis for water quality planning.

The equation calculates an annual erosion rate and consists of five variables based upon climate, surface conditions and agricultural practices.

The general form of the equation is:

$$A = R * K * LS * C * P$$

where A = soil loss rate, tons/acre/year
R = rainfall erosion index, tons/acre*/inches/hour
K = soil erodibility factor, tons/acre per unit of R
LS = slope length and steepness factor, dimensionless
C = vegetative cover factor, dimensionless
P = erosion control practice factor, dimensionless

It should be noted that the USLE estimates soil loss due to sheet and rill erosion only. The USLE is limited in the sense that it does not incorporate soil loss resulting from gully erosion, landsliding or stream bank failure. Gully erosion and bank failure are an important part of the total sediment load delivered to South County and West County surface streams. The reclamation project would stabilize many of the gullies and streambanks where they occur within and adjacent to irrigation acreage.

The best use of the USLE approach is for comparing before and after affects of various agricultural land-use changes, and subsequently defining the need for different conservation practices. Because of the numerous variables affecting erosion present in the West and South County project areas, a number of assumptions and simplifying modeling scenarios were developed and used in this analysis.

4. SOIL AND CROPPING SCENARIOS

4.1 SOILS

The most common and widely distributed soils occurring in the West County and South County project areas were used in the USLE erosion analysis. Clear Lake clay, which occurs on gently sloping valley bottoms, and Diablo clay, which occurs on moderately sloping, upland hills, were selected for analysis as representative of South County soil conditions. These are widely distributed soils in the South County project area, representing over 85 percent of the mapped soils in the Sonoma County Soil Survey (USDA, Soil Conservation Service, 1972).

Blucher loam and Pajaro fine sandy loam were selected as representative of valley bottom soils in the West County area. West County upland soils included Los Osos clay loam, Steinbeck loam, and Cotati fine sandy loam. Steinbeck loam and Goldridge fine-sandy-loam soils were evaluated as representative of soil conditions in the Sebastopol area. These seven soils represent over 80 percent of the mapped soils in the Sonoma and Marin County Soil Surveys (USDA, Soil Conservation Service, 1985) of the West County area. Steinbeck, Cotati and Goldridge soils present a particular concern because of their high inherent soil erosion potentials; their sandy surface layers make them moderately susceptible to rainfall detachment.

4.2 CROPS

A number of likely soil-crop scenarios were established for use with the USLE model. These scenarios are based on soil type and maximum slopes (i.e., worst case). The scenarios also based on the existing or potential crops that could be grown on the soils also taking into account the restrictions that would be imposed by the project.

As outlined in the Irrigation Suitability Technical Report (Questa Engineering Corporation, July 1995) and Irrigation Management Plan, because of concerns over potential soil erosion and to insure good irrigation water management, the project will impose certain restrictions on the kinds of crops that can be grown and cropping practices that can be utilized with project reclaimed water. In most cases only irrigated permanent pasture shall be grown on slopes steeper than ten percent. Hay, silage and forage crops such as sudan grass and field corn could be grown on slopes less than ten percent. Truck crops (such as cool season vegetables) would generally be restricted to slopes less than five percent. Drip irrigated specialty crops, orchards, and vineyards can be grown on steeper slopes, provided that certain soil conservation practices are implemented, such as the establishment of a winter cover crop.

A more detailed discussion of likely crops and cropping scenarios is presented in the Draft Cropping Scenarios for the West County and South County Reclamation

Alternatives Technical Memoranda (Questa Engineering Corporation, August 1995). These were used to develop the existing conditions and future cropping scenarios for comparative evaluation utilizing the USLE model.

The existing conditions scenarios for the South County and West County project alternatives were generally evaluated using oat-hay and grazed annual grass pasture for the representative soil types. Since there is currently a small acreage of vineyards on Clear Lake and Diablo soils in the Lakeville Highway portion of the South County, an existing conditions scenario also evaluated these combinations, along with irrigated vegetable crops. Existing apple orchards and vineyards on Steinbeck and Goldridge soils in the Sebastopol area were also evaluated.

Although many kinds of agricultural crops could be grown on South County and West County soils, given the availability of a dependable irrigation water supply, the future conditions scenario analysis focused on what is envisioned to be the most likely crops grown with the most extensive acreage. These included irrigated oat hay or silage, irrigated forage crops (i.e., sudan grass or field corn), and permanent irrigated pasture. Vegetables and specialty crops evaluated consisted of lettuce, strawberries and artichokes. Vineyards and apple orchards were also tested in the South County and Sebastopol area using the USLE model as their acreage could increase somewhat with the greater availability of irrigation water. An analysis was also made to determine the potential benefits of supplying irrigation water to existing orchards and vineyards with the stipulation that appropriate conservation practices (such as establishing permanent perennial cover crops) be required. Clean cultivated, dry-farmed orchards and vineyards currently grown on sloping sandy soils in the Sebastopol area are known to result in high rates of soil erosion.

5. USLE VARIABLES

Most of the USLE factor values used in the erosion evaluation were selected based on information supplied by the Petaluma field office of the NRCS. These are similar to values used by their office in evaluating farmlands for compliance with provisions of the USDA Conservation Reserve Program. Values for specialty crops (strawberries and artichokes) on moderate slopes were obtained from the Aptos (Santa Cruz) and Salinas (Monterey) field office of the NRCS.

The rainfall (R), soil (K), and slope (LS) variables remain constant under both the existing (dry-farmed) conditions and future crop (irrigated) scenarios. Since many differ in the form and density of protective vegetative cover, the cover (C) variable may change between existing conditions and the future crop scenarios. The erosion control or conservation practice (P) also changes depending upon the type of crop and practice.

The rainfall erosion index (R) is based on a Type I storm with a two year return interval, six hour precipitation intensity event. The R factor used for the Southern Sonoma County area was 60, and an R factor of 75 was used for the more rainfall intensive West County area.

The soil erodibility factor (K value), which is a measure of a soil's ability to resist rainfall detachment and transport, varies considerably among soil types in Sonoma County. The K values were obtained from calculations made by the NRCS Petaluma office. The K values of soils within the West and South County study areas range from 0.24 to 0.37. When all other erosive factors are equal (similar crops, slopes, etc.), a farm with an erosive soil (K = value of 0.37) would experience more than 1.5 times as much soil loss as a soil with a lower erosion hazard (K value of 0.24).

The detachment and transport of soil particles down a slope is strongly influenced by the slope gradient and length of slope of the field. Slope gradient and length are combined in the LS factor. Air photographs and topographic maps were used to determine a typical or representative LS factor for various kinds of agricultural land uses. In most cases, the steepest slope gradient that the project crop restrictions would allow (as outlined in the Irrigation Management Plan) was used to determine the appropriate LS factor. Since the LS factor is one of the principal or most significant determinants of soils loss, this often results in a worst-case analysis of project erosion problems.

LS values are small (less than 1.00) when slopes are less than five percent and slope lengths are less than 300 feet. On steep slopes, the erosive hazard increases dramatically. For example, crops grown on 15 percent slopes with slope lengths of 500 feet would have an LS value of 5.29 in the USLE model. Using the above LS values and holding all other factors equal, crops grown on the longer, steeper slopes would have over five times the annual soil loss.

The structure and density of vegetative cover, including stubble and mulch in fallow fields, and its ability to protect soils from the erosive energies of raindrop impact also varies among crops. Crops with a higher cover density have lower C values. For example, the C value for native vegetation corresponds to a numerical value of 0.01, indicating over 95 percent of the ground cover is vegetated. Plowed or fallow fields, which are barren in the early winter, have C values of 0.9. Grazed native vegetation where the remaining crop residue is less than 50 percent prior to the on-set of water rains was estimated to have a C value of 0.09, while ungrazed native vegetation in good condition with a plant and residue cover of about 90 percent, was assigned a C value of 0.04.

The P factor represents the employment of erosion control measures and conservation practices. These practices include contour farming, cross-slope farming, use of vegetative filter strips, cover crops and other measures. Generally, barren soils plowed up and down slopes have P values close to 1.0, while contour farmed fields with a dense winter cover crop have P values of approximately 0.1. As indicated earlier, the NRCS has developed conservation practices to greatly reduce soil erosion for nearly all of the existing and potential crops grown in Sonoma and Marin Counties. Conservation measures for specialty crops are also available from the Santa Cruz and Monterey County Resource Conservation Districts. USLE input variables for the South County and West County are summarized in Tables 1 and 2.

6. RESULTS OF USLE MODEL RUNS

The results of the USLE model runs are presented in Tables 3 and 4 for the South County and West County areas, respectively. The tables compare soil loss under existing conditions (Column 4) with various future cropping choices (Column 6) on representative soils and slope classes. Column 7 indicates the net increase or reduction in annual soil loss associated with changed agricultural practices from irrigation.

6.1 SOUTH COUNTY

The results for the South County indicate that overall, lands irrigated with project reclaimed water should have significantly less soil erosion than that occurring from existing dry-farmed hay lands and intensively grazed rangeland areas based on assumed crops and management practices specified in the IMP. Existing sloping hay lands and grazed rangeland areas have an estimated soil loss from sheet and rill erosion ranging from about three to ten tons per acre. As would be expected, haylands on flat slopes are estimated to have very low soil erosion rates, about 2.6 tons per acre for the steepest Clear Lake soils (five percent slopes), and less than one ton per acre for flat lying areas. The current practice of cutting oat hay and allowing sheep and cattle to graze the stubble, as well as intensive grazing of rangeland areas on steeper slopes can increase the soil erosion hazard by reducing the amount of residual dry matter (RDM), which serves as a mulch to protect the soil during the early fall rainfall events. RDM values of less than 1,000 pounds per acre on slopes over 10 to 15 percent generally result in highly erodible lands, with soil loss of over 15 tons per acre. For comparison, background, non-grazed areas of native vegetation in good condition are estimated to have soil losses typically of 0.5 to one ton per acre, annually, depending on slope.

The reduction in soil loss from conversion to irrigated agriculture on a per field (per acre) basis is, shown in Appendix A, Table 3, last column. This reduction assumes that the erosion control practices identified as being required in the Irrigation Management Plan are successfully implemented, and grazed areas are well managed. The USLE model runs assume the institution of such soil conservation practices as contour farming or cross-slope farming with use of vegetative filter strips, timely establishment of protective vegetation with sprinkler irrigation, cross-fencing and rest-rotation systems for irrigated pastures, and establishment of cover crops for orchards and vineyards.

The most common change we anticipate to occur in the South County project area is the conversion of dry-farmed hay on sloping lands to an irrigated oat hay or forage crop. Slope and soil conditions present limitations and constraints on the amount of land that can be utilized for vegetable and specialty crops. Conversion of oat hay or native grassland to permanent irrigated pasture using a no-till seed drill is expected to be extensively practiced on steeper slopes. This management practice will require construction of perimeter and cross fences in pastures, and fencing and restoration of gullies and streams adjacent to irrigation areas. The USLE model indicates reductions in annual soil loss ranging from about two to six tons per acre for this type of agricultural land-use change, provided that improved conservation practices are implemented. Conversion of oat hay to vegetables or specialty crops is more likely on the flatter lands east of Rohnert Park. No significant change in soil erosion is predicted.

Modest reductions in soil loss from field sheet and rill erosion could be accomplished by using sprinkler irrigation to germinate and "grow-up" fall seeded field crops. Sprinkler irrigation allows the establishment of a good, protective vegetative cover to be in place prior to the on-set of late fall and early winter rains. Under the current farming system, fall-seeded, dry-farmed crops must rely on light intensity, early season rains to germinate and establish a protective crop. These lands are particularly vulnerable to erosion-producing heavy rains if a protective plant cover is not first established. Use of sprinklers also provides protection of spring seeded crops from intense late spring rains, again by allowing timely establishment of protective vegetative cover. Irrigation water must be applied carefully and uniformly on sloping ground to avoid runoff or concentrating flows which may create or enlarge gully systems. The project Irrigation Management Plan describes the procedures and management practices that will be utilized to erosion problems on irrigated lands associated with sprinkler irrigation.

The USLE model runs predict a slight increase in soil loss when ungrazed native vegetation areas on slopes up to nine percent are converted to forage. Predicted soil loss increases are slightly less than one ton per acre. Not many areas of ungrazed native vegetation on slopes less than ten percent are predicted to be converted to these crops; most of these areas are currently used for hay production or are more intensively grazed.

It should also be noted that the existing conditions model assumption is for native vegetation areas in fair range condition. More intensively grazed areas in moderate condition are estimated to have annual soil loss rates in the range of two to five tons per acre, and in poor condition five to ten tons per acre, or more. Therefore, the magnitude of the soil loss reduction could be greater than estimated.

Substantial reductions in soil loss can occur when current orchards and vineyards grown on steep, erosive soils in the Sebastopol area (Steinbeck and Goldridge soils) are supplied with reclaimed irrigation water and follow good erosion control practices. Annual soil loss reductions on the order of four to 12 tons per acre, are possible. For comparison, a soil loss of ten tons per acre is equivalent to the thickness of a dime.

Significant visible sheet and rill erosion occur at rates of about 20 tons per acre. These erosion reductions primarily stem from the project's required use of permanent perennial cover crop within the vines and trees. The cover crops would be mowed, not disced under, during the spring and summer months. Development and implementation of erosion control measures likely will be required as a precondition to irrigation of these lands with project reclaimed water.

The model runs predict that conversion of existing oat hay lands to orchards and vineyards using permanent cover crops and other conservation practices will result in small decreases in annual soil loss. Slightly higher levels of soil erosion would occur if moderately sloping oat hay lands are converted to vineyards that do not employ good conservation practices. Significantly increased rates of soil erosion would occur if oat hay lands are converted to orchards, vineyards or specialty crops (such as drip irrigated strawberries) on steeper slopes and conservation practices are not employed. Artichokes are not modeled in the South County as it appears that microclimate conditions are less favorable (too warm) for this crop than in portions of the West County area.

The analysis indicates the strong need for either RCD input in preparation of Irrigation and Conservation Plans; or alternatively, that the plans be prepared by qualified consulting agronomists and soil scientists. Erosion implications of converting sloping lands to specialty crops are discussed more fully in the West County discussion below.

6.2 WEST COUNTY

The results of the West County USLE model runs in Appendix A, Table 4 also indicate that on a watershed wide basis, significant reductions in soil loss can occur (compared to existing conditions), in “Low Tech” and “Medium Tech” scenarios provided that good conservation practices are implemented, and crop choices are matched with land capability.

As outlined in the Stemple-Creek Americano Watershed Enhancement Plan (Prunuske Chatam, Inc., July 1994), many conservation measures can be and are being implemented on a voluntary basis, or through partial funding assistance by USDA programs and Clean Water Act grant funds. These measures can significantly reduce existing soil erosion problems in the West County area.

The majority of the agricultural land-use change is expected from converting dry farmed oat hay to either irrigated silage, hay crops, or sudan grass and field corn. The USLE model predicts modest reductions in annual soil loss on flat (five percent) and moderate (nine percent) slopes, typically of about one to three tons per acre. Significant soil loss reductions, on the order of five to ten tons per acre, are predicted to occur when steeper (15 percent) slopes currently dry farmed as oat hay or intensively grazed areas are converted to well managed permanent irrigated pasture. Slight increases in soil loss are anticipated when ungrazed rangeland in good condition is converted to irrigated hay, silage, sudan grass or field corn. As there is little ungrazed rangeland in good condition in the watershed, this is expected to be a rare occurrence.

The USLE model also predicts that converting grazed grasslands to permanent irrigated pasture will result in slight reductions in soil erosion. As in the South County alternative, for modeling purposes, the rangeland area was assumed to be well managed and in fair to good condition, with only slight erosion problems. Some West County areas have not been well managed in the past and have areas of accelerated surface erosion and gullying.

Although not modeled, these lands will experience a significant net reduction in soil loss when converted from annual grass vegetation, either mowed or grazed, to irrigated field crops or permanent pasture. This is particularly true if gullied lands are fenced and healed. Reductions on the order of 10 to 15 tons per acre, or more, can be expected in these instances.

The biggest concern is over the possible conversion of oat hay lands on steep slopes to drip-sprinkler and ordinary sprinkler irrigated specialty crops, such as cut flowers, raspberries, strawberries and artichokes. Such crops are grown on slopes as steep as 20 percent in Santa Cruz, San Mateo and Monterey Counties; significant amounts of soil erosion could occur on these lands. The potential erosion problem is even higher in coastal Sonoma County because of the occurrence of more intensive winter rains. Limitations on crops imposed by the project would generally restrict specialty crops to slopes less than ten percent. Soil erosion is an especially significant concern for these specialty crops as they typically require the application of agrochemicals (fertilizers and pesticides); eroded soil particles often transport chemicals attached to them to nearby surface waters.

To illustrate the potential problem, artichokes and strawberries were evaluated on five and nine percent slopes of the Pajaro, Steinbeck and Cotati soils, with and without incorporating soil conservation practices developed for use in the Monterey Bay Area. One scenario used fall-planted strawberries grown without a winter cover crop (W-strawberries), and the other scenario used spring planted strawberries (S-strawberries) removed and replanted to a cover crop in the fall. Extremely high rates of soil erosion occur where these specialty crops are grown without erosion control measures. Much higher rates of soil loss were predicted from strawberries and artichokes than the oat-hay existing conditions scenario, even when some erosion control measures were incorporated. The predicted increase for fall-planted strawberries and artichokes was moderate on slopes of five percent, but significant on slopes of nine percent, approximately 11 and 26 tons per acre, respectively. Soil erosion rates ranging from existing conditions to slightly decreased rates were predicted from converting oat-hay to spring planted strawberries on five percent slopes, removed and replanted with a cover crop in late fall, utilizing extensive soil erosion control technology.

Strawberries as grown in the cool, coastal Santa Cruz and Monterey areas are typically fall-planted in rows that may be cross-slope or parallel to hillside contours. They may be grown and replaced with new plantings after one or two years. The berry rows are typically 20 to 25 inches wide and are 30 to 36 inches between rows, and not necessarily cross-sloped or contour planted. Although the strawberry plants are usually grown through plastic sheeting that provides soil protection, current management practices use clean cultivation between rows. In addition, there may be a fairly large percentage of the field dedicated to access roads for maintenance and harvesting. This means that about 40 to 50 percent or more of the field consists of barren soil exposed to winter rains. The use of field border vegetative filter strips and sediment detention basins can detain and trap some of the sediment lost from the farm fields, perhaps as much as 40 to 50 percent in some coarse textured soils. Rainfall is much less intense in the southern coastal counties, with R values ranging from 15 to 50, compared to 75 in coastal Sonoma County. In other words, similar soils under similar conditions would erode 1.5 times more in coastal Sonoma.

The USLE model predicts that converting haylands to artichokes on sloping grounds will result in significant increased soil loss, but less than fall-planted strawberries. Artichokes are a perennial row crop plant. Because of the size of the plants, inter-row bare areas may account for a much smaller percent of the field than with strawberries. However, a sizable percentage of the field (approximately ten percent) may be taken up by access roads. Predicted soil loss from converting hayland to artichokes on five percent slopes was three to seven tons per acre, representing an increase of about three tons per acre. However, on nine percent slopes, soil loss increased 14 to 16 tons per acre, a significant increase.

In summary, because of the high erosion potential associated with growing specialty crops on sloping lands, net project area wide changes in soil erosion will depend on the balance between the amount of oat-hay land converted to irrigated hay and pasture (with decreased soil erosion) versus the amount converted to strawberries, artichokes or similar crops (with increased soil erosion). At this point in project planning we cannot determine the actual acreage that might eventually be planted with erosive specialty crops. We can only evaluate possible future agricultural land use scenarios, including a worst case scenario in which much of the West County lands are planted to specialty crops. According to public comment contained in the scoping report and various testimony to the BPU, many West County residents do not believe it is feasible or agriculturally viable to grow specialty crops because of the cool weather and poorly drained soil conditions. This issue is discussed in the next section.

6.4 PROJECT-WIDE AGRICULTURAL SOIL LOSS ESTIMATES

The estimates of soil erosion made under existing agricultural land-use conditions and the potential or future irrigated cropping choices represent predictions of sheet and rill soil loss from various farm fields with differing soil, slope and cropping conditions. These soil loss calculations are in units of tons per acre per year for a representative farm field that on average may be 40 to 100 acres in size.

To determine total sheet and rill soil loss on a project or watershed wide basis, the erosion data for each differing soil-crop scenario must be extrapolated to the larger planning area by proportioning the acreage among differing cropping scenarios. Multiplication of the predicted soil loss in tons per acre for the soil-slope-crop combination scenario by the anticipated total project or watershed-wide acreage of the crop will then provide a rough estimate of area wide soil loss from agricultural fields. The soil loss estimates from each scenario can than be added under existing conditions and future irrigated crop conditions to arrive at an estimate of total farm field soil loss (in tons) for the entire project. Project soil erosion impacts can then be estimated by comparing area wide existing dry-farmed conditions with future irrigated conditions.

The Cropping Scenarios Technical Report provides a basis for the required extrapolation or proportioning of future agricultural land-uses within the West and South County project areas. The three levels of project wide farming intensity, Low Tech, Medium Tech and High Tech were developed for purposes of evaluating different economic and environmental impacts.

1. Low Tech, in which much of the project areas were assumed to be used for irrigated hay, silage and irrigated pasture, with only small amounts in vegetables and specialty crops and pasture.

2. Medium Tech in which much of the area would be in irrigated hay and forage crops, with some vegetables, specialty crops and pasture.

3. High Tech, in which much of the project areas were assumed to be utilized for cultivated crops, or specialty crops with a small acreage in forage crops and pastures.

Acreages were estimated for differing types of crops based on soil limitations and slope constraints for each of these agricultural land use intensity scenarios with the acreages varying depending upon whether the one, five or ten percent Russian River discharge alternative was being considered. These acreages further varied depending upon if orchards and vineyards in the Sebastopol area were included in the project. Because drip irrigated specialty crops consume less water than field crops or pasture, a larger acreage (greater than 15 percent) was utilized for the High Tech scenario than the Medium Tech, and a smaller acreage was used for the Low Tech scenario (less than ten percent).

Based on the previously completed USLE model runs for various soil-crop combinations, typical (often worse-case-steep slope) benchmark, soil losses were then assigned to each type of crop. This acreage figure, multiplied by the benchmark soil loss for the crop, with the crop type soil losses summed up, provides an estimate of total soil loss on a project wide basis for each agricultural land use intensity scenario. The benchmark soil loss used in the analysis is shown with an asterisk in Tables 1 through 4. Because of the wide range in soil loss on differing soils and slopes and between artichokes and strawberries, a mathematical average of spring planted strawberries and artichokes on various slopes was used. Tables 5 and 6 provide the data input used in the calculations. The results are summarized in Appendix A, Table 7 for the South County and Appendix A, Table 8 for the West County. These tables also provide an estimate of the project wide existing conditions soil loss from sheet and rill for current agricultural land use.

6.4.1 The Low Tech Scenario

The results predict a significant decrease in project-wide sheet and rill soil erosion from existing condition in both the West and South County alternatives, for the Low Tech, one percent river discharge cropping scenario. Under this scenario, much of the South and West County areas are assumed to be converted from dry-farmed oat-hay and native range to irrigated hay crops (with a fall sprinkler established winter cover crop) and permanent, well-managed irrigated pasture. Total project wide annual soil loss reductions on the order of 18,600 tons are predicted for the South County area, and 14,300 tons for the West County area, as shown in Appendix A, Tables 7 and 8, respectively. Less significant soil loss reductions are predicted as total irrigated acreage declines for the five and ten percent alternatives. However, these estimates represent a worst case scenario, with specialty crops grown to the upper limit of their allowable slope class (nine percent). Much less soil loss would occur if more crops are grown on flatter slopes. The existing conditions assume all oat-hay is grown on nine percent slopes.

Even more significant project wide reductions in sheet and rill erosion are shown when the Sebastapol sub-alternative is included in the Low Tech project component. These reductions stem from the requirement to include erosion control measures, such as the establishing cover crops in existing orchards and vineyards. Project wide reductions of about 20,500 tons are predicted for the one percent alternative, South County Low Tech-Sebastapol scenario, and 16,700 tons for the West County.

6.4.2 The Medium Tech Scenario

As would be expected, much more modest decreases in soil losses from sheet and rill erosion are predicted for the Medium Tech alternative. Decreased soil losses from converting oat-hay and range to irrigated hay and pasture are somewhat counterbalanced by increased soil losses from the conversion of drip irrigated specialty crop lands, particularly for spring planted strawberries and artichokes. For the one percent alternatives, total soil loss are predicted to decrease from about 16,000 tons to 6,800 tons, a reduction of 9,200 tons in the West County. Predicted reductions in the South County One Percent, Medium Tech are from 19,150 to 21,000, about 17,050 less.

Decreases in soil loss are predicted to become more significant when the Sebastapol sub-alternative is included in the Medium Tech scenario. Again, the benefits arise from the project's soil conservation requirement for delivery of reclaimed irrigation to existing clean-cultivated vineyards and orchards. As the acreage required for irrigation diminishes with increased water discharged to the Russian River in the five percent and ten percent alternatives, reductions in total soil loss change correspondingly.

6.4.3 The High Tech Scenario

Depending on the amount of sloping land acreage presumed to be converted to drip irrigated specialty crops, there could be a significant net increase in total soil loss in the West County area. This would be particularly true if extensive acreage were devoted to fall-planted strawberries, artichokes, or similar row crops on steep slopes and appropriate erosion control and conservation practices were not implemented.

The High Tech scenario and one percent alternative predicts total soil loss for the West County of 19,6000 tons as compared to the existing conditions model of 16,000 tons, an increase of 3,600 tons. These predictions occur even when conservation practices are applied and spring planted strawberries are grown with a winter cover crop. Total soil loss for the South County High Tech scenario is predicted to decline somewhat to 6,100 tons for the one percent alternative, spring planted strawberries, as compared with an estimated background from sheet and rill erosion sources of 19,150 tons. This represents an annual reduction of 13,050 tons. When soil loss reductions from conservation practices are applied to existing orchards and vineyards in the Sebastapol area, the High Tech scenario's (one percent alternative, with Sebastapol irrigation) total soil loss drops to 18,400 tons in the South County (one percent) and 17,500 tons in the West County.

There could be a significant erosion problem if an extensive acreage of specialty crops are grown in the West County. This would require developing new soil conservation measures for these crops, and diligent application and enforcement of those measures.

7. SOIL EROSION IMPACTS

There are three primary considerations in evaluating soil loss and erosion impacts on natural resources: (1) protecting the long-term agricultural viability and productivity of the soil resource; (2) evaluating changes in soil loss from land use; and, (3) protecting water quality from sedimentation due to agricultural field soil loss.

7.1 SOIL LOSS AND AGRICULTURAL VIABILITY

Much of the productivity of a natural soil is associated with the nutrients stored in the immediate surface layers or topsoil. The gradual erosional loss of this surface layer can adversely impact the capability of the soil to produce crops over the long-term. Since soils vary in the fertility and thickness of their surface layers, they are said to have different tolerances to soil erosion. A soil with a thin topsoil will have a very low soil loss tolerance, while a soil with a very thick layer will have a high tolerance.

Soil types have been rated by the NRCS according to their soil loss tolerance, or T value. Established T values for the soils occurring in the West and South County project areas are provided in Appendix A, Tables 1 and 2, respectively. The T values are expressed as annual tons per acre of allowable soil loss. One important measure of accelerated or unacceptable erosional impacts from changed land-use or agricultural practices is when the USLE predicted annual soil loss exceeds the T value. Predicted exceedance of T values can be used as a significance criteria for evaluation of project impacts on agriculture. Currently, several dry-land, oat-hay crops grown on steep slopes as well as intensively grazed areas in both the South County or West County areas have erosion rates that approach or exceed specified T values (compare next to last and last columns in Appendix A, Tables 1 and 2). Many existing orchards and vineyards grown with clean cultivation practices (annual grasses between trees and vines disced-in) on moderate to steep slopes, also significantly exceed the T values established for these soils.

With the requirement for planning and implementing erosion control measures as a project condition assumed in the future irrigation crop scenario, no T values are predicted to be exceeded for vegetable crops and field crops. New plantings of orchards and vineyards on slopes steeper than ten percent are predicted to have soil losses exceeding allowable T values, even with winter cover crops. Additional conservation measures would need to be devised and implemented prior to project authorization of steep area vineyard and orchard plantings.

The growing of specialty crops such as fall-planted strawberries and artichokes on steep slopes (greater than five percent) also has the potential to develop significant erosion problems with soil losses expected to exceed T values, particularly in the West County area. The IMP places restrictions on crops and cropping practices for steep slopes and erosive soils. New cultural practices and conservation measures would need to be developed prior to consideration of planting of these crops using project reclaimed water. For instance, spring planted strawberries are not widely utilized because of their much lower yields than fall-planted varieties. Because of this economic/competitive disadvantage these strawberries likely would be grown only for the local fresh market.

7.2 CHANGES IN GRAZING PRACTICES

Evaluating erosion problems associated with changes in grazing practices cannot be directly evaluated by the USLE. We do not anticipate any significant increases in soil erosion from changes in grazing practices. However, the amount of irrigated pasture may be increased to reduce the need to purchase feeds. Increased demand for grazing could result in the development of additional irrigated pasture. If not properly managed, this increased grazing pressure on the land (more animals per acre) could result in increased soil erosion.

As outlined in the Irrigation Management Plan, the provisions are proposed to insure that irrigated pastures are properly managed, by matching grazing intensity and animal use with the proper pasture carrying capacity, as well as controlling animal movement and concentration through the use of water troughs, fencing and other techniques. The City will assist farmers and ranchers in developing and implementing pasture management plans and in monitoring compliance with the plans.

The increased availability of locally or ranch produced forage and feed could also conceivably serve as an incentive for ranchers and dairymen to increase herd size. A higher concentration of animals in feeding and milking areas could also result in increased soil erosion and soil compaction containing sediments and animal wastes. As described in the Agricultural Economic Analysis study completed by Economic and Planning Systems, a widespread increase in dairy herd size is not expected to occur in the West County or South County areas. Although high feed costs are a significant portion of the production costs of Sonoma County dairies, other factors including milk production agreements with creameries, price support agreements with the U.S. Department of Agriculture, and necessary infrastructure improvements such as modifications to waste management systems provide significant constraints to slow herd expansion.

8. CONCLUSIONS AND RECOMMENDATIONS

The proposed project contains management measures (the IMP) that, when successfully implemented on a project-wide basis, could reduce total sheet and rill erosion from agricultural lands to less than existing conditions or baseline levels. Reductions of 25 to 50 percent in sheet and rill soil loss from project irrigated farm lands are predicted, depending on the cropping scenario. These estimates that erosion control technologies developed elsewhere (i.e., Pajaro Valley, Napa Valley and Salinas) can and will be adopted and implemented in Sonoma County. Requirements that the project adhere to Food Security Act provisions should provide such assurance.

Sheet and rill erosion from agricultural lands contribute different percentages of the overall sediment budget for the West and South County study areas. Erosion from agricultural lands are estimated to generate only about one-third of the total sediment yield of West County watersheds (Prunuske Chatham, 1994), while gully erosion and streambank failure are more significant sources of sediment in the West County area. This may be attributable to the geologically unstable character of the West County area and the fact that the West County watersheds have relatively elongated stream lengths relative to the size of the watersheds.

On the other hand, sheet and rill erosion appears to be a more significant contributor to the total sediment budget in the South County area. Our rough estimate accounts for 40 to 50 percent or more of the total sediment yield in the South County area from sheet and rill erosion, compared to the 33 percent estimated for the West County. This may be because the South County land forms are more stable and there is less evidence of gully erosion (although still significant); the stream geometry/geomorphology is also less susceptible to bank failure.

Because of the higher rainfall conditions, the more erosive soils and greater gullying and streambank failure, total sediment yield is also thought to be much higher in the West County than the South County when expressed in terms of sediment yield of tons per square mile. As outlined in the Stemple Creek/Estero de San Antonio Watershed Enhancement Plan, sediment yield in the West County is estimated to be 1,000 tons per square mile, annually. Given the watershed characteristics of the South County area, sediment yield may be one-half that amount.

The same type of detailed erosion and sediment study that was conducted by the NRCS for the Stemple/Americano Watershed has not been completed for the Sonoma Mountain watershed portion of the Russian River drainage, or the Petaluma River drainage. Southern Sonoma RCD has submitted a 205J watershed analysis proposal for the

Petaluma River watershed which is currently under consideration for funding by the State Water Resources Control Board.

In addition to required on-farm management practices to control irrigation runoff and erosion, the proposed project includes measures to stabilize and heal gullies and streambanks on lands to be irrigated. Although lands to be irrigated constitute only a small portion of the overall watershed (depending on the alternative, from 15 to percent), incorporation of such measures throughout the South and West County project areas can make a significant difference in sedimentation rates of surface water bodies.

The Santa Rosa Long-Term Wastewater Management Program, if properly planned and managed, combined with the type of watershed enhancement projects outlined in the Stemple Creek/Estero de San Antonio Enhancement Plan, can significantly improve the water quality and biological resources of these areas. To be successful the program will require extensive coordination and cooperation between agencies, particularly U.C. Cooperative Extensive Services, the NRCS and the Resource Conservation Districts.

APPENDIX A

Table 1: South County Case Studies

1a: USLE Case Studies for Existing Dry-Farmed Conditions

Land Use	Soil Name	Slope (%)	R	K	LS	C	P	T	Annual Soil Loss Rate (tons/acre)
Apple Orchards	Steinbeck	9	60	0.37	2.19	0.28	0.45	3	6.1
Apple Orchards	Steinbeck	15	60	0.37	5.22	0.28	0.6	3	19.5
Apple Orchards	Goldridge	9	60	0.28	2.75	0.28	0.45	5	5.8
Apple Orchards	Goldridge	15	60	0.28	4.96	0.28	0.6	5	14.0
Vegetable Crops	Clearlake	5	60	0.24	1.31	0.28	0.1	5	0.5
Native Vegetation	Clearlake	5	60	0.24	0.14	0.09	0.35	5	0.06
Native Vegetation	Diablo	9	60	0.24	2.58	0.09	0.35	3	1.17
Native Vegetation	Diablo	15	60	0.24	5.86	0.09	0.45	3	3.4
Native Vegetation	Diablo	25	60	0.24	10.8	0.09	0.35	3	4.9
Native Vegetation*	Diablo	35	60	0.24	16.8	0.04	0.1	3	1.0
Vineyards	Clearlake	5	60	0.24	1.56	0.31	0.37	5	2.6
Vineyards	Diablo	9	60	0.24	2.57	0.31	0.45	3	5.2
Vineyards	Diablo	15	60	0.24	5.96	0.31	0.6	3	16.0
Vineyards	Steinbeck	9	60	0.37	2.38	0.31	0.45	3	7.4
Vineyards	Steinbeck	15	60	0.37	3.07	0.31	0.6	3	12.7
Vineyards	Goldridge	9	60	0.28	1.9	0.31	0.45	5	4.5
Vineyards	Goldridge	15	60	0.28	4.83	0.31	0.6	5	15.1
Oat-Hay	Clearlake	5	60	0.24	1.31	0.17	0.8	5	2.6
Oat-Hay	Diablo	9	60	0.24	3.19	0.17	0.8	3	6.2
Oat-Hay	Diablo	15	60	0.24	5.29	0.17	0.8	3	10.4

NOTES:

1) Apple orchards and vineyards are assumed clean cultivated having a 3+ year stage of development with 20% ground cover during the early winter months.
2) Vegetable crops are cross slope farmed with an oat hay cover crop grown during winter months.
3) Native vegetation* refers to un-grazed areas in good condition.
4) Native vegetation is grazed in fair condition with a 50% ground cover in early winter months.
5) Oat-hay is a non-irrigated, stuble-grazed cross slope till crop.
6) T = tolerance factor (tons/acre/year).
7) Existing conditions generally involve worst case slope scenarios.

Table 1: South County Case Studies

1b: USLE Case Studies for Future Irrigated Conditions

Land Use	Soil Name	Slope (%)	R	K	LS	C	P	T	Annual Soil Loss Rate (tons/acre)
Apple Orchards	Clearlake	5	60	0.24	1.31	0.1	0.37	5	0.7
Apple Orchards	Steinbeck	9	60	0.37	2.19	0.1	0.45	3	2.2
Apple Orchards	Steinbeck	15	60	0.37	5.22	0.1	0.60	3	7.0
Apple Orchards	Goldridge	9	60	0.28	2.75	0.1	0.45	5	2.1
Apple Orchards	Goldridge	15	60	0.28	4.96	0.1	0.60	5	5.0
Apple Orchards	Diablo	9	60	0.24	3.19	0.1	0.45	3	2.1
Apple Orchards	Diablo	15	60	0.24	5.29	0.1	0.60	3	4.6
Vegetable Crops	Clearlake	5	60	0.24	1.31	0.2	0.10	5	0.4
Irrigated Pasture	Clearlake	5	60	0.24	1.31	0.01	0.10	5	0.019
Irrigated Pasture	Diablo	9	60	0.24	2.58	0.01	0.10	3	0.04
Irrigated Pasture	Diablo	9	60	0.24	3.19	0.01	0.10	3	0.05
Irrigated Pasture	Diablo	15	60	0.24	5.29	0.01	0.10	3	0.08
Irrigated Pasture	Diablo	15	60	0.24	5.86	0.01	0.10	3	0.08
Vineyards	Clearlake	5	60	0.24	1.56	0.1	0.37	5	0.8
Vineyards	Steinbeck	9	60	0.37	2.38	0.1	0.45	3	2.4
Vineyards	Steinbeck	15	60	0.37	3.07	0.1	0.60	3	4.1
Vineyards	Goldridge	9	60	0.28	1.9	0.1	0.45	5	1.4
Vineyards	Goldridge	15	60	0.28	4.83	0.1	0.60	5	4.9
Vineyards	Diablo	9	60	0.24	2.57	0.1	0.45	3	1.7
Vineyards	Diablo	15	60	0.24	5.96	0.1	0.60	3	5.1
Oat-Hay	Clearlake	5	60	0.24	1.31	0.01	0.37	5	0.1
Oat-Hay	Diablo	9	60	0.24	3.19	0.01	0.45	3	0.2
Oat-Hay	Diablo	15	60	0.24	5.29	0.01	0.60	3	0.5
Sudan/Corn	Clearlake	5	60	0.24	0.14	0.03	0.25	5	0.015
Sudan/Corn	Clearlake	5	60	0.24	1.31	0.03	0.25	5	0.14
Sudan/Corn	Diablo	9	60	0.24	2.58	0.03	0.30	3	0.3
Sudan/Corn	Diablo	9	60	0.24	3.19	0.03	0.30	3	0.4
S-Strawberries	Diablo	9	60	0.24	2.58	0.2	0.31	3	2.29
S-Strawberries	Clear lake	5	60	0.24	1.31	0.2	0.30	5	1.1
W.Strawberries	Diablo	9	60	0.24	2.58	0.6	0.80	3	17.8
W.Strawberries	Clear Lake	5	60	0.24	1.31	0.6	0.80	5	9.1

NOTES:

1) Oat-hay crops are irrigated, cross-slope farmed: Oat-hay is considered a continuous annual hay (100% cover); sprinklers used to establish early winter cover.
2) Sudan grass or corn is a summer annual crop grown with a winter cover crop and is contour cropped; A winter cover crop (oat or rye grass) would be established by sprinkler irrigation in late fall.
3) Orchards and vineyards are assumed untilled, cross-slope farmed with mowed cover crops
4) Irrigated pasture is considered a perrrenial grass (95% cover).
5) Vegetable crops are contour strip cropped with a 90% canopy cover throughout winter; sprinklers used to establish early winter cover crop.
6) S-Strawberries are grown annually during the spring and summer months (April-October) with a cover crop during the winter months.
7) W-Strawberries are fall planted biannuals grown without a cover crop other than the strawberry plants.
8) T=Tolerance factor (tons/acre/year).

* Benchmark soil used in Table 5.

Table 2: West County Case Studies

2a: USLE Case Studies for Existing Dry-Farmed Conditions

Land Use	Soil Name	Slope (%)	R	K	LS	C	P	T	Annual Soil Loss Rate (tons/acre
Native Vegetation	Blucher	5	75	0.32	1.25	0.09	0.1	5	0.27
Native Vegetation	Pajaro	5	75	0.28	1.69	0.09	0.1	5	0.32
Native Vegetation	Los Osos	15	75	0.32	7.52	0.09	0.1	2	1.62
Native Vegetation	Steinbeck	9	75	0.37	3.7	0.09	0.1	3	0.92
Native Vegetation	Steinbeck	15	75	0.37	5.29	0.09	0.1	3	1.32
Native Vegetation	Cotati	9	75	0.32	2.87	0.09	0.1	3	0.62
Native Vegetation	Cotati	15	75	0.32	5.8	0.09	0.1	3	1.25
Native Vegetation	Los Osos	25	75	0.32	10.8	0.09	0.35	2	8.16
Native Vegetation*	Los Osos	35	75	0.37	16.8	0.04	0.1	2	1.86
Oat-Hay	Blucher	5	75	0.32	1.36	0.12	0.85	5	3.33
Oat-Hay	Pajaro	5	75	0.32	1.69	0.12	0.85	5	4.14
Oat-Hay	Los Osos	15	75	0.32	5.29	0.12	0.9	2	13.71
Oat-Hay	Steinbeck	9	75	0.37	2.87	0.12	0.8	3	7.65
Oat-Hay	Steinbeck	15	75	0.37	5.29	0.12	0.9	3	15.85
Oat-Hay	Cotati	9	75	0.32	1.85	0.12	0.8	3	4.26
Oat-Hay	Cotati	15	75	0.32	5.29	0.12	0.9	3	13.71
Cool Season Vegetables	Pajaro	5	75	0.32	1.46	0.31	0.37	5	4.02

NOTES:

1) Native vegetation* refers to un-grazed regions.
2) Native vegetation is grazed in good condition with a 50% ground cover in early winter months.
3) Oat-hay is a non-irrigated, stuble-grazed cross slope till crop.
4) Vegetable crops refer to potatoes and miscellaneous truck crops. Vegetable crops are cross slope farmed with an oat hay cover crop during winter months.
5) T = tolerance factor (tons/acre/year).
6) Existing conditions involve worst case scenarios.

Table 2: West County Case Studies

2b: USLE Case Studies for Future Irrigated Conditions

Land Use	Soil Name	Slope (%)	R	K	LS	C	P	T	Annual Soil Loss Rate (tons/acre)
Irrigated Pasture*	Blucher	5	75	0.32	1.25	0.01	0.1	5	0.03
Irrigated Pasture*	Pajaro	5	75	0.28	1.69	0.01	0.1	5	0.04
Irrigated Pasture*	Los Osos	15	75	0.32	7.52	0.01	0.1	2	0.18
Irrigated Pasture*	Steinbeck	9	75	0.37	3.7	0.01	0.1	3	0.10
Irrigated Pasture*	Steinbeck	15	75	0.37	5.29	0.01	0.1	3	0.15
Irrigated Pasture*	Cotati	9	75	0.32	2.87	0.01	0.1	3	0.07
Irrigated Pasture*	Cotati	15	75	0.32	5.8	0.01	0.1	3	0.14
Irrigated Pasture**	Blucher	5	75	0.32	1.36	0.01	0.1	5	0.03
Irrigated Pasture**	Pajaro	5	75	0.32	1.69	0.01	0.1	5	0.04
Irrigated Pasture**	Los Osos	15	75	0.32	5.29	0.01	0.1	2	0.13
Irrigated Pasture**	Steinbeck	9	75	0.37	2.87	0.01	0.1	3	0.08
Irrigated Pasture**	Steinbeck	15	75	0.37	5.29	0.01	0.1	3	0.15
Irrigated Pasture**	Cotati	9	75	0.32	1.85	0.01	0.1	3	0.04
Irrigated Pasture**	Cotati	15	75	0.32	5.29	0.01	0.1	3	0.13
Oat-Hay	Blucher	5	75	0.32	1.36	0.02	0.37	5	0.24
Oat-Hay	Pajaro	5	75	0.28	1.69	0.02	0.37	5	0.26
Oat-Hay	Los Osos	15	75	0.32	5.29	0.02	0.6	2	1.52
Oat-Hay	Steinbeck	9	75	0.37	2.87	0.02	0.45	3	0.72
Oat-Hay	Steinbeck	15	75	0.37	5.29	0.02	0.6	3	1.76
Oat-Hay	Cotati	9	75	0.32	1.85	0.02	0.45	3	0.40
Oat-Hay	Cotati	15	75	0.32	5.29	0.02	0.6	3	1.52
Cool Season Vegetables	Pajaro	5	75	0.28	1.46	0.2	0.25	5	1.53
Cool Season Vegetables	Blucher	5	75	0.32	1.46	0.2	0.25	3	1.75
Sudan/Corn*	Blucher	5	75	0.32	1.25	0.01	0.25	5	0.08
Sudan/Corn*	Pajaro	5	75	0.28	1.69	0.01	0.25	5	0.09
Sudan/Corn*	Los Osos	15	75	0.32	7.52	0.01	0.4	2	0.72
Sudan/Corn*	Steinbeck	9	75	0.37	3.7	0.01	0.3	3	0.31
Sudan/Corn*	Steinbeck	15	75	0.37	5.29	0.01	0.4	3	0.59
Sudan/Corn*	Cotati	9	75	0.32	2.87	0.01	0.3	3	0.21
Sudan/Corn*	Cotati	15	75	0.32	5.8	0.01	0.4	3	0.56
Sudan/Corn**	Blucher	5	75	0.32	1.36	0.01	0.25	5	0.08
Sudan/Corn**	Pajaro	5	75	0.32	1.69	0.01	0.25	5	0.10
Sudan/Corn**	Los Osos	15	75	0.32	5.29	0.01	0.4	2	0.51
Sudan/Corn**	Steinbeck	9	75	0.37	2.87	0.01	0.3	3	0.24
Sudan/Corn**	Steinbeck	15	75	0.37	5.29	0.01	0.4	3	0.59
Sudan/Corn**	Cotati	9	75	0.32	1.85	0.01	0.3	3	0.13
Sudan/Corn**	Cotati	15	75	0.32	5.29	0.01	0.4	3	0.51
W-Strawberries	Blucher	5	75	0.32	1.31	0.6	0.8	5	15.09
W-Strawberries	Cotati	9	75	0.32	2.58	0.6	0.8	3	29.72
W-Strawberries	Steinbeck	9	75	0.37	2.58	0.6	0.8	3	34.37
S-Strawberries	Blucher	5	75	0.32	1.31	0.2	0.3	3	1.89
S-Strawberries	Cotati	9	75	0.32	2.58	0.2	0.3	3	3.72
S-Strawberries	Steinbeck	9	75	0.37	2.58	0.2	0.3	3	4.30
Artichokes	Blucher	5	75	0.32	1.31	0.45	0.5	5	7.07
Artichokes	Pajaro	5	75	0.28	1.31	0.45	0.5	5	6.19
Artichokes	Cotati	9	75	0.32	2.58	0.45	0.5	3	13.93
Artichokes	Steinbeck	9	75	0.37	2.58	0.45	0.5	0.3	16.11

NOTES:

1) Irrigated Pasture* refers to the conversion of native vegetation.
2) Irrigated Pasture** refers to the conversion of oat-hay crops.
3) Sudan/Corn* refers to the conversion of native vegetation.
4) Sudan/Corn** refers to the conversion of oat-hay crops.
5) Sudan grass or corn is a summer annual crop grown with a winter cover crop and is contour cropped; a winter cover crop (oat or rye grass) would be established by sprinkler irrigation in late fall.
6) Irrigated pasture is considered a perrenial grass (95%).
7) Oat-hay crops are irrigated, cross slope farmed; Oat-hay is considered a continuous annual hay (100%).
8) Vegetable crops are contour strip cropped with a 90% canopy cover throughout the winter; sprinklers used to establish early winter cover crop.
9) Strawberries are grown annually during the spring and summer months (April-October) with a cover crop during the winter months.
10) T = tolerance factor (tons/acre/year).

* Benchmark soil used in Table 6.

Table 3: South County Predicted Changes in Soil Loss; Existing Conditions vs. Irrigation Project

Soil Name	Slope (%)	Existing Conditions	Soil Loss Rate (tons/acre/year)	Future Conditions With Irrigation Project	Soil Loss Rate (tons/acre/year)	Net Change in Soil Loss (Tons/Acre/Year
Clearlake	5	Oat-Hay	0.26	Sudan/Corn	0.02	-0.24
Clearlake	5	Vegetable Crops	0.5	Vegetable Crops	0.4	-0.1
Clearlake	5	Vineyards	2.6	Vineyards w/cover crop	0.8	-1.8
Clearlake	5	Oat-Hay	2.6	Alfalfa or Oat-Hay	0.1	-2.5
Clearlake	5	Oat-Hay	2.6	Orchards w/cover crop	0.7	-1.9
Clearlake	5	Oat-Hay	2.6	Sudan/Corn	0.14	-2.46
Clearlake	5	Oat-Hay	2.6	Irrigated Pasture	0.02	-2.58
Clearlake	5	Oat-Hay	2.6	W-Strawberries	9.095	6.50
Clearlak	5	Oat-Hay	2.6	S-Strawberries	1.13	-1.47
Diablo	9	Native Vegetation (2)	1.17	Sudan/Corn	0.3	-0.87
Diablo	9	Native Vegetation (2)	1.17	Irrigated Pasture	0.04	-1.13
Diablo	9	Native Vegetation (2)	1.17	Strawberries	17.8	16.63
Diablo	9	Vineyards	5.16	Vineyards w/cover crop	1.7	-3.46
Diablo	9	Vineyards	5.16	Strawberries	17.8	12.64
Diablo	9	Oat-Hay	6.2	Oat-Hay	0.2	-6
Diablo	9	Oat-Hay	6.2	Orchards w/cover crop	2.1	-4.1
Diablo	9	Oat-Hay	6.2	Sudan/Corn	0.4	-5.8
Diablo	9	Oat-Hay	6.2	Irrigated Pasture	0.05	-6.15
Diablo	9	Oat-Hay	6.2	Strawberries	2.2	-4
Diablo	9	Oat-Hay	6.2	Vineyards w/cover crops	1.7	-4.5
Diablo	9	Oat-Hay	6.2	W-Strawberries	17.8	11.6
Diablo	9	Oat-Hay	6.2	S-Strawberries	2.29	-3.91
Diablo	15	Native Vegetation (2)	3.4	Irrigated Pasture	0.08	-3.32
Diablo	15	Vineyards	16	Vineyards w/cover crop	5.1	-10.9
Diablo	15	Oat-Hay	10.4	Orchards w/cover crop	4.6	-5.8
Diablo	15	Oat-Hay	10.4	Irrigated Pasture	0.08	-10.32
Steinbeck	9	Orchards	6.1	Orchards w/cover crop	2.2	-3.9
Steinbeck	9	Vineyards	7.37	Vineyards w/cover crop	2.4	-4.97
Steinbeck	15	Orchards	19.5	Orchards w/cover crop	7.0	-12.5
Steinbeck	15	Vineyards	12.68	Vineyards w/cover crop	4.1	-8.58
Goldridge	9	Orchards	5.8	Orchards w/cover crop	2.1	-3.7
Goldridge	9	Vineyards	4.45	Vineyards w/cover crop	1.4	-3.05
Goldridge	15	Orchards	14	Orchards w/cover crop	5.0	-9
Goldridge	15	Vineyards	15.09	Vineyards w/cover crop	4.9	-10.19

NOTES:

1) Negative values indicate a net reduction in annual soil loss under the irrigation scenario.

2) Grazed.

Table 4: West County Predicted Changes in Soil Loss; Existing Conditions vs. Irrigation Project

Soil Name	Slope (%)	Existing Conditions	Soil Loss Rate (tons/acre/year)	Future Conditions With Irrigation Project	Soil Loss Rate (tons/acre/year)	Net Soil Loss Changes (tons/acre/year)
Blucher	5	Native Vegetation	0.27	Irrigated Pasture	0.03	-0.24
Blucher	5	Oat-Hay	3.33	Irrigated Pasture	0.03	-3.3
Blucher	5	Oat-Hay	3.33	Oat-Hay	0.24	-3.09
Blucher	5	Native Vegetation	0.27	Sudan/Corn	0.08	-0.19
Blucher	5	Oat-Hay	3.33	Cool Season Vegetables	1.75	-1.58
Blucher	5	Oat-Hay	3.33	W-Strawberries	15.09	11.76
Blucher	5	Oat-Hay	3.33	S-Strawberries	1.89	-1.44
Blucher	5	Oat-Hay	3.33	Artichokes	7.78	4.45
Blucher	5	Oat-Hay	3.33	Sudan/Corn	0.08	-3.25
Pajaro	5	Native Vegetation	0.32	Irrigated Pasture	0.04	-0.28
Pajaro	5	Oat-Hay	4.14	Irrigated Pasture	0.04	-4.1
Pajaro	5	Oat-Hay	4.14	Oat-Hay	0.26	-3.88
Pajaro	5	Native Vegetation	0.32	Sudan/Corn	0.09	-0.23
Pajaro	5	Oat-Hay	4.14	Sudan/Corn	0.1	-4.04
Pajaro	5	Vegetable Crops	4.02	Vegetable Crops	1.53	-2.49
Los Osos	15	Native Vegetation	1.62	Irrigated Pasture	0.18	-1.44
Los Osos	15	Oat-Hay	13.71	Irrigated Pasture	0.13	-13.58
Los Osos	15	Oat-Hay	13.71	Oat-Hay	1.52	-12.19
Los Osos	15	Native Vegetation	1.62	Sudan/Corn	0.72	-0.9
Los Osos	15	Oat-Hay	13.71	Sudan/Corn	0.51	-13.2
Los Osos	25	Native Vegetation	8.16			
Los Osos	35	Native Vegetation*	1.86			
Steinbeck	9	Native Vegetation	0.92	Irrigated Pasture	0.1	-0.82
Steinbeck	9	Oat-Hay	7.65	Irrigated Pasture	0.08	-7.57
Steinbeck	9	Oat-Hay	7.65	Oat-Hay	0.72	-6.93
Steinbeck	9	Native Vegetation	0.92	Sudan/Corn	0.31	-0.61
Steinbeck	9	Oat-Hay	7.65	Sudan/Corn	0.24	-7.41
Steinbeck	9	Oat-Hay	7.65	Strawberries	4.78	-2.87
Steinbeck	9	Oat-Hay	7.65	W-Strawberries	4.78	-2.87
Steinbeck	9	Oat-Hay	7.65	S-Strawberries	4.78	-2.87
Steinbeck	9	Oat-Hay	7.65	Artichokes	4.78	-2.87
Steinbeck	15	Native Vegetation	1.32	Irrigated Pasture	0.15	-1.17
Steinbeck	15	Oat-Hay	15.85	Irrigated Pasture	0.15	-15.7
Steinbeck	15	Oat-Hay	15.85	Oat-Hay	1.76	-14.09
Steinbeck	15	Native Vegetation	1.32	Sudan/Corn	0.59	-0.73
Steinbeck	15	Oat-Hay	15.85	Sudan/Corn	0.59	-15.26
Cotati	9	Native Vegetation	0.62	Irrigated Pasture	0.07	-0.55
Cotati	9	Oat-Hay	4.26	Irrigated Pasture	0.04	-4.22
Cotati	9	Oat-Hay	4.26	Oat-Hay	0.4	-3.86
Cotati	9	Native Vegetation	0.62	Sudan/Corn	0.21	-0.41
Cotati	9	Oat-Hay	4.26	Sudan/Corn	0.13	-4.13
Cotati	9	Oat-Hay	4.25	W-Strawberries	29.72	25.47
Cotati	9	Oat-Hay	4.26	S-Strawberries	3.7	-0.56
Cotati	9	Oat-Hay	4.26	Artichokes	13.93	9.67
Cotati	15	Native Vegetation	1.25	Irrigated Pasture	0.14	-1.11
Cotati	15	Oat-Hay	13.71	Irrigated Pasture	0.13	-13.58
Cotati	15	Oat-Hay	13.71	Oat-Hay	1.52	-12.19
Cotati	15	Native Vegetation	1.25	Sudan/Corn	0.56	-0.69
Cotati	15	Oat-Hay	13.71	Sudan/Corn	0.51	13.2

NOTES:

1) Negative values indicate a net reduction in annual soil loss under the irrigation scenario.

Table 5 Total Annual Soil Loss Estimates
South County Reclamation Alternative (Con't)

		Low Tech			Medium Tech			High Tech		
Discharge Scenario	Land Use	Acreage	Soil Loss Tons/Acre	Total Tons	Acreage	Soil Loss Tons/Acre	Total Tons	Acreage	Soil Loss Tons/Acre	Total Tons
5% w/Sebastapol	Vineyards (new)	0	2.40	0	0	2.40	0	300	2.40	720
	Apples (exist)	1,600	2.20	3,520	1,600	2.20	3,520	1,600	2.20	3,520
	Vineyards (exist)	600	2.40	1,440	600	2.40	1,440	600	2.40	1,440
	Specialty Crops	0	0.00	0	200	2.29	458	300	2.29	687
	Vegetable Crops	100	0.40	40	400	0.40	160	700	0.40	280
	Forage/Hay/Silage	250	0.30	75	500	0.30	150	200	0.30	60
	Irrigated Pasture	950	0.08	76	200	0.08	16	0	0.30	0
	Total	**3,500**		**5,151**	**3,500**		**5,744**	**3,700**		**6,707**
10% w/Sebastapol	Vineyards (new)	0	2.40	0	0	2.40	0	0	2.40	0
	Apples (exist)	1,600	2.20	3,520	1,600	2.20	3,520	1,600	2.20	3,520
	Vineyards (exist)	600	2.40	1,440	600	2.40	1,440	600	2.40	1,440
	Specialty Crops	0	2.29	0	0	2.29	0	200	2.29	458
	Vegetable Crops	0	0.40	0	100	0.40	40	200	0.40	80
	Forage/Hay/Silage	100	0.30	30	150	0.30	45	0	0.30	0
	Irrigated Pasture	200	0.08	16	50	0.08	4	0	0.08	0
	Total	**2,500**		**5,006**	**2,500**		**5,049**	**2,600**		**5,498**
		1% Acreage Requirement			**5% Acreage Requirement**			**10% Acreage Requirement**		
Existing Conditions	Orchards	0	6.10	0	0	6.10	0	0	6.10	0
	Vineyards	200	5.20	1,040	200	5.20	1,040	100	5.20	520
	Specialty Crops	0	6.20	0	0	6.20	0	0	0.00	0
	Vegetable Crops	100	0.50	50	100	0.50	50	50	0.50	25
	Dry-farmed Hay/Silage	2,200	6.20	13,640	1,300	6.20	8,060	950	6.20	5,890
	Native Pasture/Range	1,300	3.40	4,420	1,000	3.40	3,400	500	3.40	1,700
		3,800		**19,150**	**2,600**		**12,550**	**1,600**		**8,135**
Existing Conditions w/Sebastapol	Orchards	1,600	6.10	9,760	1,600	6.10	9,760	1,600	6.10	9,760
	Vineyards	600	5.20	3,120	600	5.20	3,120	600	5.20	3,120
	Specialty Crops	0	0.00	0	0	6.20	0	0	0.00	0
	Vegetable Crops	100	0.50	50	50	0.50	25	0	0.50	0
	Dry-farmed Hay/Silage	1,600	6.20	9,920	800	6.20	4,960	200	6.20	1,240
	Native Pasture/Range	900	3.40	3,060	450	3.40	1,530	100	3.40	340
		4,800		**25,910**	**3,500**		**19,395**	**2,500**		**14,460**

Table 5 Total Annual Soil Loss Estimates
South County Reclamation Alternative

		Low Tech			Medium Tech			High Tech		
Discharge Scenario	Land Use	Acreage	Soil Loss Tons/Acre	Total Tons	Acreage	Soil Loss Tons/Acre	Total Tons	Acreage	Soil Loss Tons/Acre	Total Tons
1%	Vineyards (new)	0	2.40	0	300	2.40	720	1,300	2.40	3,120
	Specialty Crops	0		0	250	2.29	573	900	2.29	2,061
	Vegetable Crops	200	0.40	80	800	0.40	320	900	0.40	360
	Hay/Forage/Silage	800	0.30	240	1,300	0.30	390	800	0.30	240
	Irrigated Pasture	2400	0.08	192	1,150	0.08	92	300	0.08	24
	Total	**3400**		**512**	**3,800**		**2,095**	**4,200**		**5,805**
5%	Vineyards (new)	0	2.40	0	250	2.40	600	600	2.40	1,440
	Specialty Crops	0		0	200	2.29	458	600	2.29	1,374
	Vegetable Crops	200	0.40	80	600	0.40	240	1,200	0.40	480
	Hay/Forage/Silage	600	0.30	180	1,100	0.30	330	300	0.30	90
	Irrigated Pasture	1500	0.08	120	450	0.08	36	200	0.08	16
	Total	**2300**		**380**	**2,600**		**1,664**	**2,900**		**3,400**
10%	Vineyards (new)	0	2.40	0	200	2.40	480	400	2.40	960
	Specialty Crops	0		0	150	2.29	344	400	2.29	916
	Vegetable Crops	150	0.40	60	350	0.40	140	700	2.29	1,603
	Hay/Forage/Silage	400	0.30	120	600	0.30	180	200	0.30	60
	Irrigated Pasture	950	0.08	76	300	0.08	24	100	0.08	8
	Total	**1500**		**256**	**1,600**		**1,168**	**1,800**		**3,547**
1% w/Sebastapol	Vineyards (new)	0	2.40	0	250	2.40	600	600	2.40	1,440
	Apples (exist)	1600	2.20	3,520	1,600	2.20	3,520	1,600	2.20	3,520
	Vineyards (exist)	600	2.40	1,440	600	2.40	1,440	600	2.40	1,440
	Specialty Crops	0	2.29	0	200	2.29	458	600	2.29	1,374
	Vegetable Crops	200	0.40	80	600	0.40	240	1,100	0.40	440
	Forage/Hay/Silage	600	0.30	180	1,100	0.30	330	400	0.30	120
	Irrigated Pasture	1500	0.08	120	450	0.08	36	200	0.08	16
	Total	**4500**		**5,340**	**4,800**		**6,624**	**5,100**		**8,350**

Table 6 Total Annual Soil Loss Estimates
West County Reclamation Alternative

		Low Tech			Medium Tech			High Tech		
Discharge Scenario	Land Use	Acreage	Soil Loss Tons/Acre	Total Tons	Acreage	Soil Loss Tons/Acre	Total Tons	Acreage	Soil Loss Tons/Acre	Total Tons
1%	Specialty Crops	0	0.00	0	450	7.60	3,420	2,000	7.60	15,200
	Vegetable Crops	200	1.75	350	600	1.75	1,050	1,500	1.75	2,625
	Hay/Forage/Silage	900	0.72	648	2,750	0.72	1,980	2,300	0.72	1,656
	Irrigated Pasture	4,500	0.15	675	2,400	0.15	360	1,000	0.15	150
	Total	**5,600**		**1,673**	**6,200**		**6,810**	**6,800**		**19,631**
5%	Specialty Crops	0	0.00	0	300	7.60	2,280	1,400	7.60	10,640
	Vegetable Crops	100	1.75	175	450	1.75	788	1,150	1.75	2,013
	Hay/Forage/Silage	950	0.72	684	2,000	0.72	1,440	1,600	0.72	1,152
	Irrigated Pasture	2,950	0.15	443	1,650	0.15	248	700	0.15	105
	Total	**4,000**		**1,302**	**4,400**		**4,755**	**4,850**		**13,910**
10%	Specialty Crops	0	0.00	0	200	7.60	1,520	1,050	7.60	7,980
	Vegetable Crops	200	1.75	350	350	1.75	613	900	2.29	2,061
	Hay/Forage/Silage	850	0.72	612	1,400	0.72	1,008	950	0.30	285
	Irrigated Pasture	1,650	0.15	248	950	0.15	143	300	0.08	24
	Total	**2,700**		**1,210**	**2,900**		**3,283**	**3,200**		**10,350**
1% w/Sebastapol	Apples (exist)	1,600	2.20	3,520	1,600	2.20	3,520	1,600	2.20	3,520
	Vineyards (exist)	600	2.40	1,440	600	2.40	1,440	600	2.40	1,440
	Specialty Crops	0	0.00	0	300	13.93	4,179	1,350	7.60	10,260
	Vegetable Crops	100	1.75	175	450	1.75	788	1,200	1.75	2,100
	Forage/Hay/Silage	950	0.72	684	2,000	0.72	1,440	1,300	0.72	936
	Irrigated Pasture	2,850	0.15	428	1,550	0.15	233	750	0.15	113
	Total	**6,100**		**6,247**	**6,500**		**11,599**	**6,800**		**18,369**

Table 7
Summary, South County Area

Low Tech Comparison

Discharge Scenario	Existing Conditions (Tons Per Year))	Irrigation Project (Tons Per Year)	Difference (Tons Per Year)
1%	19,150.00	512.00	18,638.00
5%	12,550.00	380.00	12,170.00
10%	8,135.00	256.00	7,879.00
1% w/Sebastapol	25,910.00	5,340.00	20,570.00
5% w/Sebastapol	19,395.00	5,151.00	14,244.00
10% w/Sebastapol	14,460.00	5,006.00	9,454.00

Medium Tech Comparison

Discharge Scenario	Existing Conditions (Tons Per Year)	Irrigation Project (Tons Per Year)	Difference (Tons Per Year)
1%	19,150.00	2,094.50	17,055.50
5%	12,550.00	1,664.00	10,886.00
10%	8,135.00	1,167.50	6,967.50
1% w/Sebastapol	25,910.00	6,624.00	19,286.00
5% w/Sebastapol	19,395.00	5,744.00	13,651.00
10% w/Sebastapol	14,460.00	5,049.00	9,411.00

High Tech Comparison

Discharge Scenario	Existing Conditions (Tons Per Year)	Irrigation Project (Tons Per Year)	Difference (Tons Per Year)
1%	19,150.00	6,085.00	13,065.00
5%	12,550.00	3,435.00	9,115.00
10%	8,135.00	3,781.50	4,353.50
1% w/Sebastapol	25,910.00	8,390.00	17,520.00
5% w/Sebastapol	19,395.00	6,707.00	12,688.00
10% w/Sebastapol	14,460.00	5,498.00	8,962.00

Ref.: 93012SCS.WB2

Table 8
Summary, West County Area

Low Tech Comparison

Discharge Scenario	Existing Conditions (Tons Per Year)	Irrigation Project (Tons Per Year)	Difference (Tons Per Year)
1%	15,969.00	1,673.00	14,296.00
5%	10,812.00	1,302.00	9,510.00
10%	7,326.00	1,210.00	6,116.00
1% w/Sebastapol	22,978.00	6,247.00	16,731.00
5% w/Sebastapol	18,904.00	5,887.00	13,017.00
10% w/Sebastapol	14,992.00	5,346.00	9,646.00

Medium Tech Comparison

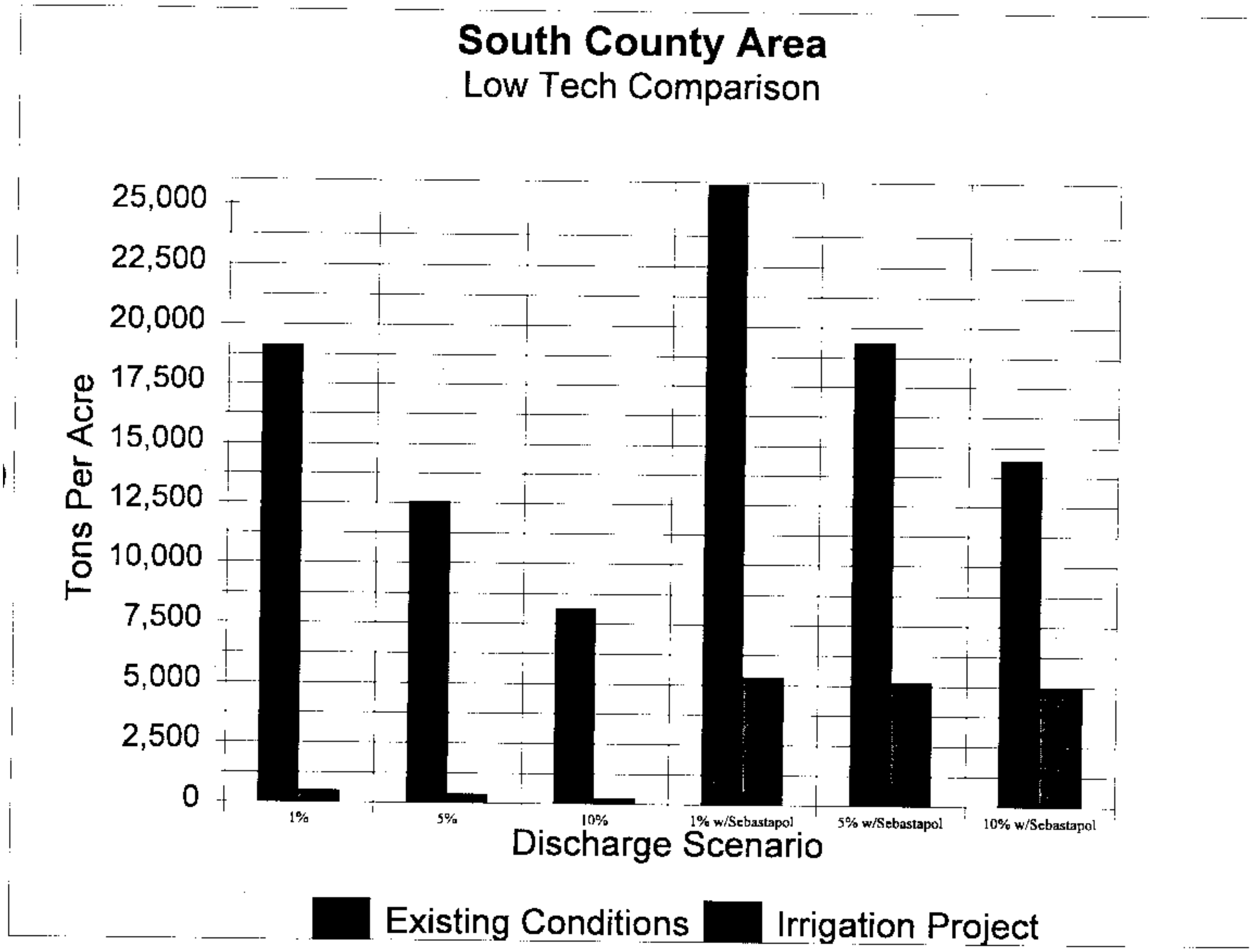
Discharge Scenario	Existing Conditions (Tons Per Year)	Irrigation Project (Tons Per Year)	Difference (Tons Per Year)
1%	15,969.00	6,810.00	9,159.00
5%	10,812.00	4,755.00	6,057.00
10%	7,326.00	3,283.00	4,043.00
1% w/Sebastapol	22,978.00	11,599.00	11,379.00
5% w/Sebastapol	18,904.00	7,781.00	11,123.00
10% w/Sebastapol	14,992.00	6,008.00	8,984.00

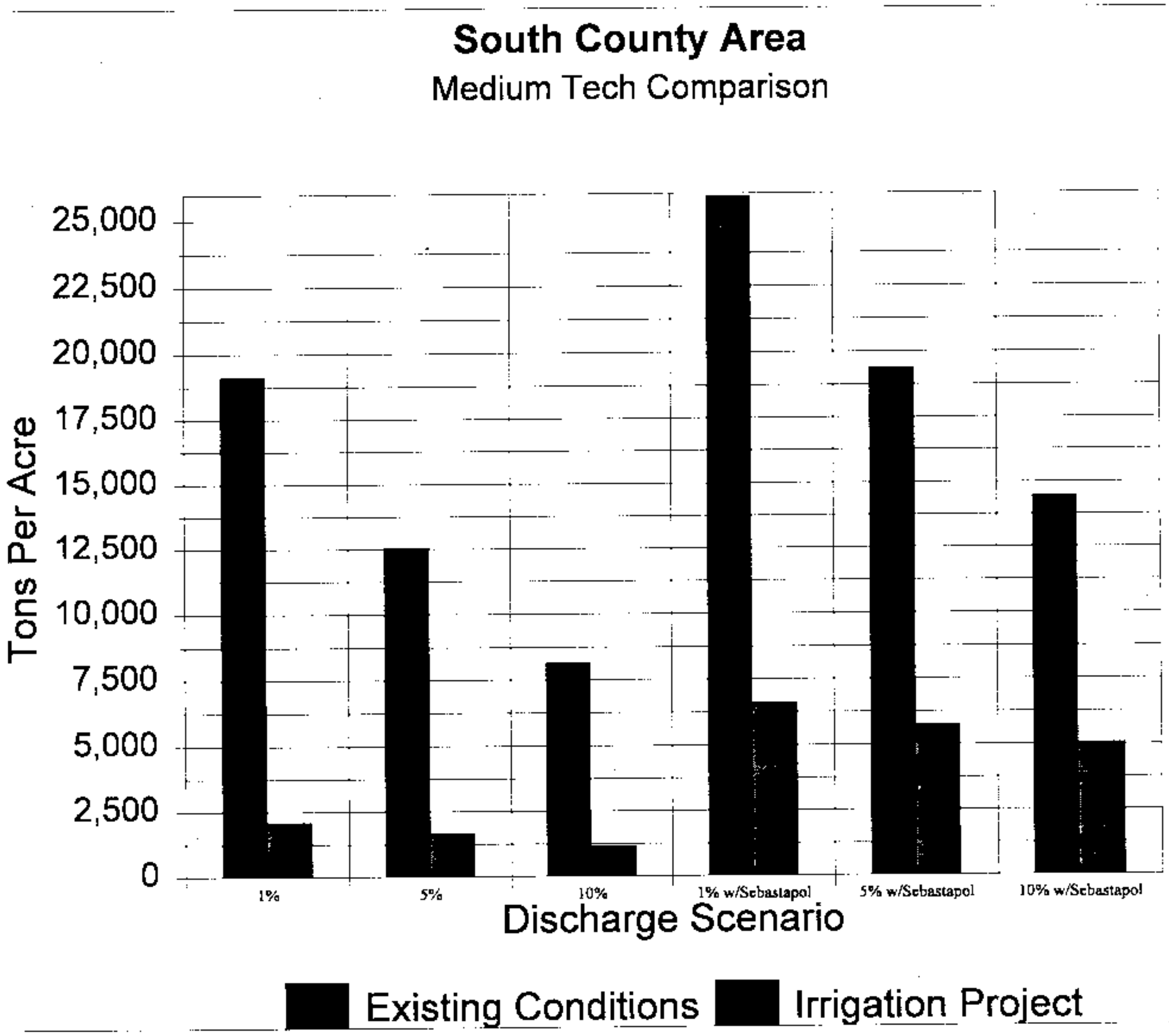
High Tech Comparison

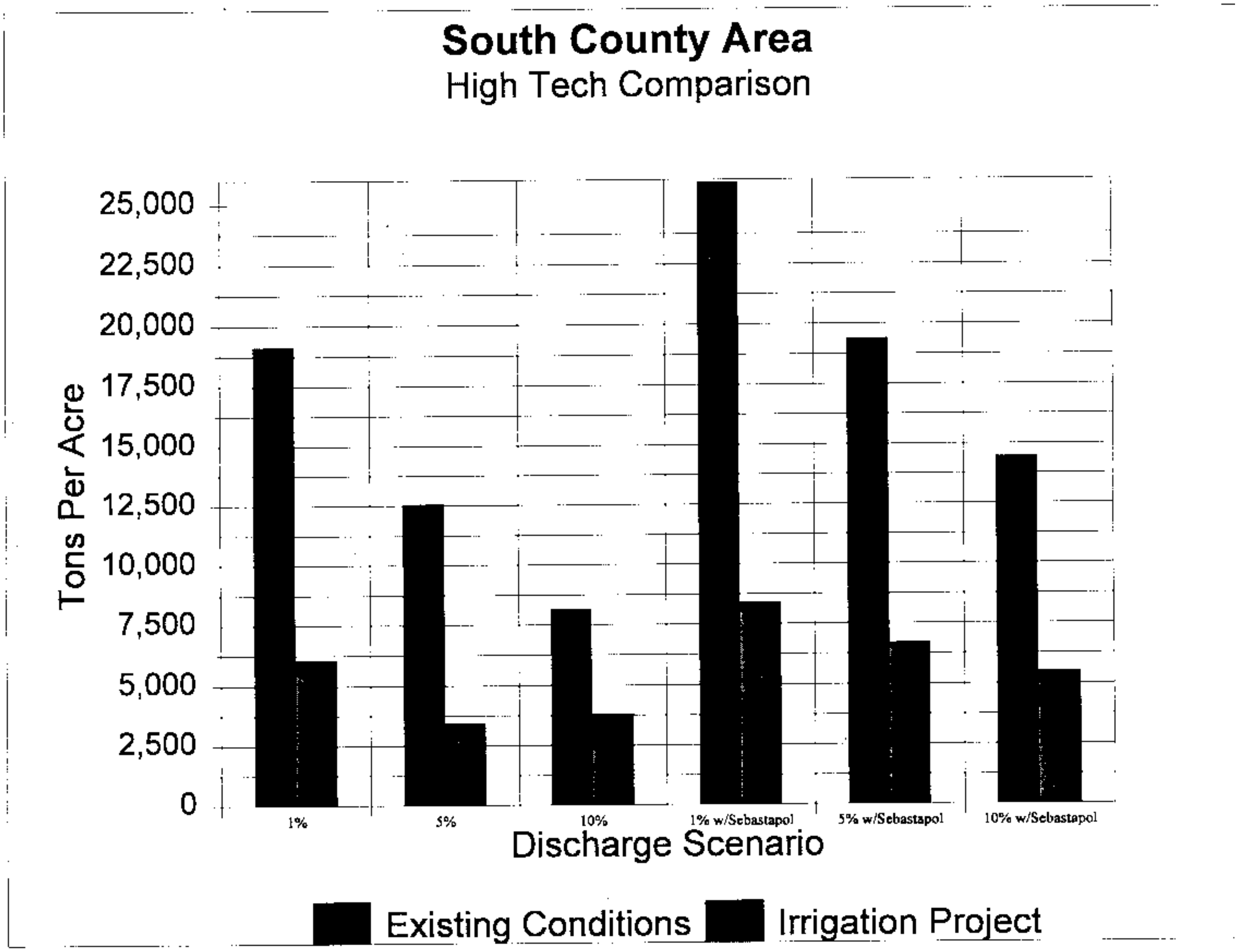
Discharge Scenario	Existing Conditions (Tons Per Year)	Irrigation Project (Tons Per Year)	Difference (Tons Per Year)
1%	15,969.00	19,631.00	(3,662.00)
5%	10,812.00	13,910.00	(3,098.00)
10%	7,326.00	10,350.00	(3,024.00)
1% w/Sebastapol	22,978.00	18,369.00	4,609.00
5% w/Sebastapol	18,904.00	11,782.00	7,122.00
10% w/Sebastapol	14,992.00	9,260.00	5,732.00

Ref.: 93012WCS.WB2

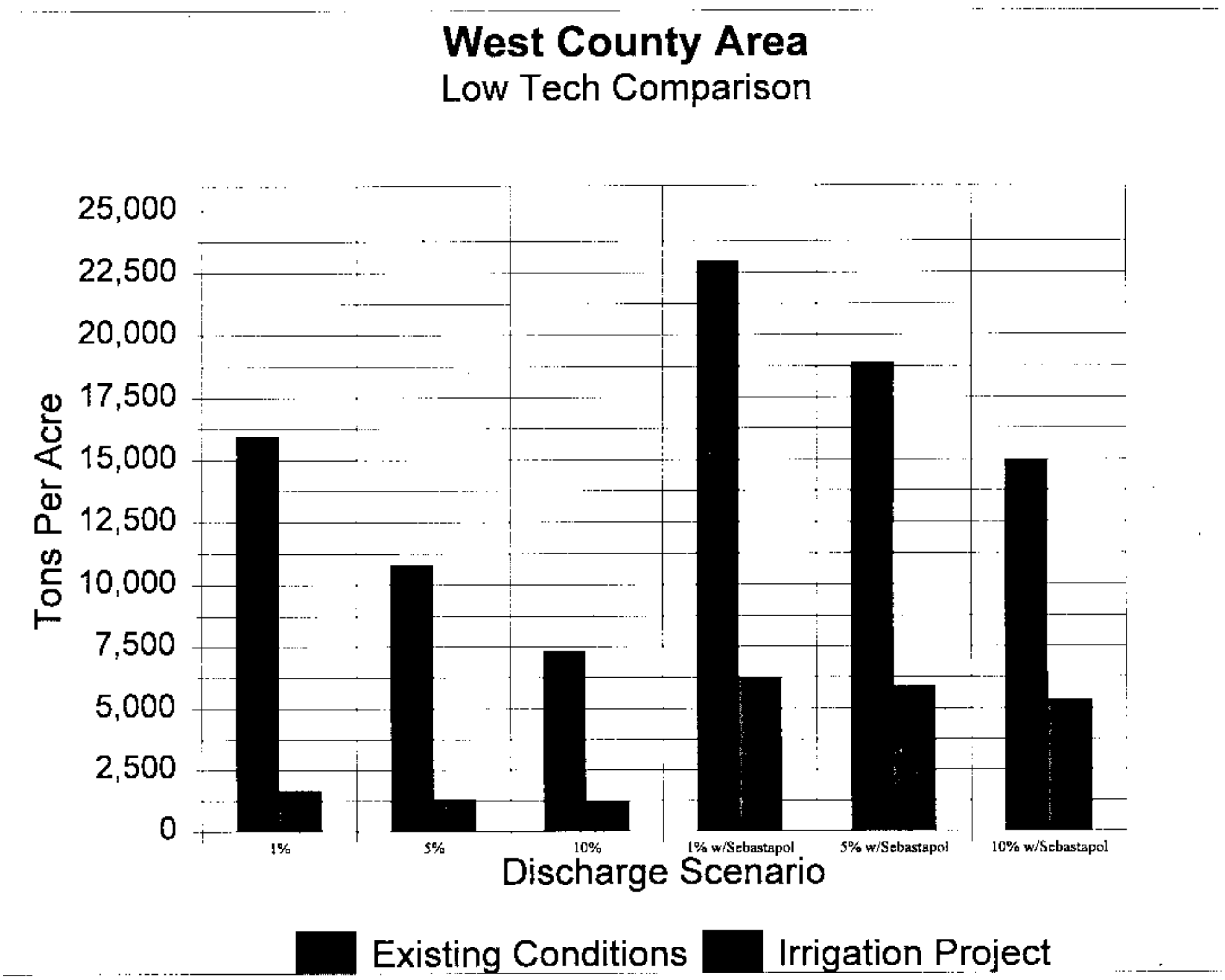
APPENDIX B

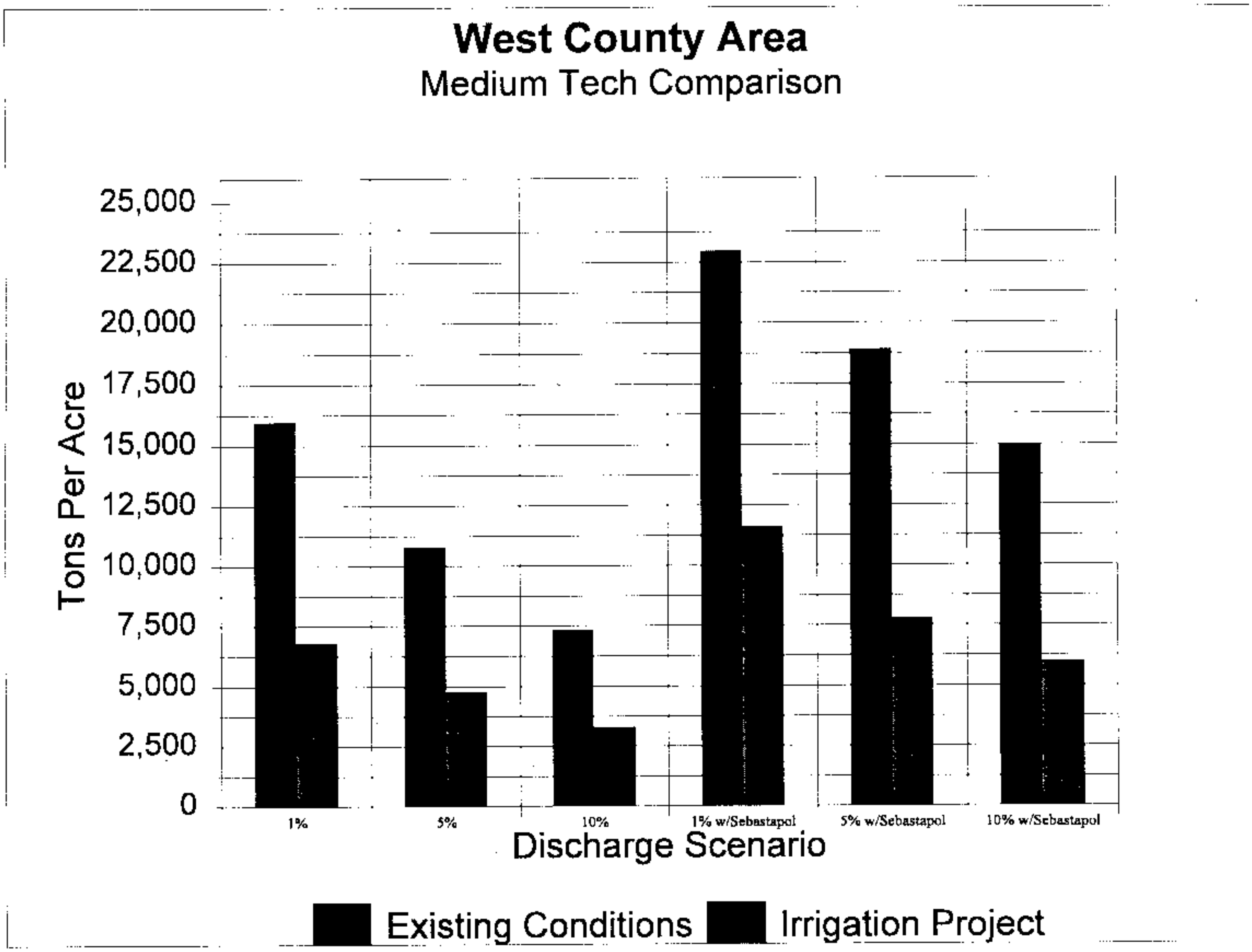

South County Area
Low Tech Comparison
Tons Per Acre
25,000
22,500
20,000
17,500
15,000
12,500
10,000
7,500
5,000
2,500
0
1%
5%
10%
1% w/Sebastapol
5% w/Sebastapol
10% w/Sebastapol
Discharge Scenario
Existing Conditions
Irrigation Project

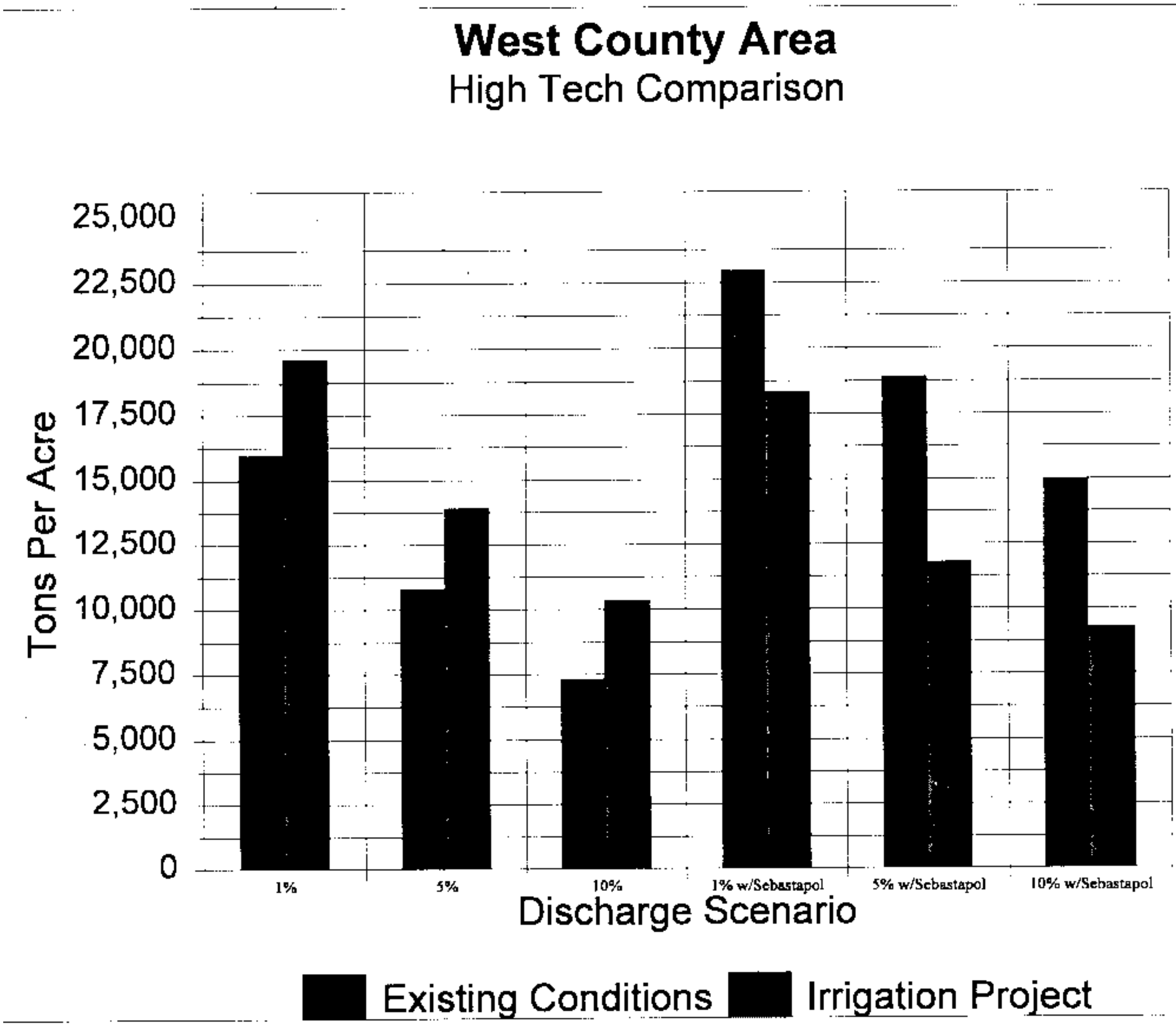

South County Area
Medium Tech Comparison
Tons Per Acre
25,000
22,500
20,000
17,500
15,000
12,500
10,000
7,500
5,000
2,500
0
1%
5%
10%
1% w/Sebastapol
5% w/Sebastapol
10% w/Sebastapol
Discharge Scenario
Existing Conditions
Irrigation Project



South County Area
High Tech Comparison
Tons Per Acre
25,000
22,500
20,000
17,500
15,000
12,500
10,000
7,500
5,000
2,500
0
1%
5%
10%
1% w/Sebastapol
5% w/Sebastapol
10% w/Sebastapol
Discharge Scenario
Existing Conditions
Irrigation Project


West County Area
Low Tech Comparison
Tons Per Acre
25,000
22,500
20,000
17,500
15,000
12,500
10,000
7,500
5,000
2,500
0
1%
5%
10%
1% w/Sebastapol
5% w/Sebastapol
10% w/Sebastapol
Discharge Scenario
Existing Conditions
Irrigation Project


West County Area
Medium Tech Comparison
Tons Per Acre
25,000
22,500
20,000
17,500
15,000
12,500
10,000
7,500
5,000
2,500
0
1%
5%
10%
1% w/Sebastapol
5% w/Sebastapol
10% w/Sebastapol
Discharge Scenario
Existing Conditions
Irrigation Project


West County Area
High Tech Comparison
Tons Per Acre
25,000
22,500
20,000
17,500
15,000
12,500
10,000
7,500
5,000
2,500
0
1%
5%
10%
1% w/Sebastapol
5% w/Sebastapol
10% w/Sebastapol
Discharge Scenario
Existing Conditions
Irrigation Project