

IDENTIFICATION OF METHODOLOGY AND THE
TECHNICAL AND INSTITUTIONAL FEASIBILITY
FOR DEVELOPMENT AND IMPLEMENTATION OF
BEST MANAGEMENT PRACTICES FOR
IRRIGATED AGRICULTURE

WORK PROGRAM FOR THE
U. S. ENVIRONMENTAL PROTECTION AGENCY

Submitted by:

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TABLE OF CONTENTS

TASK 1	SELECTION OF REPRESENTATIVE AREAS FOR STUDY, INFORMATION SOURCES, AND LOCAL COORDINATION.	1
TASK 2	DETAILED DEFINITION OF AGRICULTURAL PRACTICES	2
TASK 3	EFFICIENCY OF CONVEYANCE SYSTEMS.	3
TASK 4	EFFICIENCY OF ON-FARM IRRIGATION SYSTEMS.	3
TASK 5	DEFINITION OF AGRICULTURAL WASTE LOADS.	4
TASK 6	EFFECTIVENESS OF BEST MANAGEMENT PRACTICES.	5
TASK 7	IMPLEMENTATION REQUIREMENTS FOR BEST MANAGEMENT PRACTICES.	6
TASK 8	FEASIBILITY OF BEST MANAGEMENT PRACTICES IN THE REGION	6
TASK 9	IMPACTS OF BEST MANAGEMENT PRACTICES ON WATER RESOURCES	6
TASK 10	DESCRIPTION OF EXISTING AGRICULTURAL INSTITUTIONS IN THE LARIMER-WELD REGION	7
TASK 11	INSTITUTIONAL FEASIBILITY OF BEST MANAGEMENT PRACTICES.	12
TASK 12	REVIEW, ANALYSIS, AND RECOMMENDATIONS	13
TASK 13	REPORTS OF WORK	13
	TABLE	15

TASK 1 SELECTION OF REPRESENTATIVE AREAS FOR STUDY, INFORMATION SOURCES, AND LOCAL COORDINATION

The Larimer-Weld Region contains over 477,000 acres of irrigated land, and it will not be possible to conduct a detailed analysis of the potential for Best Management Practices throughout the Region at this time. The procedure is to select irrigated areas representative of the Region for detailed analysis, and then to extrapolate the results of the analysis to the entire Region.

The information developed as part of the Region's 208 planning process will be used extensively to select the representative study areas. There is a vast amount of information available within the Region which will be reviewed and utilized where appropriate to assist in determining feasible Best Management Practices. Sources of this information will include:

- . Ten Soil Conservation Districts (SCDs)
- . Four Field Offices of the Soil Conservation Service, USDA
- . Colorado State University Extension Service
- . U. S. Department of Agriculture - Agricultural Research Service

Much of this information is proprietary, in disaggregated form, and raw data of a site-specific nature. To insure that the demonstration project is carried out cost effectively and that local and State agricultural interests can effectively provide review and comment throughout the process, a Best Management Practices (BMP) Advisory Committee will be formed. This will be facilitated in part by a cooperative agreement between the LWRCOG, the ten SCDs, the SCS, and the State Soil Conservation Board. In addition, a member of the SCS will be assigned to the LWRCOG under the Federal Intergovernmental Personnel Act to assist in data collection and liaison with agricultural interests.

Specific information to be used will include:

- . Distribution of irrigated lands
- . Location of major agricultural discharges to surface waters
- . Magnitude of agricultural discharges
- . Relative impact of agricultural discharges on water quality

This information will be combined with a set of specific criteria for selecting representative areas. The criteria would be defined as part of this task.

TASK 2 DETAILED DEFINITION OF AGRICULTURAL PRACTICES

There are three types of irrigation practices in the Region which affect pollutant loading. These include ditch and furrow irrigation, sprinkling, and flood irrigation. One of the purposes of this task is to identify the extent of these practices and the location of these practices within the planning units previously defined.

The most direct methods of defining the acreages under sprinkler involve review of aerial photographs of the Region, discussion with Soil Conservation Service and Soil Conservation District personnel, water users associations, and equipment distributors. The combination of the sources should provide an indication of the extent of sprinkler irrigation use in the Region, the acreage under sprinkler irrigation, and the location of sprinkler irrigated land.

Practice of flood irrigation is generally confined to irrigation of pasture lands and certain grass crops. Identification of parcels irrigated by flood irrigation will depend on essentially the same sources as used for identification of areas irrigated by sprinkling, i.e., aerial photos, discussions with Soil Conservation Service, Soil Conservation District, and irrigation company personnel. Identification of areas irrigated by furrow irrigation, which is believed to be the most extensive practice in the Region, will be done primarily by a process of elimination after flooding and sprinkler irrigated areas are defined.

The detailed definition of agricultural practices will not include the entire irrigated area in the Larimer-Weld Region, but will be limited to those planning units selected for detailed study in the previous task.

TASK 3 EFFICIENCY OF CONVEYANCE SYSTEMS

The conveyance systems used in this Region consist primarily of unlined ditches of widely varying capacities. These ditches are usually owned by irrigation companies or ditch companies and water is distributed to shareholders in the companies. Conveyance system is defined herein as a means of transporting water from the point of diversion on the stream to the head gate of individual farms. From the information available, these systems appear to have the common characteristic of high water loss between the point of diversion and the point of delivery. The purpose of this task is to develop representative estimates of water losses in conveyance systems of various sizes. The size of each diversion ditch in the Region is a matter of record with the State Engineer's District Water Commissioner. This data will be analyzed to determine the range of sizes within the region. This information will be divided into capacity categories and representative ditches will be selected from each category. With the permission of the ditch companies, flow will be measured at various points on the system during the irrigation season to obtain representative values of conveyance system loss for ditches of various capacities. The purpose of collecting this data is to define what proportion of the pollution load emitted to ground water basins and subsequently to streams is derived from canal and ditch seepage losses which will be determined in a subsequent task.

TASK 4 EFFICIENCY OF ON-FARM IRRIGATION SYSTEMS

The purpose of this task is to collect data which will describe on-farm irrigation system efficiencies for various irrigation methods, soil types, drainage practices, and topographic characteristics. From the data collected in Task 2 (Definition of Agricultural Practices), representative farms will be selected for study. Efficiency factors would be developed for flood irrigation, sprinkler irrigation, furrow irrigation, and for various soil types and slope conditions. In order to provide a reasonable estimate of efficiencies under various

conditions, it is estimated that the study include at least five farms and/or fields.

TASK 5 DEFINITION OF AGRICULTURAL WASTE LOADS

The objective of this task is to develop agricultural waste loading functions which can be associated with irrigation practices, drainage practices, soil types, applied water quality, topography, and fertilizer and pesticide use. Waste loading functions will be developed from information generated in the previous four tasks and information (sampling and measuring data) provided by the Larimer-Weld COG's 208 program. The representative nature of the sampling program, definition of efficiencies, and description of irrigation water quality will be such that the loading functions developed in this task can be applied broadly and will encompass most of the agricultural waste loading situations encountered in the Larimer-Weld Region and other regions in the West.

The data base developed in the previous tasks should enable definition of loading functions for salinity, sediment, nitrogen, phosphorus, pesticides, temperature, turbidity, ammonia, and BOD. The process of developing the loading function would consist of correlating theirrigation methods, irrigation efficiencies, applied water quality, topography, soil type, on-farm efficiency, drainage practices, and general crop type with water quality data. This correlation will facilitate a determination of the specific impacts of the above characteristics or changes in water quality.

The loading function for individual waste constituents can then be verified. The verification procedure would consist of predicting the waste output from a farm or drainage system which has not previously been sampled and then sampling that particular system. Predictions should be made of several systems to indicate the probable range of error associated with the waste loading functions.

TASK 6 EFFECTIVENESS OF BEST MANAGEMENT PRACTICES

The purpose of this task is to develop estimates of the reduction in the agricultural waste loads which could be achieved by implementation of best management practices. The Environmental Protection Agency has defined best management practices as follows:

"The term best management practices (BMP) means a practice or combination of practices that is determined by the state (designated areawide planning agency) after problem assessment, examination of alternative practices, and appropriate public participation to be the most effective, practicable (including technological, economic, and institutional considerations) means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water quality roles."

Examples of best management practices for pollution control include improving irrigation efficiency to reduce surface runoff and sub-surface drainage, tail water recovery systems, (also known as tail water pump-back systems), land leveling, construction of sedimentation basins, and various modifications of the aforementioned practices. Many of these practices have been implemented over the years as a means of soil and water conservation rather than pollution control options. One result of this is that a considerable volume of literature has been developed regarding the implementation and feasibility of these practices in widely scattered areas in the West. These areas represent a variety of characteristics associated with the agricultural irrigation. This task will include an analysis of the best management practices with respect to the information developed as part of the previous five tasks. Due to the wide variation in agricultural characteristics in the West, it is probable that the sets of conditions described in the literature will not be identical to those found in this Region. However, using the information developed as part of this program, the impacts of various best management practices on the pollution load within the region can be identified. Those practices which appear to have the most potential for reducing pollution loading within specific planning units will be identified,

and the estimated reduction in pollutant loading will be quantified. The estimated reductions in quantity of waste load and improvements in quality of agricultural discharges will be incorporated into the water quality model and the potential impact of best management on stream quality will be identified. These will be compared to waste load allocations developed as part of the COG's 208 program to determine if best management practices will enable attainment of water quality goals.

TASK 7 IMPLEMENTATION REQUIREMENTS FOR BEST MANAGEMENT PRACTICES

The implementation requirements for various Best Management Practices to be defined in this task include manpower, equipment, structures (if required), and other factors which contribute to the cost of implementing Best Management Practices. The cost factors will be unitized for application throughout the region and in other regions.

TASK 8 FEASIBILITY OF BEST MANAGEMENT PRACTICES IN THE REGION

The effectiveness analysis in Task 6 and the cost analysis in Task 7 will be combined to define cost effectiveness of various Best Management Practices. Cost effectiveness can be examined in terms of dollars per unit of waste load reduction. The feasibility analysis must go beyond this and include the cost and benefits to the irrigator. Costs on a per acre basis will have been developed in Task 7. The benefit analysis must include such factors as reduced labor costs, increased crop yield, and reduction in water costs. The combination of the cost effectiveness analysis for pollution reduction, and the cost benefit analysis for the irrigator is the only realistic method of determining the net cost of pollution control for irrigated agriculture.

TASK 9 IMPACTS OF BEST MANAGEMENT PRACTICES ON WATER RESOURCES

Modifications in management procedures resulting from implementation of Best Management Practices will impact the overall water resources picture in the Region. For example,

improved irrigation management may reduce total water demand and also may nearly eliminate irrigation return flows. This would have a dual impact: 1) down-stream diverters relying on return flow would be denied a source of water, and 2) the in-stream ecosystem supported by return flows would be eliminated. Many have hypothesized about the net effect of BMP on water resource management, but few research projects conducted to date have been of sufficient areal extent to examine effects on a regional basis. Water resource impacts can be analyzed in a systematic manner using the COG's water quality model. The model incorporates both diversions and return flows, and the COG will expend 208 funds to insure that the model accurately reflects the existing system - both quantitatively and qualitatively. Projected modifications to diversions, point source return flows, and nonpoint source return flows resulting from implementation of BMP can be incorporated into the model, and the impacts of Best Management Practices can be analyzed.

TASK 10 DESCRIPTION OF EXISTING AGRICULTURAL INSTITUTIONS IN THE LARIMER-WELD REGION

The purpose of the agricultural institutional identification and description will be to determine the present and historic roles of various local, regional, state, and federal agencies and organizations. It will be necessary to have an informative description of the present capabilities of each institution in the Region. This will involve the collection and organization of data on each institution in a manner which will permit ready comparison and facilitate a comprehensive overview of the strengths and weaknesses of each institution and its financial capabilities.

A. Agencies and contacts will be identified for existing and potential management or regulatory roles within the following departments:

1. Federal Agencies

- a. Department of Agriculture (SCS, ASCS, FHA)
- b. Department of the Interior (USGS, B of R, BOR)
- c. Environmental Protection Agency
- d. U. S. Fish and Wildlife Service
- e. Agricultural Research Service

2. State Agencies

- a. Department of Agriculture
- b. Department of Health
- c. Department of Local Affairs
- d. Department of Natural Resources
- e. State Extension Service
- f. State Experimental Stations

3. Local Agencies

- a. Larimer and Weld Counties
- b. Water Conservancy Districts
 - . Northern Colorado Water Conservancy District
 - . Central Weld Water Conservancy District
 - . Lower South Platte Water Conservancy District
- c. Industrial Systems (15 in the Region)
- d. Ditch Companies
 - . Arthur Ditch Company
 - . Bee Line Ditch Company
 - . Big Thompson Ditch and Manufacturing Company
 - . Big Thompson and Platte River Ditch Company
 - . Bijou Ditch Company
 - . Blower Ditch Company
 - . Boulder and Larimer Ditch Company
 - . Boulder and Lefthand Ditch Company
 - . Boulder and Weld Ditch Company
 - . Boulder and Whiterock Ditch Company
 - . Box Elder Ditch Company
 - . Buckhorn Highline Ditch Company
 - . Cache la Poudre Irrigation Company
 - . Canyon Canal Ditch Company
 - . Carr and Tyler Ditch Company
 - . Chaffee Ditch Company
 - . Clover Basin Ditch Company
 - . Coal Ridge Ditch Company
 - . Culver Ditch Company
 - . Davis and Downing Ditch Company
 - . Delehant Ditch Company

- . Denio and Taylor Ditch Company
- . Dixon Reservoir Company
- . Eagle Ditch Company
- . B. H. Eaton Ditch Company
- . Eglin Ditch Company
- . Farmers Ditch Company
- . George Rist Ditch Company
- . Godding Ditch Company
- . Greeley-Loveland Ditch Company
- . Handy Ditch Company
- . Highland Ditch Company
- . Hill and Brush Ditch Company
- . Hillsboro (consolidated) Ditch Company
- . Home Supply Ditch Company
- . Houck #2 Ditch Company
- . Ide and Starbird Ditch Company
- . Jackson Ditch Company
- . James Ditch Company
- . Lake Canal Ditch Company
- . Larimer County #2 Ditch Company
- . Larimer and Weld Ditch Company
- . Lefthand Ditch Company
- . Leggett Ditch Company
- . Longmont Supply Ditch Company
- . Louden Ditch Company
- . Lower Boulder (consolidated) Ditch Company
- . Lower Latham Ditch Company
- . Miner and Longan Ditch Company
- . New Cache la Poudre Ditch Company
- . New Ish Ditch Company
- . New Mercer Ditch Company
- . Niwot Ditch Company
- . North Boulder Farmers Ditch Company
- . North Poudre Irrigation Company
- . Ogilvy Ditch Company
- . Oligarchy Ditch Company
- . Osborn and Caywood Ditch Company
- . Palmerton Ditch Company
- . Peck Ditch Company
- . Platte Valley Irrigation Company
- . Pleasant Valley and Lake Ditch Company
- . Poudre Valley Ditch Company
- . Riverside Irrigation District
- . Rockwell Ditch Company
- . Rough and Ready Ditch Company
- . Rural Ditch Company
- . Silver Lake Ditch Company
- . Smith and Emmons Ditch Company
- . South Flat Ditch Company
- . South Ledge Ditch Company
- . South Side Ditch Company
- . Star Ditch Company
- . Suburban Ditch Company
- . Supply Ditch Company

- . Swede Ditch Company
 - . Upper Baldwin Ditch Company
 - . Water Supply and Storage Ditch Company
 - . Webster Ditch Company
 - . Whitney Irrigation Ditch Company
 - . Williamson Ditch Company
- e. Domestic Associations and Water Companies
- . Bald Mountain Water Association
 - . Buckhorn Water Users Association
 - . Crystal Water Company
 - . Diagonal Water and Sanitation District
 - . East Larimer County Water District
 - . Fort Collins-Loveland Water District
 - . Lefthand Water Supply Company
 - . Little Thompson Valley Water District
 - . Mariana Water District
 - . North Carter Lake District
 - . North Weld County Water District
 - . Prospect Mountain Water District
 - . Spring Canyon Water and Sanitation District
 - . Sunset Water District
 - . West Fort Collins Water District
 - . Windcliff Water Association, Inc.
- f. Soil Conservation Districts
- . Southeast Weld SCD
 - . West Adams SCD
 - . Platte Valley SCD
 - . Fort Collins SCD
 - . Big Thompson SCD
 - . Morgan County SCD
 - . West Greeley SCD
 - . Longmont SCD
 - . Boulder Valley SCD
 - . Centennial SCD
- g. Other Agencies
- . Denver Regional Council of Governments
4. Potential Sub-State Regional Agencies Under Existing State Laws
- a. Joint governmental agreement
- B. Characteristics to be Included in Agency or Contact Profile
1. The specific focus of this data collection activity is to compile agency information as dictated by the criteria developed in the COG's institutional analysis for use in Agency evaluation. Some of this information is quantifiable, some is not. The data collected will include, but not be limited to, the following:

- a. Primary function presently performed (operations, management, financial, regulation) or the institution of which they are a sub-unit;
 - b. Legal powers and responsibilities, existing and potential statutory powers that might be exercised;
 - c. Source of power (state, electorate, local charter, or Congress) and flexibility to change its structure, operations, or area of concern;
 - d. Area of jurisdiction;
 - e. Operational capabilities (facilities);
 - f. Administrative capacities (staff, administrative systems, leadership);
 - g. Existing financial commitments, revenue and rate structures, service cost characteristics, and unused financial capabilities and techniques for funding;
 - h. Organizational structure
 - i. staff,
 - ii. governing body, and
 - iii. members or constituents for sewer service;
 - i. Pricing philosophy and basis for its development (if an operational agency);
 - j. Perceived role and goals for future growth of the agency that would affect the institutional plan and the relation of the agency to the areawide wastewater treatment problem or solution (e.g., are they a source of pollution, treatment agency, regulator, land management, or special interest group?);
 - k. Stability of the agency, factors which would affect the feasibility of expanding the agency's role or reducing or eliminating its role (e.g., financial legal, political, or historical); and
 - 1. Political acceptance by the public and other agencies.
 - 2. Organization/formatting of data profiles for existing agencies in a manner that will facilitate the subsequent existing agency evaluation.
 - 3. Initial screening of each agency's potential capabilities/limitations as an element in the 208 institutional structure.
- C. To keep agricultural interests abreast of this component of study, the LWRCOG and consultants will initiate a public participation program to include meetings, workshops, and other communications. Agricultural interests will be

encouraged to participate by voicing local perceptions about the dangers and benefits of institutional arrangements as they exist now. They will be encouraged to offer suggestions for possible future arrangements.

TASK 11 INSTITUTIONAL FEASIBILITY OF BEST MANAGEMENT PRACTICES

The institutional feasibility of best management practices will be highly dependent on the involvement of the agricultural interests, Soil Conservation Districts, and appropriate agencies through the program. The mechanism for insuring an active involvement by regional agricultural interests throughout the demonstration project has been established in the LWRCOG Revised Final 208 Work Plan and is described, in part, in Task 1. As the institutional profiles from Task 10 are evaluated, it will become more evident which of the agencies or organizations will be likely candidates for institutional and financial responsibilities for BMP. It will then be necessary that these agencies receive greater involvement in the study effort. Recommendations will be made to determine the requirements for implementation of BMP and the various responsibilities of various agencies.

A small number of strategies for 208 plan implementation will be prepared. Each strategy will be developed at some length, describing the implications of the individual planning strategies so that the general public and decision makers can understand the positive and negative aspects of the various approaches.

Distillation and public presentation of previously developed materials regarding feasible solutions for:

- A. Agency(s) to perform the operation, management, financial, and regulatory roles necessary to implement technical best management practices
- B. Regulatory programs to support agricultural land management practices for nonpoint sources
- C. Regulatory programs to support agricultural land management practices for point sources which fall under the EPA 402 permit requirements

- D. Financial programs to fund the development of the technical plans and continue to supply the financial needs on an equitable basis
- E. Monitoring programs to assure progress in the achievement of the clean water areawide plan and meeting the goals of P.L. 92-500
- F. Phasing programs which permit moving from the current situation to each of the suggested solutions, including mitigating strategies that would be necessary for changing roles and responsibilities
- G. Identification of specific existing problems which do not appear solvable by any solution and that the affected parties must be willing to accept
- H. Public review to seek understanding, comments on the alternatives and reaction
- I. Integration of recommendations to overall implementation of the Areawide Plan.

TASK 12 REVIEW, ANALYSIS, AND RECOMMENDATIONS

An overall technical review of the project will be conducted, and information developed will be analyzed with the objective of developing sound conclusions and recommendations regarding the research project.

TASK 13 REPORTS OF WORK

The following named items will be delivered to the EPA, Region VIII, Denver, Colorado.

<u>ITEM NO.</u>	<u>DESCRIPTION</u>	<u>QUANTITY</u>	<u>SCHEDULE</u>
1	Progress Report	2	Two (2) months after project period beginning date
2	Progress Report	2	Five (5) months after project period beginning date
3	Progress Report	2	Eight (8) months after project period beginning date
4	Draft Final Report	3	Ten (10) months after project period beginning date

<u>ITEM NO.</u>	<u>DESCRIPTION</u>	<u>QUANTITY</u>	<u>SCHEDULE</u>
5	Final Report	1 Repro- ducible Master & 4 Photo- copies	Twelve (12) months after project period beginning date
6	<p>Conduct technology transfer workshop to be sponsored by Region VIII describing Best Management Practices and feasibility for implementation to be held in Denver. Specific date to be scheduled by mutual agreement, but not more than 60 days after the Grantee receives the Government approved copy of the Draft Final Report.</p> <p>Periodic Progress Reports - Report briefly stating progress made and percent completion. Specific areas shall include difficulties encountered and necessary remedial action and activity anticipated during next reporting period. Submit two copies to the Project Office, Region VIII, Denver, Colorado.</p> <p>Draft Final Report - Submit three copies of the Draft Final Report to the Project Officer, Region VIII, Denver, Colorado, within ten (10) months after project period beginning date. The Government will review and return the approved draft with comments, if necessary, within thirty (30) calendar days. The draft copy shall be typed doubled-spaced or space-and-a-half and shall include all illustrations, tables, drawings, charts, data sheets, and other pertinent material required by the approved final report.</p> <p>Final Report - Within thirty (30) calendar days after the Grantee receives the Government approved copy of the Draft Final Report, the Grantee shall submit one (1) reproducible master and four (4) photocopies of the Final Report to the Project Officer, Region VIII, Denver, Colorado.</p>		