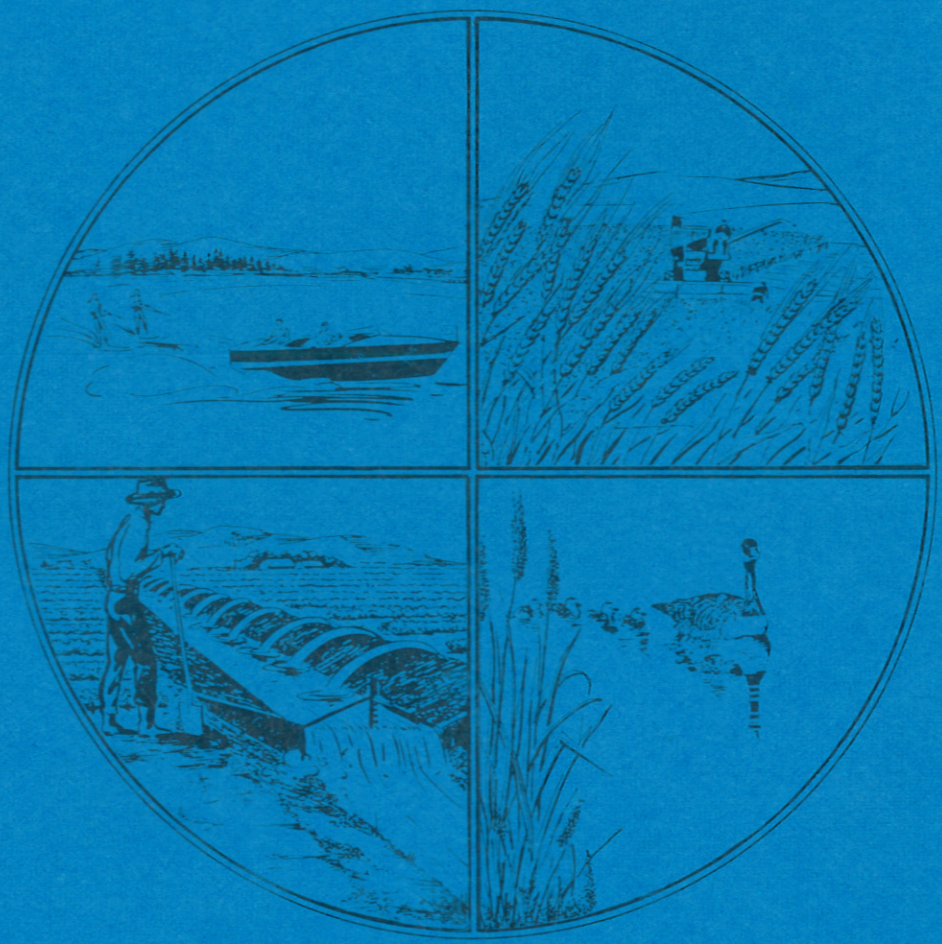
MOSES LAKE CLEAN LAKE PROJECT

1985 ANNUAL REPORT



PREPARED FOR

MOSES LAKE IRRIGATION AND REHABILITATION DISTRICT

WITH GRANT FUNDING ASSISTANCE FROM

WASHINGTON STATE DEPARTMENT OF ECOLOGY

U.S. ENVIRONMENTAL PROTECTION AGENCY

MARCH 1986

PREPARED BY

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View of the Pelican Horn Area of Moses Lake

MOSES LAKE CLEAN LAKE PROJECT

1985 ANNUAL REPORT

The Moses Lake Clean Lake Project is working to improve the water quality of Moses Lake through control of local pollution sources. This pollution source control effort encompasses the developing urban area around Moses Lake as well as extensive blocks of irrigated crop land, feed lots, dairies and rangeland which drains to the lake. Because of the diverse nature of the pollution sources, a variety of controls have been identified. The project is now in the implementation phase and many of the needed source controls are being installed. This report describes the project and the progress made during 1985.

BACKGROUND

The Moses Lake Clean Lake Project was initiated in 1982 as part of an effort by a number of public agencies to improve Moses Lake water quality. Moses Lake has experienced extensive algae growth for over two decades, resulting in diminished recreational use of the lake. Nuisance levels of blue-green algae form unsightly floating mats in the summer recreation season. Aquatic weed growth is also a problem in some shoreline areas. Nitrogen and phosphorus are the major nutrients causing over-fertilization of Moses Lake. The major emphasis of the Clean Lake Project is to reduce the amount of these nutrients entering Moses Lake through source controls.

The lake has been studied since the early 1960's to determine the causes of the algae blooms and to develop algae control mechanisms. Since the late 1970's, low nutrient water has been added to dilute a portion of the lake. Although this has resulted in a localized reduction of algae blooms, the dilution water is not always available. The Clean Lake Project is intended to provide for long term watershed nutrient controls to prevent further enrichment of Moses Lake.

PROJECT AREA

The project area is shown in Figure 1. This area includes Moses Lake and the tributary watershed downstream of Brook Lake near Stratford. Moses Lake itself is a large shallow lake centrally located in the State of Washington. The lake is regulated as part of the Columbia Basin Project which supplies water stored behind Grand Coulee Dam to over 500,000 acres of farmland. Moses Lake serves as a supply route for water passing from the East Low Canal, north of Moses Lake, south to the Potholes Reservoir, providing water to the lower part of the irrigation project.

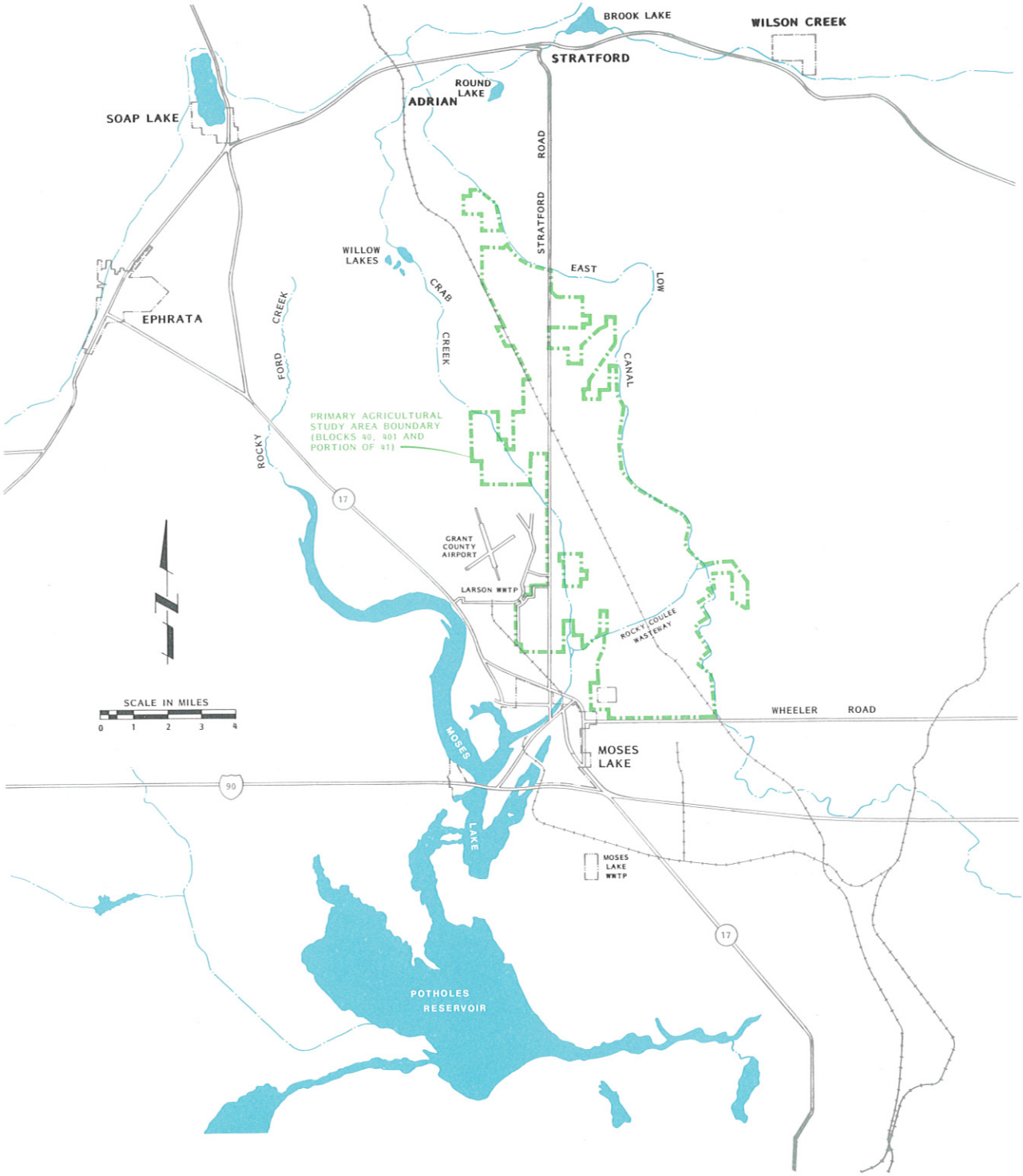


Figure 1: Project Area

Moses Lake is used extensively for recreational purposes, primarily fishing, boating and swimming. Residential and commercial development around the lake is oriented to lake views and recreational opportunities.

The City of Moses Lake is the major urban center in the watershed. The city and surrounding urban fringe account for a population of approximately 20,000. The urban centers of Ephrata-Soap Lake (population 10,400) lie west of the watershed but contribute to the underground flow to Moses Lake. There are sewer systems in Moses Lake, Ephrata and Soap Lake, although much of the urban fringe and all of the rural population is unsewered. However, groundwater testing indicates waste disposal practices in the Ephrata-Soap Lake area do not contribute significant amounts of nutrients to Moses Lake.

The major tributaries are Rocky Ford Creek and Crab Creek. Rocky Ford is spring fed and enters the main arm of Moses Lake from the north. Crab Creek drains over 80 percent of the watershed and flows into Parker Horn at the southeastern portion of the lake. Although the total watershed for Moses Lake encompasses approximately 2,450 square miles (6,255 square kilometers), the project is focused on the lower portion of that watershed.

Much of the land in the Crab Creek watershed is devoted to agriculture. Irrigated crops predominate in the lower watershed, while dryland wheat farming and cattle range are the major agricultural activities in the northern area. Coarse, shallow (Ephrata-Malaga) soils predominate in the southern Crab Creek watershed.

THE MOSES LAKE CLEAN LAKE PROJECT

The Moses Lake Clean Lake Project is a five year effort to restore water quality of the lake. The project is being conducted in three stages. Stage 1, completed in March of 1984, emphasized nutrient source identification through data collection and monitoring. Stage 2, completed in March of 1985, emphasized nutrient control demonstrations and analysis of the feasibility of control practices. Stage 3, to run from April of 1985 through March of 1987, will provide for the implementation of control practices which were analyzed in Stage 2. A number of these controls were put into place in 1985 and are described in this summary report.

The project is being funded by the Moses Lake Irrigation and Rehabilitation District (MLIRD), the Washington State Department of Ecology (DOE) and the U.S. Environmental Protection Agency (EPA). Study participants also include the Moses Lake Conservation District, the Upper Grant Conservation District, the Washington Conservation Commission, the Soil Conservation Service, and private engineering consultants. The technical staff operates from a project office in Moses Lake.

STAGE 1 SUMMARY

Stage 1 focused on nutrient source identification. The Stage 1 effort included water quality monitoring and an inventory of existing farming practices in the watershed. Water monitoring included measurement of nitrogen and phosphorus in area streams and groundwaters and in the soil profile of irrigated farms. Data collected in the farm practice inventory included information on cropping patterns, acreage farmed, irrigation methods and fertilizer application.

Data collected during Stage 1 indicated that farms in the area near Moses Lake are over-irrigating, causing deep percolation of water and nutrients (particularly soluble nitrates) in the coarse local soils. There are at least 28,000 acres of irrigated land in this area. Approximately 81 percent utilize sprinkler irrigation and 19 percent, furrow irrigation. Although furrow irrigation accounts for less than one-fifth of the irrigated acreage, it contributes over one-third of the nitrogen leached by deep percolation.

Other sources of nutrients identified during Stage 1 include wastes from cattle operations, fish hatcheries, urban runoff, septic tanks and potential contributions from in-lake recycling of nutrients from carp and decay of aquatic plants.

The major sources of nitrogen included contributions from Crab Creek and groundwater. The nitrogen sources were linked to agricultural activity in the watershed between Stratford and Moses Lake. The major sources of phosphorus included Rocky Ford Creek and sewage effluent.

STAGE 2 SUMMARY

Stage 2 focused on the identification of nutrient controls and the evaluation of the effect of these controls on Moses Lake water quality. These included demonstration of Best Managment Practices on local farms and a variety of other nutrient control approaches in the watershed and within the lake itself.

On-Farm Nutrient Controls

Farm practices were analyzed by carrying out demonstration programs on four farms near Moses Lake during the 1984 irrigation season. The demonstration involved a combination of changes in irrigation equipment and changes in the management of irrigation water and fertilizer. Four local farmers (Chris Matheson, Bill Bellomy, Tracy Schmidt and Bob Reffett) cooperated in this phase of the project. Each demonstration field was monitored to determine the effect of the change in equipment or management practice on nutrient loss, irrigation water use, and crop yield. When compared to adjacent reference fields, the demonstration

fields showed savings in water and nutrients as well as increased crop yields. See Figure 2.

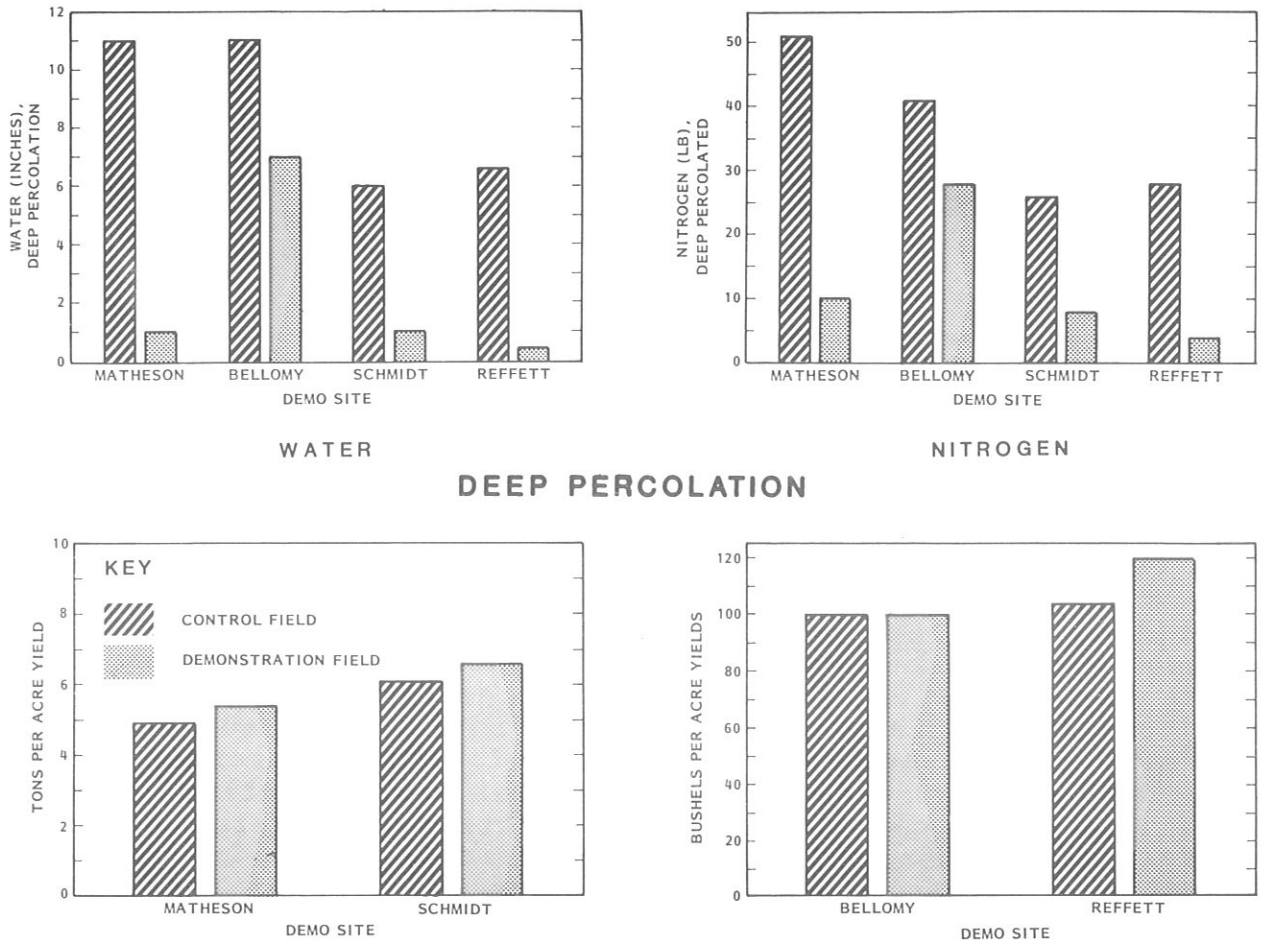


Figure 2: Farm Demonstration Results

Agricultural activity in the Block 40 and 41 area (and the portion of Block 401 tributary to Moses Lake) were determined to be the most significant contributors of nitrogen to the lake. The most effective controls involve changes in irrigation practices. Results from the demonstrations were then used to estimate the effect of implementing the demonstrated practices throughout the watershed. First, farmers in the 28,000 acre irrigation area near Moses Lake were asked to indicate their willingness to participate in a program involving changes on their farms. Farmers representing 77 percent of the project area indicated they would participate. Ten model farm plans, or Water Quality Management Plans, were then developed from a representative sampling of these cooperating farms. The farm plans described appropriate changes in equipment and management practices. Costs of these measures and nitrogen and water savings, and crop yields were then estimated.

The most cost-effective approach for irrigation controls was determined to be a mix of cost-share programs involving some equipment improvements and water and fertilizer management. Estimated nitrogen and irrigation water savings associated with these controls are shown in Table 1. These savings are estimated for the initial 9,880 acres involved and the 17,640 acres projected under full participation by cooperating farmers.

Table 1: Estimated Fertilizer and Irrigation Water Savings

	Initial Watershed Controls	Projected Watershed Controls
Participating Acreage	9,880	17,640
Nitrogen Savings (lbs)	208,100	372,200
Water Savings (acre-ft.)	5,780	10,319

Miscellaneous Nutrient Controls

Miscellaneous nutrient controls were also evaluated, including detention ponds to trap phosphorus associated with suspended sediment from tributaries; control of runoff from livestock operations; more stringent local septic tank controls; and projects in the lake or tributaries including dredging, weed harvesting, carp eradication and circulation improvement around existing causeways and bridges. The most cost-effective controls from this evaluation included construction of several sediment detention ponds; eradication of carp in Rocky Ford Creek; and restricting livestock access to surface waters. In addition, a septic tank policy is recommended for consideration by the City of Moses Lake and Grant County which would place greater restriction on septic tanks and encourage sewering in urban areas.

Project Related Benefits

Project-related benefits include Moses Lake water quality improvements, savings in farming costs, and increased crop yields. Farm-related benefits including savings in nitrogen fertilizer and irrigation water and increased crop yields are summarized in Table 2. The water quality impacts of the various nutrient controls was evaluated using a mathematical model, developed specifically for Moses Lake at the University of Washington. Improvements to lake quality, expressed in terms of chlorophyll content, were predicted on the basis of planned nutrient controls and even greater improvements were predicted when watershed nutrient controls were supplemented with dilution water releases. See Figures 3 and 4. The value of these water quality improvements was estimated to be in the $250,000 to $500,000 per year range.

Table 2: Monetary Benefits of Watershed Controls to the Moses Lake Area Farms

	Benefit ($/year)	
	Initial Watershed Controls	Projected Watershed Controls
Fertilizer	$ 52,000	$ 93,000
Irrigation	43,200	77,400
Crop Yield	444,600	793,800
Totals	$539,800	$ 964,200

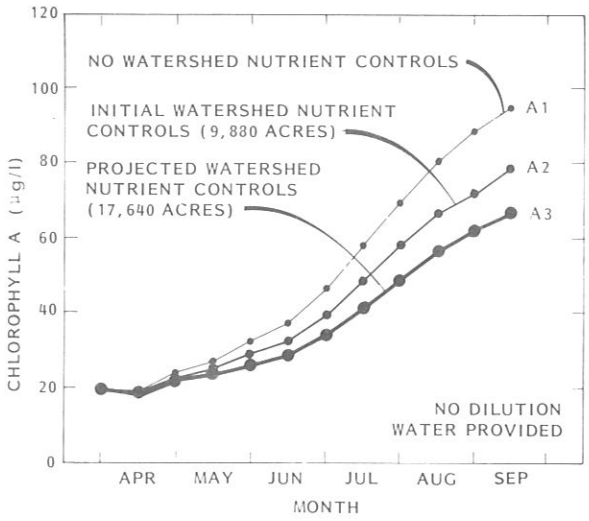


Figure 3: Predicted Chlorophyll Concentrations with Watershed Nutrient Controls

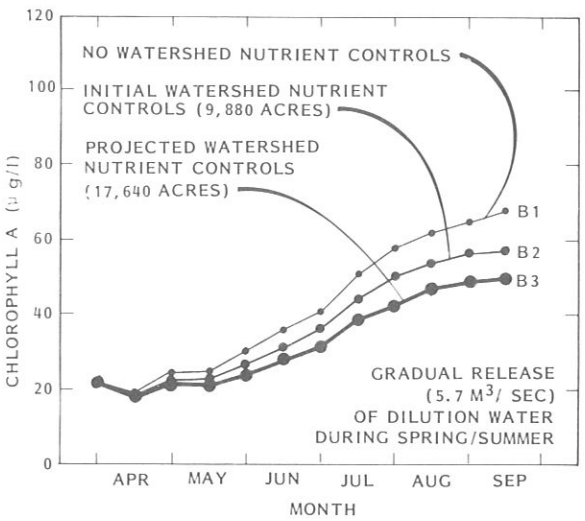


Figure 4: Predicted Chlorophyll Concentrations with Dilution Water Release and Watershed Controls

STAGE 3

Stage 3 is a multi-year program of the Clean Lake Project which is implementing cost-effective on-farm irrigation practice improvements and miscellaneous other off-farm nutrient controls identified in Stage 2 such as detention ponds for nutrient trapping, carp controls and septic tank policy development. On-farm technical assistance includes development of water quality management plans (WQMPs) and irrigation water management approaches (IWMs). Stage 3 is scheduled to be completed in 1987.

ON-FARM PROGRESS

Substantial progress was made in 1985 through a special cost-share program which was designed to control nutrient sources from farming activities. The cost-share program helps to fund physical improvements which will encourage more efficient water and fertilizer management. Improved techniques for managing irrigation water and fertilizer use will be described to local farmers in public workshops and other on-farm education programs in 1986.

Farm Tours Were a Major Feature of the Information Education Program

Corn Harvesting in the Project Area

Physical improvements to farms covered by the program range from irrigation system changes to drainage projects. All eligible projects are tributary to Moses Lake and virtually all of the on-farm activities are within the Block 40, 41 and 401 area of the Columbia Basin Project identified as the agricultural study area in Figure 1. Details concerning the cost-share program and on-farm activities in 1985 are described below.

On-Farm Cost-Share Program

Stage 3 project activities directly affect farms in the project area through a unique cost-share program funded through grants from the Environmental Protection Agency (EPA) and from the Agricultural Stabilization and Conservation Service (ASCS) cost-share budgets. Farmers who wish to participate in the cost-share program are rated and prioritized according to their contribution to Moses Lake nutrient loads. Funding is provided for technical assistance and implementation of management and structural practices which reduce the on-farm deep percolation of water and nutrient loading to groundwater from irrigation operations. Cost-share money is also available for eligible livestock controls. Eligible structural improvements, such as irrigation system conversions from furrow (rill irrigation) practices to cablegation or sprinklers, and pipeline or pumping improvements are reimbursed at a 50 percent cost-share rate.

The use of management practices, such as installation and use of soil moisture testing equipment and soil sampling for nutrients which will be used in scheduling irrigation water and determining fertilizer applications, is reimbursed at a 75 percent cost-share rate. The maximum cost-share available to a participating farmer from the EPA grant program is $50,000.

Farmers wishing to participate in the cost-share program were first asked to sign up during the spring of 1985; a second sign-up was held in the fall. The normal sequence of events following sign-up is itemized below:

1. Sign-up held (twice/year)
2. SCS contacts farmers who sign up
3. SCS/farmers develop WQMP
4. WQMP's are presented before the HUB Council[a]
5. Farmer receives acceptance letter from project manager within 30 days (if approved by HUB)
6. Contract with MLIRD is signed following legal review provided farmer has his secured financing
7. System engineering designs approved by SCS
8. Construction begins
9. SCS inspects construction
10. SCS certifies completed project meets applicable standards and specifications
11. Project manager initiates application for payment
12. Project manager checks invoices submitted by farmer
13. Project manager sends application for payment to MLIRD
14. MLIRD issues check to farmer
15. SCS begins the work-up on irrigation and fertilizer management to maximize benefits to lake water quality

[a] The HUB Council is a policy-making board of elected officials including one member each from the Moses Lake Irrigation and Rehabilitation District, the Moses Lake Conservation District and the Upper Grant Conservation District.

The status of the on-farm cost share program is summarized in Table 3. As of December 31, 1985, 77 participants had signed up either in the spring or fall sign-up periods. All participants were rated according to their nutrient savings and

prioritized as high, medium or low. Thirty-eight of the 77 have completed plans which have been approved by HUB representing 7,141 acres for an estimated annual nitrogen savings of 180,512 pounds. See Figure 5 for location of the farms which have completed plans and been approved by HUB. As of December 31, 1985, HUB had committed $1,177,848 of the $1,250,000 EPA funds available. Before contracts are signed, each farmer must obtain financing for his portion of the cost. Eight farmers cancelled from the program in 1985 because of financing and farm economy concerns. Ten of the 38 had secured necessary financing and signed formal contracts with the MLIRD and four of these were in operation with improved facilities during the 1985 irrigation season. These ten farms represent 1,987 acres for an estimated annual nitrogen savings of 60,098 pounds. These contracted and completed farm projects are shown on Figure 6 along with the completed Stage 2 demonstration projects.

Table 3: Summary of On-Farm Activities [a]

	Number	Acreage	Nitrogen Saving (lbs)
Farmer Sign-ups	77		
WQMPs Approved	38	7,141	180,512
WQMPs Contracted [b]	10	1,987	60,098

[a] As of December 31, 1985

[b] At least 30 farms are expected to have contracts and improvements in place during 1986. This is expected to triple the acreage and nitrogen savings by the end of 1986.

In addition, ASCS support has been received by farms in the project area for improvements such as mainlines for conversions from rill to sprinkler irrigation. The maximum amount of cost share money available to an individual farm under the ASCS program is $3,500. Approximately $68,800 has been paid out to cooperators under the ASCS part of the program.

Farm participation based on signups and subsequent commitments and the nature of controls expected to be achieved through the water quality management plans are near the goals for the initial watershed controls described in Table 1. The acreage of participating farms committed by HUB (7,141 acres) has already reached 72 percent of the acreage originally planned (9,880 acres) for the initial (Stage 3) controls. Because of greater efficiency in the farm conversions, the projected nitrogen savings for the committed farms is 86 percent of the planned savings of 208,100 lbs. cited in Table 1. Actual contracted farm acreage represents only 20 percent of the initial goal and will account for nearly 29 percent of the nitrogen saving goal; however, more contracts are expected to be signed and implemented before the 1986 irrigation season.

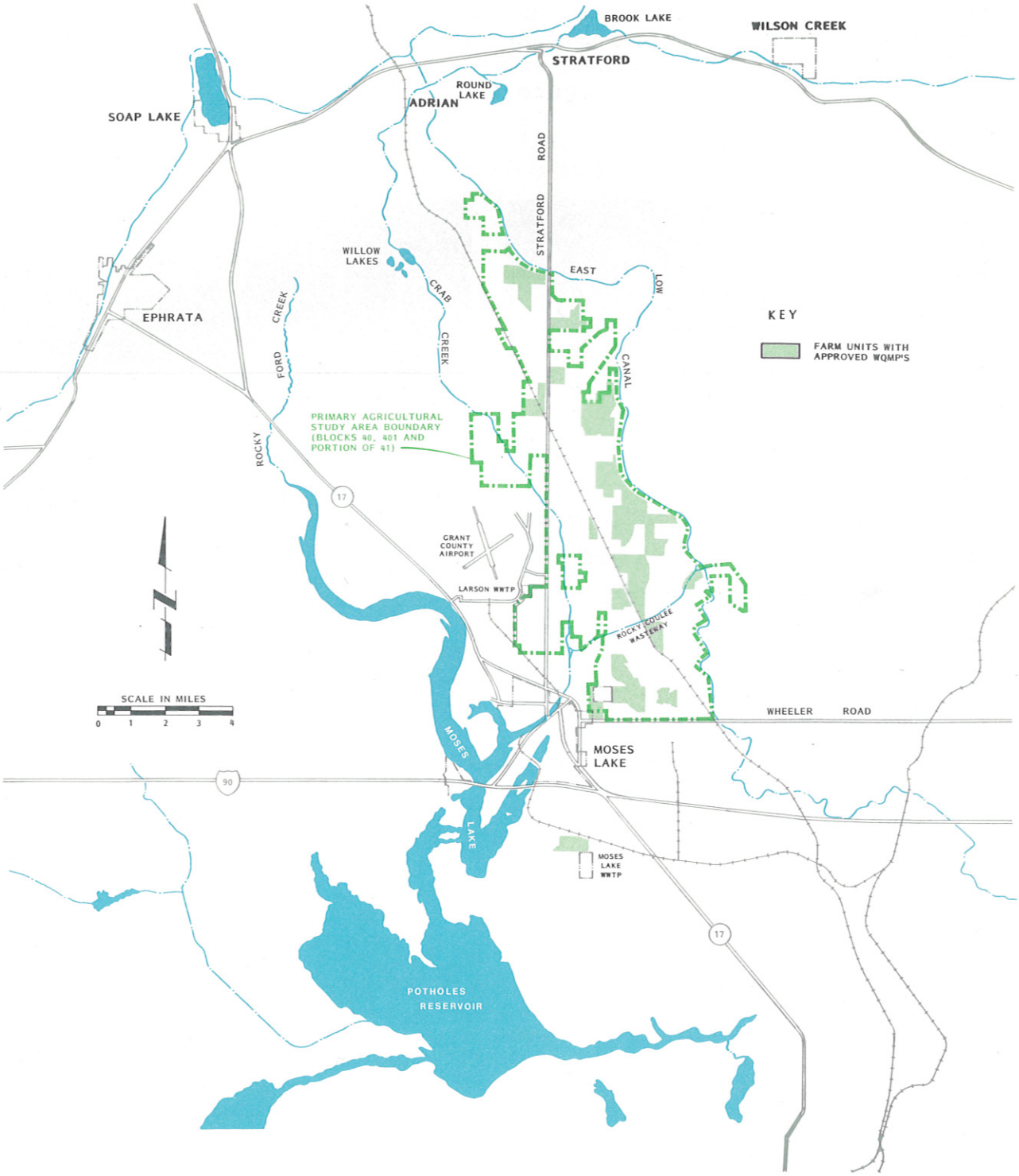
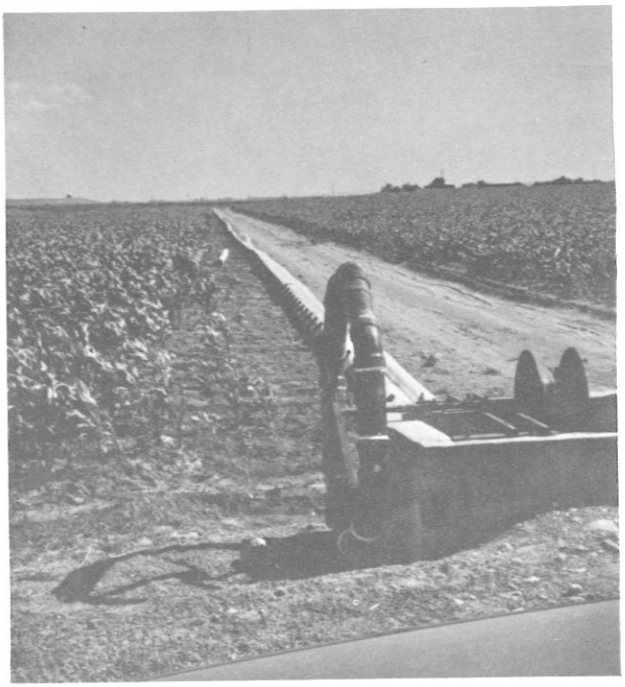


Figure 5: Farms with Approved Water Quality Management Plans

Projected savings require farmer participation in water and fertilizer management in addition to the new equipment provided by the cost-share program. Substantial monetary benefits are projected to the participating farms in the form of fertilizer and irrigation cost savings and increased crop yields as demonstrated in Stage 2. See Figure 2 and Table 2.

Center Pivot Sprinkler Unit with Corner Catcher



Cablegation Installation Used in Stage 2 Demonstration Program

Benefits to Moses Lake water quality for the initial level of control as well as subsequent projected watershed controls are illustrated in Figures 3 and 4 in the Summary of Stage 2. These water quality benefits can also be described in monetary terms. Based on the committed acreage and nitrogen savings projections, the water quality benefit for the committed acreage is estimated to be about $200,000 per year assuming the committed farms actually implement the water quality management plans approved in 1985. Using only the lesser contracted acreages as of the end of 1985, an annual water quality benefit of nearly $75,000 is estimated for the 1986 season. However, at least 20 more contracts are expected to be signed in 1986 which will substantially increase this benefit.

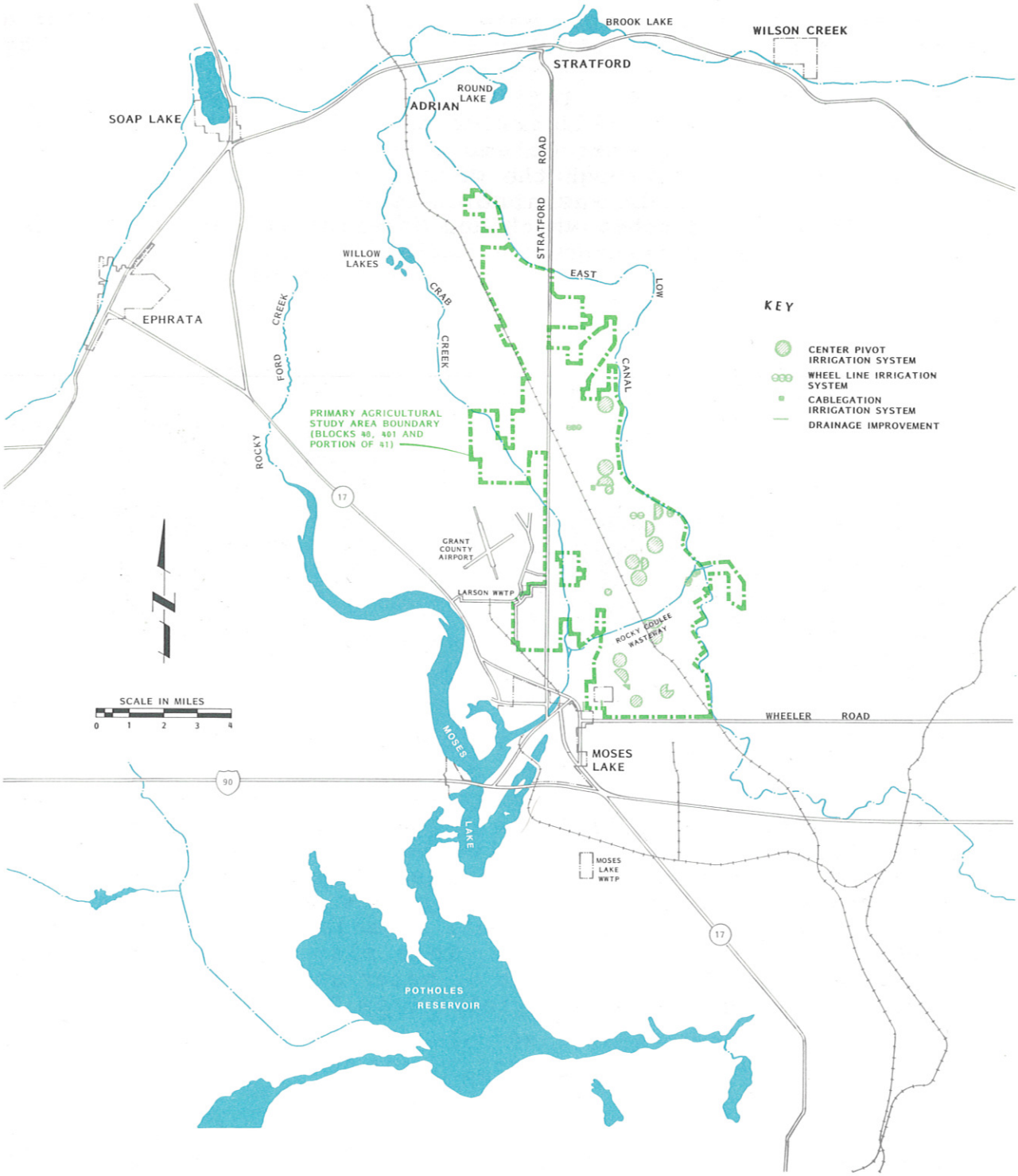


Figure 6: Farm with Contracted or Completed Projects

Example Water Quality Management Plan

Figure 7 shows a typical water quality management plan for a Block 40 farm. This particular farm is owned and operated by Demar Duvall. Hay has been the primary crop produced on this farm in recent years. The left portion of the figure shows the farm as it existed with rill irrigated fields. Water supply was drawn from an existing East Columbia Irrigation District surface lateral which flowed through the middle of the property. Irrigation of the many fields was accomplished through about 10,000 feet of older farm ditches which had deteriorated and were losing water from excessive seepage.

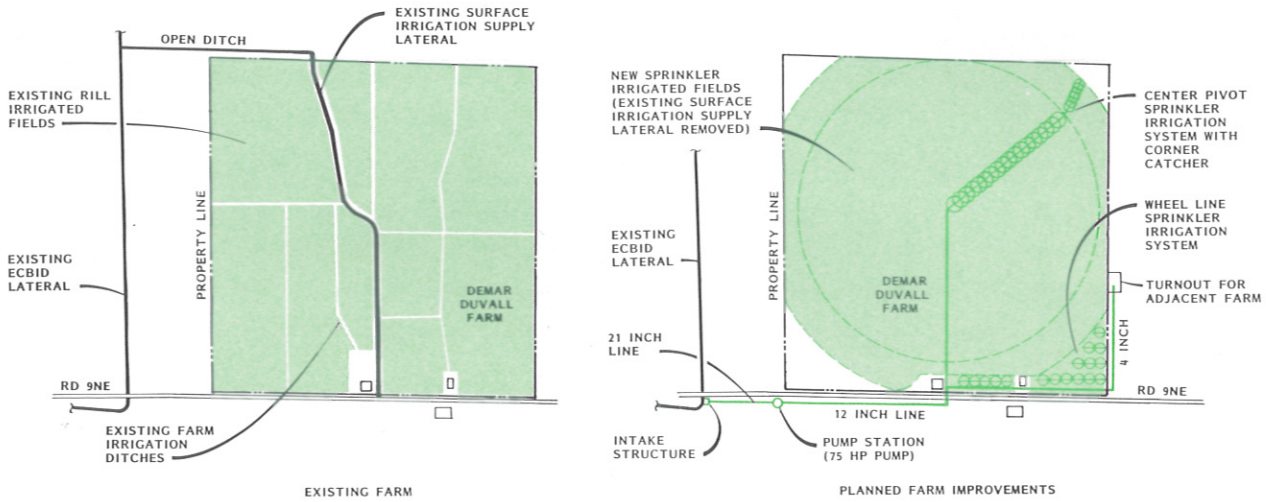


Figure 7: Example Farm Management Plan

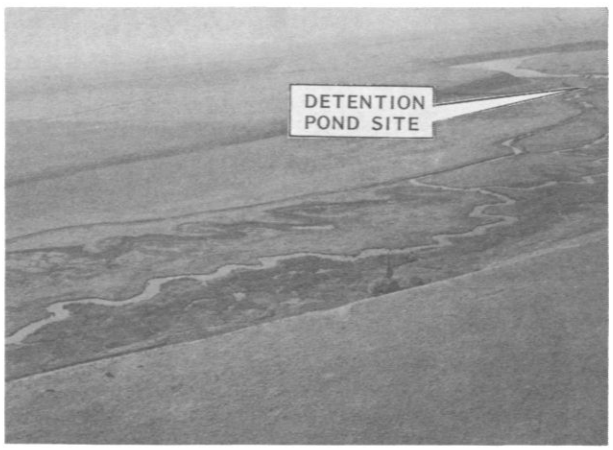
The water quality management plan, shown on the right hand portion of Figure 7, calls for elimination of the supply lateral and the farm ditches and substitution of sprinkler irrigation systems to replace the rill systems. New piping and pumping facilities are included to supply both a new center pivot and wheelline irrigation system as well as adjacent farms originally served by the surface lateral. This plan eliminates lateral water losses, reduces the amount of water and labor required, and projects increased annual hay yields from 3 tons to 5 tons.

OFF-FARM PROGRESS

The major off-farm activities have centered on siting and preliminary design of a detention pond structure on lower Rocky Ford Creek, plans for eradication of carp in that creek, and documentation of problems caused by percolation of sewage effluent, particularly from urban areas near the lake which rely on septic tank systems. Other activities include weed harvesting, dilution water releases, outlet structure repair and improvements in the vicinity of the Alder Street fill within the City of Moses Lake.

Detention Pond Structures

Detention ponds are being developed to enhance trapping of nutrients through deposition of phosphorus-rich sediments and utilization of nitrogen by aquatic plants and algae in these shallow ponds. Ponds on Rocky Ford Creek will also serve as barriers to carp which enter from Moses Lake. An earth dike with a concrete spillway structure is being designed to form a shallow (four foot) pond near the mouth of Rocky Ford Creek. The site is currently in private ownership but is within a block of riparian land that has been tentatively approved for purchase using federal grant funds. A preliminary site survey and soil investigation was completed in the summer of 1985 and a clay material found at the site appears suitable for dike construction. Flood flow information obtained from the US Geological Survey will be used in sizing the spillway which will be a sloping concrete apron. The environmental permitting will be started in early 1986. An aerial view of the site is shown in the photograph below. Additional detention pond structures are being planned for Upper Rocky Coulee Wasteway and upper Rocky Ford Creek.



Aerial View of Lower Rocky Ford Creek Showing Detention Pond Site

Meeting of Moses Lake Irrigation and Rehabilitation District Board

Carp Controls

The Rocky Ford Creek detention pond dike is being designed to block migration of carp which enter the creek from Moses Lake. Following completion of this barrier, the Department of Game will eradicate carp from Rocky Ford Creek. This will allow aquatic vegetation to reestablish in the creek which will enhance nutrient uptake within the stream system. In addition, the resuspension of the rich bottom sediments by grazing carp will cease. All of these factors, coupled with the detention pond downstream, will help reduce the high phosphorus load from Rocky Ford Creek into Moses Lake. A trout fishery will be maintained in the Creek by the Department of Game.

The Game Department has been discussing this program with the owners of Trout Lodge, the hatchery on upper Rocky Ford

Creek, in order to assure carp eradication programs do not harm hatchery fish. A second barrier may be developed near the hatchery to simplify control of the downstream portion of the creek. Much of the lower portion of Rocky Ford Creek is expected to be placed in public ownership as a result of a Federal grant purchase of the riparian corridor south of Highway 17.

Wastewater Disposal Management

The project includes a review of urban wastewater disposal practices and their impact on Moses Lake. This review includes an assessment of the effects of septic tank leachate as well as percolation of treated effluent from the Larson Sewage Treatment Plant operated by the City of Moses Lake.

Special groundwater monitoring wells were installed by the Clean Lake Project to facilitate water quality testing within selected urban areas within the City of Moses Lake and near densely populated county areas near the lake. Some of the wells and springs sampled had high phosphorus levels approaching levels found in sewage effluent. Phosphorus levels in sewage are often high because of detergents. In contrast, agricultural areas have relatively low phosphorus values compared with those found in parts of the urban area. See Figure 8. A report will be issued in 1986 describing the effects of wastewater disposal practices as related to local conditions around Moses Lake.

Maps were developed describing natural constraints affecting wastewater disposal, including soil suitability, groundwater levels, and land slope, and population densities were determined within the urban area around Moses Lake.

Weed Harvesting

A mechanical weed harvesting machine has been obtained by special arrangement between the Moses Lake Irrigation and Rehabilitation District and Seattle Metro. This machine was first used on a trial basis on the lake in 1984 and was brought back in 1985 for long term use. The machine is now being kept in Moses Lake for future use under the special agreement with Metro. During 1985 approximately 60 acres were cleared during August and September. Weeds were cut down to a depth of 1-1/2 feet below the surface based on Game Department recommendations.

Dilution Program

During 1985 Moses Lake received 600 cfs of clean canal water released through Rocky Coulee Wasteway from the U.S. Bureau of Reclamation Columbia Basin Project between April and September. This volume of dilution water exceeds releases received in recent years and resulted in major increases in water clarity, particularly in Parker Horn. During 1984 no dilution water was diverted into Moses Lake and water clarity was significantly

reduced. See Figure 9. The Parker Horn pumping station continued to transfer approximately 50 cfs of clean water across the city of Moses Lake for release to Pelican Horn with excellent results. The USBR intends to route large volumes of water through Moses Lake whenever possible. Large volumes of dilution water are expected to be available in 1986.

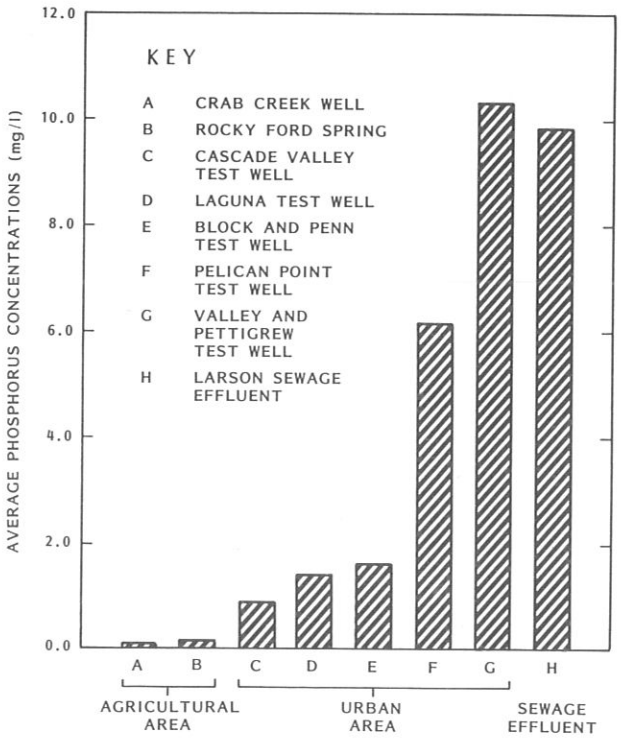


Figure 8: Phosphorus in Project Area Groundwater

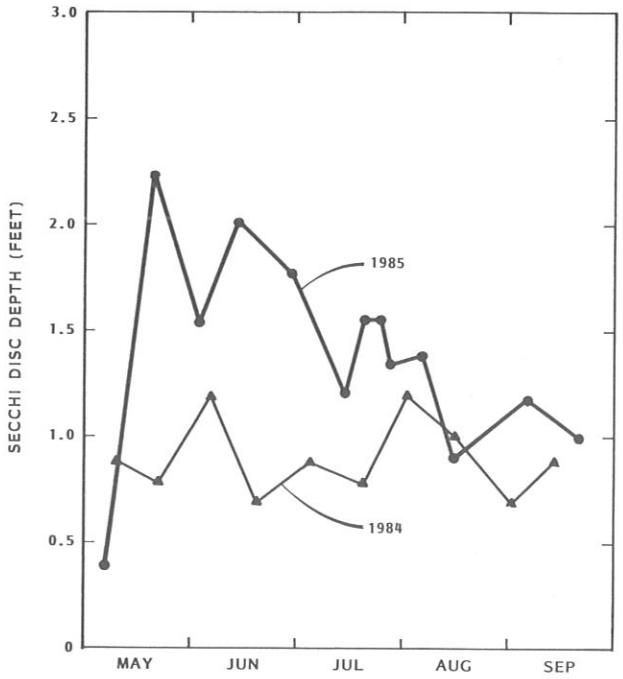


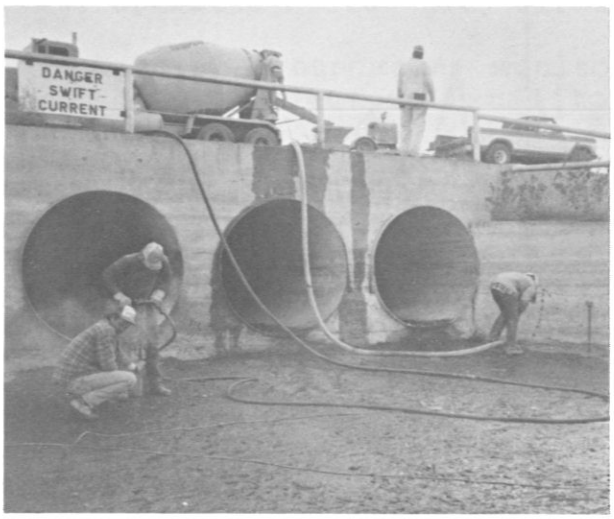
Figure 9: Comparison of Water Clarity in Parker Horn in 1984 and 1985

Alder Street Fill Improvements

Water circulation and debris accumulation near the Alder Street fill were among the water quality related concerns evaluated in Stage 2. Two corrective measures have been authorized and funded by the MLIRD. The first, which is now completed, is a modification to the inlet of the northern-most culvert. This design modification should help move more water from a counterclockwise current eddy through the culvert to improve conditions in a stagnant area near the culvert outlet. The second is to construct a concrete bulkhead around the northern side of the stagnant area which will facilitate cleaning of windblown debris from this stagnant pocket. See Figure 10. The concrete wall has received necessary environmental permits and is to be built in March 1986 while the lake levels are low.

Moses Lake Outlet Repair

A void was discovered under the spillway apron of the northerly outlet structure for Moses Lake. This cavity had been caused by water moving fine sand over the years from beneath the concrete apron through an open construction joint. The structure was originally built in the late 1920's. An emergency repair was made in October 1985 by pumping a bentonite-concrete grout mixture into the cavity after sealing the downstream end of the apron. This work was funded by the MLIRD as part of their normal operations.



The Northerly Outlet Structure for Moses Lake Was Repaired in 1985

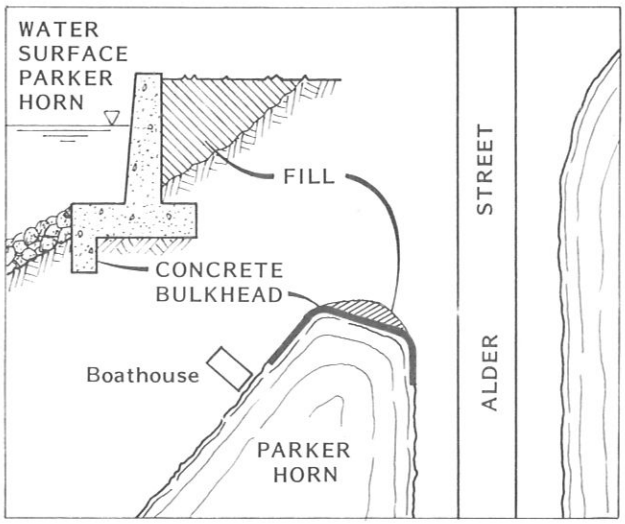


Figure 10: Bulkhead on Parker Horn at Alder Street

INFORMATION AND EDUCATION

A public opinion survey was completed by G.M.A. Research Corporation which documented significant support for the Clean Lake Project goals. This survey found strong support for increased efforts and expenditures for water quality control, including sewer system hookups.

Numerous farm tours, presentations and media contacts occurred during the past year which informed local residents. Twenty Clean Lake Project signs were placed around the lake and in local schools. An Irrigation Water Management workshop scheduled for early 1986 will inform local farmers on water and fertilizer management approaches designed to optimize crop yields while reducing nitrogen loss to groundwater. This important aspect of the project will be followed up by individual contacts by project technicians on farms during the 1986 irrigation season.