# Owyhee Subbasin Plan

## Appendix 3: Appendices for the Inventory of Restoration Activities (Chapter 3)

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Prepared for:
The Northwest Power and Conservation Council

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**Disclaimer:**
***Final approval by the Northwest Power and Conservation Council is contingent upon a favorable review by the Independent Scientific Review Panel and meeting requirements for adoption as an amendment to the Council's Fish & Wildlife Program.***

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# Appendix 3. Appendices to Inventory of Restoration Activities (OSP Chapter 3)

## Appendix 3.1. Bibliography for Chapter 3 of the Owyhee Subbasin Plan.

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Idaho Depatment of Fish and Game (IDFG). 1995 Fisheries Management Plan1995-2000. Idaho Department of Fish and Game. Boise, Idaho.

Idaho Department of Fish and Game, 2001b. Fisheries Management Plan, 2001-2006. Idaho Department of Fish and Game. Boise, Idaho.ODEQ 2000

Perkins et al. (unpublished). ODFW Trout Management Plan.

# Appendix 3.2. Laws related to Fish & Wildlife Management

## Appendix Table 3.2.1. Nationwide Laws Guiding Agency Activities Affecting Columbia River Basin Fish and Wildlife (source GAO 2004).

| Nationwide law | Citation | Description |
|---|---|---|
| Anadromous Fish Conservation Act | 16 U.S.C. §§ 757a-757f | Authorizes the Secretaries of Commerce and of the Interior to enter into cooperative agreements for the development, conservation, and enhancement of anadromous (migratory) fish resources. |
| Bald Eagle Protection Act | 16 U.S.C. §§ 668-668d | Prohibits the taking or possession of and commerce in bald and golden eagles, with limited exceptions. |
| Clean Air Act | 42 U.S.C. §§ 7401 -7671 q | Requires EPA to set limits on air pollutants and approve state implementation plans to reduce pollutants that exceed limits, and requires federal activities to comply with limits. |
| Federal Water Pollution Control Act (commonly referred to as the Clean Water Act) | 33 U.S.C. §§ 1251-1387 | Provides for the restoration and maintenance of the Nation's waters. Authorizes EPA to establish effluent limitations and requires permits for the discharge of pollutants from a point source to navigable waters. EPA approves state and tribal limits for the maximum amount of a pollutant that a water body can receive and still meet water quality standards for specified -purposes, including fish and wildlife. |
| Coastal Zone Management Act of 1972 | 16 U.S.C. §§ 1451 -1465 | Directs federal agencies to cooperate with state and local governments to control polluted runoff in coastal waters and to |

| Nationwide law | Citation | Description |
|---|---|---|
| | | otherwise generally protect, develop, and restore the resources of the nation's coastal zone, including fish and wildlife and their habitats. |
| Comprehensive Environmental Response, Compensation, and Liability Act of 1980 | 42 U.S.C. §§ 9601-9675 | Provides for the cleanup of hazardous waste by imposing, liabilities and duties on responsible parties, including federal agencies, and by authorizing the federal government to take cleanup actions in response to releases or threatened releases of hazardous substances. |
| Endangered Species Act | 16 U.S.C. §§ 1531 -1544 | Provides for the conservation and recovery of species of plants and animals that the National Marine Fisheries Service or the U.S. Fish and Wildlife Service determine to be in danger of or soon to become in danger of extinction. Includes measures to protect the habitats of these species. |
| Federal Water Project Recreation Act | 16 U.S.C. §§4601-12 to 1-21 | Declares that recreation and fish and wildlife enhancement should be given full consideration as purposes of federal water development projects. |
| Fish and Wildlife Conservation Act of 1980 | 16 U.S.C. §§ 2901 -2912 | Provides for financial and technical assistance to states for development and implementation of conservation plans and programs for nongame fish and wildlife. |
| Fish and Wildlife Coordination Act | 16 U.S.C. §§ 661 -666c | Authorizes the Secretary of the Interior to, among other things, provide assistance to, and cooperate with, federal, |

| Nationwide law | Citation | Description |
|---|---|---|
| | | state, and public or private agencies and organizations in the development, protection, rearing, and stocking of all species of wildlife and their habitat, in minimizing damages from overabundant species, and in providing public shooting and fishing areas. |
| Flood Control Acts | E.g. Flood Control Act of 1970, Pub. L. No. 91 -611, 84 Stat. 1818(1970) and Flood Control Act of 1965, Pub. L. No.89- 298, 79 Stat. 1073(1965). | Authorize projects for the benefit of navigation, the control of destructive floodwaters, protection of the shorelines, and other purposes. |
| Magnuson-Stevens Fishery Conservation and Management Act of 1972 | 16 U.S.C. §§ 1801 -1883 | Establishes a framework for the conservation and management of United States coastal and Outer Continental Shelf fishery resources and anadromous species, which includes the establishment of national standards for fishery management and conservation and of eight Regional Fishery Management Councils to develop fishery management plans. Requires federal agencies to consult with the Secretary of the Interior with respect to any of the Department's actions that may adversely affect fish habitat, and requires the Secretary to recommend habitat conservation measures to the agency. |
| Marine Mammal Protection Act | 16 U.S.C. §§ 1361 -1421 h | Enacts various measures to protect marine mammals and their habitats. Most notably, prohibits the taking of marine mammals, except under certain conditions, including as an |

| Nationwide law | Citation | Description |
|---|---|---|
| | | incidental take during commercial fishing operations. |
| Marine Protection, Research and Sanctuaries Act of 1972 | 33 U.S.C. §§ 1401-1445,16 U.S.C. §§ 1431-1434 | Regulates the dumping of all types of materials into ocean water sand authorizes the EPA to issue dumping permits for material other than dredged material and the Army Corps of Engineers to issue permits for the transportation and dumping of dredged materials, based in part on the effect of the dumping on fish and wildlife and the marine environment. |
| Migratory Bird Conservation Act | 16 U.S.C. §§ 715-715r | Establishes a Migratory Bird Conservation Commission, headed by the Secretary of the Interior, to approve areas of land or water recommended by the Secretary, and approved by the state in which the land is located, for acquisition as reservations for migratory birds. |
| Migratory Bird Treaty Act | 16 U.S.C. §§ 703-712 | Implements various treaties and conventions between the United States, Canada, Japan, Mexico, and the former Soviet Union for the protection of migratory birds. Prohibits taking, killing, or-possessing migratory birds. |
| National Environmental Policy Act of 1969 | 42 U.S.C. §§ 4321 -4347 | Enacts measures to promote efforts to prevent or eliminate damage to the environment. Requires federal agencies to examine the impacts of proposed major federal actions "significantly affecting" the environment. |

| Nationwide law | Citation | Description |
|---|---|---|
| National Historic Preservation Act of 1966 | 16 U.S.C. §§ 470 | Encourage agencies and individuals to develop historic preservation programs, and requires agencies to oversee any historic sites under their jurisdiction and consider the effects of its actions on historic sites. Provides for tribes to designate an official to administer the preservation program on tribal lands |
| Non indigenous Aquatic Nuisance Prevention and Control Act of 1990 | 16 U.S.C. §§ 4701 -4751 | Enacts measures to prevent the unintentional introduction of non indigenous species into the waters of the United States and to minimize the economic and ecological effects of such species that become established. Establishes a task force, comprising, among others, the FWS, the Coast Guard, and EPA to develop a program to prevent introduction of and to control the spread of introduced aquatic nuisance species. |
| North American Wetlands Conservation Act | 16 U.S.C. §§ 4401-4414 | Enacts measures to protect, enhance, restore, and manage wetlands and their ecosystems (which include fish and wildlife). Authorizes the Secretary of the Interior to fund wetland |
| Oil Pollution Act of 1990 | 33 U.S.C. §§ 2701 -2761 | Imposes liability on responsible parties for damages (e.g., loss of natural resources) and for removal costs those agencies, tribes, and others incur from oil discharges into navigable waters. |
| Public Rangelands | 43 U.S.C. §§ 1901 -1908 | Establishes a national |

| Nationwide law | Citation | Description |
|---|---|---|
| Improvement Act of 1978 | | policy to improve conditions on public rangelands; requires the Secretary of the Interior and Secretary of Agriculture to develop, update, and maintain and inventory of range conditions; and authorizes funding for range improvement projects. |
| River and Harbor Act of 1899, §§9,10 | 33 U.S.C. §§ 401, 403 | Prohibits projects that interfere with navigation, unless Congressional approval is given and a permit is obtained from the Department of Transportation for bridges or causeways, or from the Army Corps of Engineers for other projects such as piers, wharfs, breakwaters, bulkheads, jetties, weirs, dams, or dikes. |
| Safe Drinking Water Act of 1974 | 42 U.S.C. §§ 300f to j-26 | Enacts measures to protect public drinking water. Requires EPA to promulgate national drinking water regulations to be enforced by states, and prohibits federal agencies from assisting actions that will contaminate an aquifer designated as a drinking water source. |
| Sikes Act | 16 U.S.C. §§ 670-670o | Establishes a program for conservation and rehabilitation of natural resources, including fish and wildlife, at military installations, in accordance with a plan developed by the Secretaries of Defense and the Interior in coordination with the appropriate state agency. |
| Transportation Equity Act | §49 U.S.C. § 138 note | Directs the Secretary of |

| Nationwide law | Citation | Description |
|---|---|---|
| for the 21sf Century, 3039 | | Transportation, in coordination with the Secretary of the Interior, to study alternative transportation needs on public lands, such as national parks, recreation areas, and wildlife refuges, to encourage and promote the development of transportation systems for the betterment of those areas in order to, among other things, conserve natural, historical, and cultural resources and prevent adverse impacts, relieve congestion, reduce pollution, and enhance the visitor experience. |
| Watershed Protection and Flood Prevention Act | 16 U.S.C. §§ 1001 -1010 | Authorizes the Secretary of Agriculture to provide financial and other assistance to state and local entities and to Indian tribes to plan and carry out projects in watersheds for flood prevention, conservation, development, utilization, and disposal of water, or for conservation and proper use of land. |
| Wild and Scenic Rivers Act | 16 U.S.C. §§ 1271-1287 | Institutes a national wild and scenic rivers system and implements a policy of protecting rivers that comprise the system and preserving them in a free-flowing state, by enacting protective and other measures. |
| Wilderness Act | 16 U.S.C. §§ 1131-1136 | Establishes a National Wilderness Preservation System composed of federally owned areas the Congress designates as "wilderness areas," which |

| Nationwide law | Citation | Description |
|---|---|---|
| | | are to be administered in a way that protects the areas and preserves their wilderness character. Federal agencies that had jurisdiction over areas designated as part of the system are to retain jurisdiction and continue to manage them. |

# Appendix 3.3. Inventory of existing fish, wildlife, and habitat restoration activities in the Owyhee Subbasin.

## Appendix Table 3.3.1 Summary of attributes for of fish & wildlife projects in the Owyhee Subbasin; including both BPA-funded projects and those funded from other sources.

| **Project Title/ Duration** | **Management Entity/ Funding Source and ID # (BPA # if applicable)** | **Brief Project Description/ Scale of Project** | **Subwatershed Name/ (Subwatershed # see reference map attached)** | **Key Ecological Functions Addressed/ Goal of Project** | **Results of Project: Accomplishments and failures (Include a Quantitative assessment)** |
|---|---|---|---|---|---|
| Assess Resident Fish Stocks of the Owyhee/Bruneau Subbasins | DVIR/ **BPA # 200007900** | access the current status of native salmonids in the rivers and tributaries within the boundaries of the Duck Valley Indian Reservation/ **rivers and tributaries within the boundaries of the Duck Valley Indian Reservation** | | salmonid populations and habitat/ **(1) provide baseline information on genetic variation within and among populations of redband trout within the East Fork Owyhee River and Bruneau River drainage; (2) assess the extent of hatchery introduced rainbow trout introgression within these populat** | **Six of the ten streams scheduled for sampling in 2001 were completed and fin clips are currently being analyzed at a regional genetics laboratory** |
| Agricultural component of comprehensive TMDL implementation plans for the Bruneau subbasin/ **Initiated** | ISCC | Agricultural component of comprehensive TMDL implementation plans for the Bruneau subbasin | | | |
| Bruneau Hot Springsnail Cooperative | BLM, ISU | | | | |

| **Project Title/ Duration** | **Management Entity/ Funding Source and ID # (BPA # if applicable)** | **Brief Project Description/ Scale of Project** | **Subwatershed Name/ (Subwatershed # see reference map attached)** | **Key Ecological Functions Addressed/ Goal of Project** | **Results of Project: Accomplishments and failures (Include a Quantitative assessment)** |
|---|---|---|---|---|---|
| Monitoring project/ **Ongoing since 1993** | | | | | |
| Bruneau Hot Springsnail habitat monitoring project/ **Ongoing since 1999** | USFWS, ISU | | | | |
| Bull trout in the Jarbidge River system | Southwest Basin Native Fish Technical Group | seek funding for the Jacks Creek bridge in Nevada; to identify ways to reduce road impacts and explore ways to move the road from the flood plain | | Protect bull trout habitat and populations/ **To recover spawning and juvenile rearing habitat and populations** | |
| California Bighorn Sheep | The Nature Conservancy | Protect and maintain California bighorn sheep populations and their habitats | | California bighorn sheep populations and habitats/ **Protect and maintain California bighorn sheep populations and their habitats** | |
| Fenced off Bruneau hot springsnail habitat from cattle grazing/ **Completed 1992** | BLM | Fenced off Bruneau hot springsnail habitat from cattle grazing | | | |
| Fenced off Indian Bathtub in Hot Creek Watershed**/ Completed 1990** | USFWS | Fenced off Indian Bathtub in Hot Creek Watershed | | | |
| Groundwater, spring discharge and annual well | USFWS, USGS | | | | |

| Project Title/ Duration | Management Entity/ Funding Source and ID # (BPA # if applicable) | Brief Project Description/ Scale of Project | Subwatershed Name/ (Subwatershed # see reference map attached) | Key Ecological Functions Addressed/ Goal of Project | Results of Project: Accomplishments and failures (Include a Quantitative assessment) |
|---|---|---|---|---|---|
| withdrawals monitoring/ **Ongoing since 1993 (excluding 1997)** | | | | | |
| Habitat enhancement and protection – Shoshone-Paiute Reservation/ **Ongoing** | Shonshone-Paiute Tribes/ **BPA # 9701100** | Habitat enhancement and protection – Shoshone-Paiute Reservation | | Habitat enhancement and protection | |
| Intermittent Streams and Rivers | The Nature Conservancy | Maintain the high quality and diversity of the riparian communities within and along intermittent streams and rivers and prevent the degradation of these systems | | Protect riparian communities/ **Maintain the high quality and diversity of the riparian communities within and along intermittent streams and rivers and prevent the degradation of these systems** | |
| Jarbidge Sage Grouse Working Group | BLM, IDFG, local ranchers, sportsmen, environmental groups | Prevent fire in critical Wyoming big sagebrush, low sagebrush and mountain sagebrush communities and related cheatgrass and exotic annual grass infestations; Rehabilitate areas following wild fire with native seeds before weed infestation occurs/ **Jarbidge Resource** | | **Maintain huntable and sustainable sage grouse populations; Sustain, maintain or improve sage grouse habitat in the various sub-units of the Jarbidge Resource Area** | |

| **Project Title/ Duration** | **Management Entity/ Funding Source and ID # (BPA # if applicable)** | **Brief Project Description/ Scale of Project** | **Subwatershed Name/ (Subwatershed # see reference map attached)** | **Key Ecological Functions Addressed/ Goal of Project** | **Results of Project: Accomplishments and failures (Include a Quantitative assessment)** |
|---|---|---|---|---|---|
| | | **Area** | | | |
| Native Salmonid Assessment Project / **1998-** | IDFG/ **BPA # 199900200** | **a**ssess the current status of native salmonids in the Middle and Upper Snake Provinces in Idaho (Phase I), identify factors limiting populations (Phase II), and develop and implement recovery strategies and plans (Phase III)/ **Middle and Upper Snake Provinces in ID** | | Salmonid populations and habitat | |
| Owyhee County Sage Grouse Working Group | | Map locations of all known active and historic sage grouse leks in Owyhee County; Identify and map sage grouse breeding (nesting and early brood) habitat associated with active leks; Identify and map known sage grouse wintering habitat/ **Owyhee County** | | Preserve sage grouse populations/ **Preserve and increase sage grouse populations in Owyhee County** | |

| **Project Title/ Duration** | **Management Entity/ Funding Source and ID # (BPA # if applicable)** | **Brief Project Description/ Scale of Project** | **Subwatershed Name/ (Subwatershed # see reference map attached)** | **Key Ecological Functions Addressed/ Goal of Project** | **Results of Project: Accomplishments and failures (Include a Quantitative assessment)** |
|---|---|---|---|---|---|
| Project 32007 | | monitor bull trout densities and habitat conditions annually to assess project effectiveness; Bull trout spawning surveys | | | |
| Project 32012 | | assessing water quality standards attainment and meeting grazing, fisheries and terrestrial objectives | | | |
| Rangewide surveys for all geothermal springs/ **Ongoing (every 2-3 years) since 1993** | USFWS, ISU | | | | |
| Redband and Bull Trout | The Nature Conservancy | Protect and maintain population strongholds of redband trout by focusing on the protection and enhancement of riparian habitat within the stronghold population's watershed | | Protect redband and bull trout populations and habitat/ **Protect and maintain population strongholds of redband trout by focusing on the protection and enhancement of riparian habitat within the stronghold population's watershed** | |
| Replace culvert on Jack Creek to remove passage barrier/ | Jarbidge Bull Trout Group | Replace culvert on Jack Creek to remove | | | |

| Project Title/ Duration | Management Entity/ Funding Source and ID # (BPA # if applicable) | Brief Project Description/ Scale of Project | Subwatershed Name/ (Subwatershed # see reference map attached) | Key Ecological Functions Addressed/ Goal of Project | Results of Project: Accomplishments and failures (Include a Quantitative assessment) |
|---|---|---|---|---|---|
| **Completed in 1997** | | passage barrier | | | |
| Sage grouse habitat fragmentation study/ **2000-2004** | IDFG and UI | Researchers will monitor sage grouse using radio telemetry to determine sage grouse use of fragmented habitats; examine sagebrush patch size selection, nest site selection, seasonal movements, and seasonal habitat use in fragmented versus continuous habit/ **Jarbidge Resource Area** | | Sage grouse populations and habitat | |
| Sage grouse life history study/ **Data collected in 2000/2001** | IDFG, UI | | | | |
| Sage Grouse Predator Project/ **2002-2008** | IDFG | six year study that will monitor six sage grouse populations across the state, one of which is in the Sheep Creek drainage west of the Bruneau River/ **Idaho** | | Sage grouse populations and predator effects/ **(1) evaluate the effect of predator control on sage grouse nest success; (2) evaluate the effect of predator control on sage grouse survival; (3) document cause-specific** | |

| **Project Title/ Duration** | **Management Entity/ Funding Source and ID # (BPA # if applicable)** | **Brief Project Description/ Scale of Project** | **Subwatershed Name/ (Subwatershed # see reference map attached)** | **Key Ecological Functions Addressed/ Goal of Project** | **Results of Project: Accomplishments and failures (Include a Quantitative assessment)** |
|---|---|---|---|---|---|
| | | | | **mortality of sage grouse eggs, juveniles and adults; (4) evaluate the effect of preda** | |
| Sage grouse recovery in Elko County | Eastern Nevada Stewardship Group, Inc. (Northeast Nevada 2001) | Rehabilitate annual grasslands to perennial plant communities capable of supporting diverse land uses; Improve water quality and quantity within managed basin; Manage uplands and riparian vegetation to improve systems at risk and nonfunctioning systems/ **Elko County** | | Preserve sage grouse populations/ **To manage watersheds, basins, or subbasins in a manner that restores or enhances (as appropriate) the ecological processes necessary to maintain proper function ecosystems inclusive of sage grouse** | |
| Shoshone-Paiute Tribes Sage Grouse Working Group | tribal members, Wildlife and Parks Department biologists and Tribal Business Council members | **Duck Valley Indian Reservation** | | Preserve sage grouse populations/ **To maintain a sustainable sage grouse population on the Duck Valley Indian Reservation, promote healthy ecosystems and preserve traditional and cultural appreciation of the species** | |

| **Project Title/ Duration** | **Management Entity/ Funding Source and ID # (BPA # if applicable)** | **Brief Project Description/ Scale of Project** | **Subwatershed Name/ (Subwatershed # see reference map attached)** | **Key Ecological Functions Addressed/ Goal of Project** | **Results of Project: Accomplishments and failures (Include a Quantitative assessment)** |
|---|---|---|---|---|---|
| Shrub Steppe Habitat | The Nature Conservancy | Identify and protect the existing high quality shrub steppe habitat (late seral condition areas), while moving the fair quality shrub steppe (mid seral areas) into late seral conditions | | Protect shrub steppe habitat/ **Identify and protect the existing high quality shrub steppe habitat (late seral condition areas), while moving the fair quality shrub steppe (mid seral areas) into late seral conditions** | |
| Snake River Native Salmonid Assessment/ **1998-2015** | IDFG/ **BPA # 980002** | assess the status of native salmonids in the Middle and Upper Snake Provinces in Idaho (Phase I), identify factors limiting populations of native salmonids (Phase II), and develop and implement recovery strategies and plans (Phase III)/ **Snake River** | | Salmonid populations | **in the first 3+ years of the project, fish and habitat surveys have been made at a total of 757 sites on private and public lands across southern Idaho in nearly all other major watersheds, including the Weiser, Owyhee, Payette, Boise, Goose, Raft, Rock,** |
| Spotted frog surveys/ **ongoing** | USFWS, IDFG, BSU | | | | |
| Springs, Spring Creek Systems, and Wetlands | The Nature Conservancy | Maintain or improve the ecological conditions of all springs, spring creek systems, and wetlands so as | | Protect springs, spring creek systems, and wetlands/ **Maintain or improve the ecological conditions of all** | |

| Project Title/ Duration | Management Entity/ Funding Source and ID # (BPA # if applicable) | Brief Project Description/ Scale of Project | Subwatershed Name/ (Subwatershed # see reference map attached) | Key Ecological Functions Addressed/ Goal of Project | Results of Project: Accomplishments and failures (Include a Quantitative assessment) |
|---|---|---|---|---|---|
| | | to be rated in Proper Functioning Condition | | **springs, spring creek systems, and wetlands so as to be rated in Proper Functioning Condition** | |
| SWCD Agricultural Implementation Projects: The Bruneau River SWCD/ **ongoing** | SWCD | currently working with private landowners to apply agricultural BMPs on 1,800 acres of cropland with the objective of preserving Bruneau hot Springsnail habitat, and improving groundwater quality. The project also includes planting native plants/ **1,800 acres of agricultural land** | | Preserving Bruneau hot springsnail habitat | |
| Jordan Valley Range Improvement/ **5 years** | NRCS/ **EQIP** | Fencing, livestock water pipe & troughs, range seeding/ **1 Ranch** | **170501090902** | Improving upland function and riparian condition | |
| Irrigation Improvement Project/ **5 years** | NRCS/ **EQIP** | Buried mainline, pump, sprinklers, gated pipe, irrigation water management, sediment ponds, grazing management, fencing/ | **170501102502** | Improving water quality | |

| **Project Title/ Duration** | **Management Entity/ Funding Source and ID # (BPA # if applicable)** | **Brief Project Description/ Scale of Project** | **Subwatershed Name/ (Subwatershed # see reference map attached)** | **Key Ecological Functions Addressed/ Goal of Project** | **Results of Project: Accomplishments and failures (Include a Quantitative assessment)** |
|---|---|---|---|---|---|
| | | **4 Farms** | | | |
| Irrigation Improvement Project/ **5 years** | NRCS/ **EQIP** | Buried mainline, pump, sprinklers, gated pipe, irrigation water management, sediment ponds, grazing management, fencing/ **10 Farms** | **170501102501** | Improving water quality | |
| Irrigation Improvement Project/ **5 years** | NRCS/ **EQIP** | Buried mainline, pump, sprinklers, gated pipe, irrigation water management, sediment ponds, grazing management, fencing/ **2 Farms** | **170501100104** | Improving water quality | |
| Irrigation Improvement Project/ **5 years** | NRCS/ **EQIP** | Buried mainline, pump, sprinklers, gated pipe, irrigation water management, sediment ponds, grazing management, fencing/ **1 Farm** | **170501150303** | Improving water quality | |
| Irrigation Improvement Project/ **5 years** | NRCS/ **EQIP** | Buried mainline, pump, sprinklers, gated pipe, irrigation water management, sediment ponds, grazing management, | **170501030102** | Improving water quality | |

| **Project Title/ Duration** | **Management Entity/ Funding Source and ID # (BPA # if applicable)** | **Brief Project Description/ Scale of Project** | **Subwatershed Name/ (Subwatershed # see reference map attached)** | **Key Ecological Functions Addressed/ Goal of Project** | **Results of Project: Accomplishments and failures (Include a Quantitative assessment)** |
|---|---|---|---|---|---|
| | | fencing/ **1 Farm** | | | |
| Irrigation Improvement Project/ **5 years** | NRCS/ **EQIP** | Buried mainline, pump, sprinklers, gated pipe, irrigation water management, sediment ponds, grazing management, fencing/ **1 Farm** | **170501100104** | Improving water quality | |
| Irrigation Improvement Project/ **5 years** | NRCS/ **EQIP** | Buried mainline, pump, sprinklers, gated pipe, irrigation water management, sediment ponds, grazing management, fencing/ **1 Farm** | **170501100101** | Improving water quality | |
| Irrigation Improvement Project/ **5 years** | NRCS/ **EQIP** | Buried mainline, pump, sprinklers, gated pipe, irrigation water management, sediment ponds, grazing management, fencing/ **2 Farm** | **170501170101** | Improving water quality | |
| Erosion Control Project/ **2 years** | OWC/ **OWEB** | converting from open dirt ditch to pipe/ **1 Ranch** | Jordan | Improve water quality/ **Reduce soil erosion** | |
| Riparian Protection Project/ **2 years** | OWC/ **OWEB** | Install animal waste management system to prevent animal | Jordan | Improve water quality/ **Elimate any potential animal waste** | |

| **Project Title/ Duration** | **Management Entity/ Funding Source and ID # (BPA # if applicable)** | **Brief Project Description/ Scale of Project** | **Subwatershed Name/ (Subwatershed # see reference map attached)** | **Key Ecological Functions Addressed/ Goal of Project** | **Results of Project: Accomplishments and failures (Include a Quantitative assessment)** |
|---|---|---|---|---|---|
| | | waste contamination; fencing of riparian area/ **1 Ranch** | | **contamination and protect riparian area** | |
| Rangeland enhancement project/ **2 years** | OWC:BLM/ **OWEB** | **o**ff-site water development and use exclusion from the Owyhee River/ **BLM Allotment** | Lower Owyhee | **I**mprove upland condition and protect riparian areas/ **Improve livestock distribution and minimize livestock impacts on the banks of the Owyhee River** | |
| Sagebrush Pasture Solar Project/ **2 years** | OWC:BLM/ **OWEB** | off-site water development / installation of a solar pumping system/ **pasture within a BLM allotment (Nyssa Allotment)** | Lower Owyhee | Improve upland condition and function/ **Improve livestock distribution, enhance wildlife habitat, and improve riparian conditions** | |
| S. Board Mainline Extension/ **2 years** | OWC/ **OWEB** | conversion of cement ditch irrigation system to sprinkler and/or drip system/ **1 Farm** | Lower Owyhee | Improve water quality/ **Reduce irrigation-induced erosion through improved farm irrigation system** | |
| Irrigation Improvement Project/ **2 years** | OWC/ **OWEB** | off-site water development and reduction of irrigation-induced erosion/ **portion of 1 Farm** | Lower Owyhee | Improve water quality and protect riparian areas/ **Improve riparian condition and reduce irrigation-induced erosion through improved farm** | |

| **Project Title/ Duration** | **Management Entity/ Funding Source and ID # (BPA # if applicable)** | **Brief Project Description/ Scale of Project** | **Subwatershed Name/ (Subwatershed # see reference map attached)** | **Key Ecological Functions Addressed/ Goal of Project** | **Results of Project: Accomplishments and failures (Include a Quantitative assessment)** |
|---|---|---|---|---|---|
| | | | | **irrigation system** | |
| Range Seeding Project/ **2 years** | OWC/ **OWEB** | **brush control and range seeding/** portion of 1 ranch (approx. 640 acres) | Lower Owyhee | Improve hydrologic function of uplands/ **Improve grazing management for the benefit of livestock and wildlife** | |
| Rangeland enhancement project/ **2 years** | OWC/ **OWEB** | off-site water development / installation of a solar pumping system/ **portion of 1 ranch** | Middle Owyhee | Improve upland condition and function/ **Achieve proper grazing management; provide reliable source of water for livestock/wildlife** | |
| Rangeland enhancement project/ **2 years** | OWC/ **OWEB** | off-site water development**/ portion of 1 ranch** | Crooked-Rattlesnake | Improve upland condition and function/ **Improve livestock distribution, reduce pressure on riparian areas, achieve proper grazing management** | |
| Erosion Control Project/ **2 years** | OWC/ **OWEB** | conversion from dirt ditch irrigation system/ poriton of 1 farm | Jordan | Improve water quality/ **Reduce irrigation-induced erosion through improved farm irrigation system** | |

# Appendix 3.4. Owyhee Subbasin Existing / Past Restoration Activities Inventory Survey Questionnaire, contact lists, and responses.

## Appendix 3.4.1 Owyhee Subbasin Existing / Past Restoration Activities Inventory Survey Questionnaire sent out by Jennifer Martin on April 12th, 2004.

Please answer the following questions to the best of your ability and return to Steven Vigg via email as soon as possible at Vigg@earthlink.net. If you would prefer to return your survey by mail, please send to Jennifer Martin at: Owyhee Watershed Council 2925 S.W. 6th Ave., Ste. 2 Ontario, OR 97914

Organization Name:

Organization Type:

- Federal
- State
- Local
- Private
- Tribe
- Special District
- Other (please list)

Project Title:
Project ID (if applicable):
Contact Information (name, phone number, address, and email):
County:
Stream Name(s):

Project Type:

- Agricultural/Rangeland Improvements: e.g.) riparian fencing, guzzlers, tailwater recovery ponds, filter strips, sediment basin and terraces.
- Fish Passage Improvement projects: e.g.) fish screens, ladders, infiltration galleries.
- In-stream Flow Restoration: e.g.) canal piping or lining project, water right acquisition, leasing
- In-stream Habitat Restoration: e.g.) large woody debris, fish habitat improvements
- Monitoring
- Road Abandonment/Restoration
- Stream bank restoration e.g.) riparian plantings, floodplain improvements
- Upland Habitat Restoration: e.g.) forest health, juniper removal, range seedling, road rehabilitation

- Wetland Restoration projects
- Other: (please describe)

Land Owner:
- BLM
- USFS
- Other federal
- City
- County
- Private
- Private non-profit
- State
- Tribal
- Multiple
- Other

Funding Source:
- Federal
- State
- Local
- Private
- Mix
- Other

Budget:
- Actual Budget Amount

Start Date & End Date

Project Size:
- acres
- feet
- miles
- lat/long
- each

Project Location:
- township/range/section
- latitude / longitude
- HUC #

Status:
- complete
- not started
- on-going

Limiting Factor/Environmental Process Addressed:

- Fish habitat
- Water quality
- Water quantity
- Upland habitat
- Riparian/wetland habitat

Brief Description
Results

### 3.4.2. Owyhee Subbasin Existing / Past Restoration Activities Inventory Survey Questionnaire Contact List.

| Name | Organization Name | Email Address |
|---|---|---|
| Brayton Willis | Army Corps of Engineers | Brayton.P.Willis@usace.army.mil |
| Jenna Whitlock | Bureau of Land Management | jenna_whitlock@blm.gov |
| Glen Secrist | Bureau of Land Management | glen_secrist@blm.gov |
| Dave Henderson | Bureau of Land Management | dave_henderson@or.blm.gov |
| | Bureau of Water Quality Planning | tporta@ndep.state.nv.us |
| Duane LaFayette | IASCD | dlafayette@netboise.com |
| Jeff Dillon | Idaho Dept. of Fish and Game | jdillon@IDFG.State.ID.US |
| Tom Hemker | Idaho Dept. of Fish and Game | themker@idfg.state.id.us |
| Jon Rachael | Idaho Dept. of Fish and Game | jrachael@idfg.state.id.us |
| Pam Smolczynski | IDEQ | psmolczy@deq.state.id.us |
| Dave Ferguson | ISCC | DFERGUSO@agri.state.id.us |
| Bob Lattan | NDOW | blayton@ndow.org |
| Loren Jamison | NDOW | |
| Gary Johnson | NDOW | |
| Doug Hunt | NDOW | twells@ndow.org |
| Pete Sinclair | NRCS | Pete.Sinclair@id.usda.gov |
| Ed Petersen | NRCS | ed.petersen@or.usda.gov |
| Ken Diebel | ODA | kdiebel@oda.state.or.us |

| | | |
|---|---|---|
| Ron Jones | ODA | rjones@odat.state.or.us |
| Phil Richerson | ODEQ | richerson.phil@deq.state.or.us |
| Mitch Wolgamott | ODEQ | wolgamott.mitch@deq.state.or.us |
| Bob Hooton | ODFW | robert.m.hooton@state.or.us |
| Ray Perkins | ODFW | raymond.a.perkins@state.or.us |
| Walt VanDyke | ODFW | walt.a.VanDyke@state.or.us |
| Nancy Pustis | Oregon Dept. of State Lands | nancy.pustis@dsl.state.or.us |
| Randy Wiest | Oregon Dept. of State Lands | Randy.Wiest@dsl.state.or.us |
| Clint Shock | OSU Malheur Experiment Station | ccshock@fmtc.com |
| Trish Klahr | The Nature Conservancy | tklahr@tnc.org |
| Bas Hargrove | The Nature Conservancy | bhargrove@TNC.org |
| Alynn Meuleman | USBR | ameuleman@pn.usbr.gov |
| Tom Woolf | USDA-ARS | twoolf@nwrc.ars.usda.gov |
| Pat Clark | USDA-ARS | pclark@nwrc.ars.usda.gov |
| Keith Paul | USFWS | keith_paul@fws.gov |
| Jack Doyle | USGS | jddoyle@usgs.gov |

### 3.4.3. Owyhee Subbasin Existing / Past Restoration Activities Inventory Survey Questionnaire Responses:

#### Idaho Department of Environmental Quality Response:

**Organization Name:** IDEQ
**Organization Type:**
- Federal
- State X
- Local
- Private
- Tribe
- Special District
- Other (please list) -

**Project Title:** No Projects have been funded under our grant program in the Owyhee Subbasin. HOWEVER The TMDLs have been completed for the Subbasin. Monitoring projects have occurred as a result of the TMDL process.
**Project ID (if applicable):**
**Contact Information (name, phone number, address, and email):**
**County:**
**Stream Name(s):**
**Project Type:**

- Agricultural/Rangeland Improvements: e.g.) riparian fencing, guzzlers, tailwater recovery ponds, filter strips, sediment basin and terraces.
- Fish Passage Improvement projects: e.g.) fish screens, ladders, infiltration galleries.
- In-stream Flow Restoration: e.g.) canal piping or lining project, water right acquisition, leasing
- In-stream Habitat Restoration: e.g.) large woody debris, fish habitat improvements
- Monitoring
- Road Abandonment/Restoration
- Stream bank restoration e.g.) riparian plantings, floodplain improvements
- Upland Habitat Restoration: e.g.) forest health, juniper removal, range seedling, road rehabilitation
- Wetland Restoration projects
- Other: (please describe)

**Land Owner:**

- BLM
- USFS
- Other federal
- City
- County
- Private
- Private non-profit
- State
- Tribal
- Multiple
- Other

*Funding Source:*

- ***Federal***
- ***State***
- ***Local***
- ***Private***
- Mix
- ***Other***

**Budget:**

- Actual Budget Amount

**Start Date & End Date**

**Project Size:**

- acres
- feet
- miles
- lat/long
- each

**Project Location:**

- township/range/section
- latitude / longitude
- HUC #

**Status:**

- complete
- not started
- on-going

**Limiting Factor/Environmental Process Addressed:**

- Fish habitat
- Water quality
- Water quantity
- Upland habitat
- Riparian/wetland habitat

**Brief Description**

**Results**

## Oregon Department of Fish and Wildlife Response:

**Organization Name:**ODFW
**Organization Type:**
- State X

**Project Title:**Fish Population monitoring
**Project ID (if applicable):**
**Contact Information (name, phone number, address, and email):**
**County:**Malheur
**Stream Name(s):**Owyhee River, Dry Creek, N. F. Owyhee River, West Little Owyhee River
**Project Type:**
- Monitoring

**Land Owner:**
- BLM

*Funding Source:*
- ***State***

**Budget:**
- Actual Budget Amount

**Start Date & End Date1951-present**
**Project Size:**
- acres
- feet
- miles
- lat/long
- each

**Project Location:**
- township/range/section
- latitude / longitude
- HUC #

**Status:**
- on-going

**Limiting Factor/Environmental Process Addressed:**
- Fish habitat
- Water quality
- Water quantity
- Upland habitat
- Riparian/wetland habitat

**Brief Description**
Normal inventory of fish populations
**Results**

## Appendix 3.5. Alternative Funding Sources (Source Inter-mountain Province Subbasin Planning, GEI Consultants, Inc. November 17, 2003; NWPCC Web site).

The Technical Guide for Subbasin Planners requests that subbasin plans include activities outside the responsibility of the Bonneville Power Administration (BPA). Specifically, the Technical Guide says, "Subbasin plans need to integrate and coordinate Bonneville obligations under the NW Power Act, Endangered Species Act and Clean Water Act requirements and tribal trust and treaty based responsibilities. Beyond Bonneville specific responsibilities, subbasin plans should be developed broadly enough to take into account other federal, state, and local activities, objectives, and responsibilities. Including these other elements, though they may not be a funding responsibility of Bonneville, should enable planners and implementers to coordinate their activities in a more cost-effective manner and in a way that produces cumulative and synergistic benefits."

This subbasin plan does include recommended strategies for fish and wildlife protection and restoration that are outside BPA's mandate. In order to aid fish and wildlife managers and the public in implementing this plan, we have included this appendix with a list of alternative funding sources that may be willing to provide financial support for strategies in this plan. The information in this appendix came from: Directory of Watershed Funding Resources - Environmental Finance Center at Boise State University: http://ssrc.boisestate.edu/index.asp . More detailed information about funding is available on this website.

The mission of the Environmental Finance Center (EFC) at Boise State University is to provide help to those facing the "how to pay" challenges of environmental protection. The EFC is committed to helping the regulated community build and improve the technical, managerial, and financial capabilities needed to comply with federal and state environmental protection laws. Their goal is to assist local communities and watershed groups in finding creative funding solutions to support their own plans for environmental protection.

There is a tremendous volume of information available for funding watershed restoration. However, finding and sorting through this information can be a daunting task. In an effort to address this need, the EFC has created an on-line, searchable database for watershed restoration funding. The database includes information on funding programs available for federal, state (Oregon, Washington, Idaho, and Alaska), private, and other funding sources.

Users can query the information in a variety of ways including agency sponsor, keyword, or by a detailed search. At the end of a query, a brief description of each matching program will be displayed. When a specific program is selected, a detailed page of that program will be displayed and can be printed.

The database is a work-in-progress. Information is added and updated regularly. The database is a result of a collaborative effort between the EFC and the following organizations:

* Alaska Department of Community and Economic Development (OCED)
* Idaho Department of Water Resources (IDWR)
* Oregon Watershed Enhancement Board (OWEB)
* Washington Infrastructure Assistance Coordinating Council (IACC)
* U.S. Environmental Protection Agency (EPA)

| CATEGORY | NON - BPA FUNDING SOURCES |
|---|---|
| Federal / Interstate Agency Sponsors | |
| | Bureau of Indian Affairs |
| | Agriculture on Indian Lands |
| | Bureau of Indian Affairs |
| | Environmental Management on Indian Lands |
| | Fish, Wildlife, and Parks Programs on Indian Lands |
| | Forestry on Indian Lands |
| | Indian Loan Guaranty Program - BIA |
| | Native American Employment Assistance (BIA) |
| | Soil and Moisture Conservation |
| | Training and Technical Assistance for Indian Tribal Governments |
| | Water Resources on Indian Lands |
| | Bureau of Land Management |
| | BLM Learning Landscapes - Idaho |
| | BLM Learnng Landscapes - Oregon & Washington |
| | Challenge Cost Share |
| | Secure Rural Schools & Community Self-Determinatio |
| | Wyden Amendment |
| | Bureau of Reclamation |
| | Bridging-the-Headgate - A Conservation Partnership |
| | Construction Program |
| | General Investigations Program |
| | Native American Program |
| | Planning/Technical Assistance Program |
| | Technical Assistance to States |
| | Waste Water Reuse Program |
| | Cooperative State Research Education and Extension Service |
| | Sustainable Agriculture Research Education (SARE) |
| | Water Quality Special Research Grants Program |
| | Corporation for National and Community Service |
| | AmeriCorps Education Awards Program |

AmeriCorps Indian Tribes and US Territories Program
AmeriCorps National Civilian Community Corps (NCCC)
AmeriCorps National Program
AmeriCorps State Program
AmeriCorps Volunteers In Service To America (VISTA)
Learn and Serve America Program
Senior Corps

Department of Health and Human Services
Indian Environmental Regulatory Enhancement

Economic Development Administration
Center for Economic Development - University of Alaska
Economic Adjustment Program
Partnership Planning Grants for Economic Development Districts, Indian Tribes, & Other Eligible Area
Public Works and Development Facilities Program
Public Works and Economic Development Program
Sudden and Severe Economic Dislocation Program
Support for Planning Organizations
Technical Assistance Program (Local)

Environmental Protection Agency
Brownfields Assessment and Demonstration Projects
Brownfields Cleanup Revolving Loan Fund Pilots
Brownfields Job Training and Development Pilots
Capitalization Grants for Drinking Water State Revolving Fund
Chemical Emergency Preparedness and Prevention Technical Assistance Grants
Clean Water Act Indian Set-Aside Grant Program
Clean Water Act Water Quality Cooperative Agreements
Direct Implementation Tribal Cooperative Agreements
Drinking Water SRF Tribal Set-Aside Program
Energy Star Program
Environmental Education Grants Program
Environmental Justice Collaborative Problem-Solving Grant Program
Environmental Justice Grants to Small Community Groups
Environmental Justice Through Pollution Prevention
Environmental Monitoring for Public Access and Community Tracking (EMPACT)
Five-Star Restoration Program
Guidebook of Financial Tools
Hazardous Waste Management Grants for Tribes
Indian Environmental General Assistance Program (GAP) Grant
Indian Set-Aside Wastewater Treatment Grant Program
National Estuary Program
Nonpoint Source Implementation Grants
Pesticide Environmental Stewardship Grants
Pollution Prevention Incentives for States
Regional Geographic Initiative (RGI) Program
Science to Achieve Results Program
Small Community Wastewater Technical Assistance and Outreach Program

State/Tribal Wetland Planning Grants
Superfund Technical Assistance Grants
Sustainable Development Challenge Grants
Toxic Substances Compliance Monitoring Cooperative Agreements
Tribal Drinking Water Capacity Building/Source Water Protection Grants
Tribal Grants for Surface and Groundwater Protection, Pesticide Management Planning
Tribal Multimedia Compliance Assistance and Enforcement Support
Tribal Municipal Solid Waste Landfills Programs
Tribal Pesticide Program Support
Water Pollution Control - State and Interstate Program Support
Water Protection Grants to the States
Water Quality Cooperative Agreements
Watershed Assistance Grants
Watershed Iniative
Wetland Protection, Restoration, and Stewardship Discretionary Funding
Wetlands Program Development Grants

Farm Service Agency
Conservation Reserve Enhancement Program
Conservation Reserve Program
Conservation Reserve Program - Idaho
Conservation Reserve Program - Washington
Emergency Conservation Program
Farm Debt Cancellation-Conservation Easement Program
Farm Ownership and Operating Loans
Interest Assistance Program
Water Quality Incentives Projects

Federal Emergency Management Agency
Flood Mitigation Assistance Program
Hazard Mitigation Grant Program
Project Impact Grant Program

Federal Highway Administration
Alaska Scenic Byways Program
Transportation Environmental Research Program (TERP)
Transportation Equity Act for the 21st Century (TEA-21)

National Credit Union Administration
Revolving Loan Fund for Credit Unions

National Fish & Wildlife Foundation
Bring Back the Natives
Centennial Refuge Legacy
Challenge Grants for Conservation
National Wildlife Refuge Support Group Grant Program 2002 Application Kit
Pacific Grassroots Salmon Initiative

National Oceanic and Atmospheric Administration
Coastal Services Center Cooperative Agreements
Coastal Zone Management Administration/Implementation Awards
Community-Based Restoration Program
Fisheries Development and Utilization Research & Development Grants & Cooperative Agreement Program

- Fisheries Financing Program
- Saltonstall-Kennedy Fisheries Research and Development Grants

National Park Service

- Historic Preservation Grants-In-Aid
- Outdoor Recreation
- Rivers, Trails, and Conservation Assistance Program

Natural Resources Conservation Service

- Columbia-Pacific Resource Conservation and Economic Development District
- Conservation of Private Grazing Land Program
- Conservation Security Program (CSP)
- Conservation Technical Assistance Program
- Emergency Watershed Protection Program
- Environmental Quality Incentive Program - Idaho
- Environmental Quality Incentive Program - Washington
- Farm and Ranch Land Protection Program (FRPP)
- Farm Bill 2002 Conservation Programs
- Forestry Incentives Program - Washington
- Plant Materials Program
- Resource Conservation and Development (RC&D) Program
- River Basin Surveys and Investigations
- Rural Development (RD) Program
- Snow Survey & Water and Climate Services Program
- Soil and Water Conservation
- Soil Survey Program
- Tribal Conservation Districts
- Water Bank Program
- Watershed Protection and Flood Prevention Program
- Wetlands Reserve Program (WRP)
- Wildlife Habitat Incentives Program (WHIP)

Small Business Administration

- Pollution Control Loans
- SBA Bond Guarantees for Small Businesses
- SBA Business Development Assistance to Small Businesses
- SBA Loans for Small Businesses
- SBA Minority Enterprise Development
- Small Business Development Centers

U.S. Army Corps of Engineers

- Basinwide Restoration New Starts General Investigation
- Construction of Municipal and Industrial Water Supply Projects
- Ecosystem Restoration in the Civil Works Program
- Flood Fighting
- Floodplain Management Services Program
- Levee Rehabilitation
- Partners for Environmental Progress
- Section 107: Small Navigation Projects
- Section 1135: Project Modifications to Improve the Environment
- Section 14: Emergency Streambank and Shoreline Protection
- Section 203: Tribal Partnership Program
- Section 204: Environmental Restoration Projects in Connection with

Dredging
- Section 205: Flood Damage Reduction Projects
- Section 206: Aquatic Ecosystem Restoration Program
- Section 208: Snagging and Clearing for Flood Control
- Section 22: Planning Assistance to the States Program (PAS)
- Section 306: General Investigation Studies for Environmental Restoration

U.S. Department of Agriculture
- Agricultural and Economic Research
- Business and Industry Loans
- Grassland Reserve Program
- National Integrated Water Quality Program (NIWQP)
- National Organic Certification Cost-Share Program - Idaho
- National Research Initiative Competitive Grants Program
- Small Watershed Rehabilitation Program
- Water Conservation Program
- Watershed Processes and Water Resources Program

U.S. Department of Commerce
- Alaska Export Assistance Center
- Alaska Minority Business Development Center
- Community Development Quota (CDQ) Fisheries Program

U.S. Department of Defense
- Doing Business with the Federal Government (PTAC)

U.S. Department of Energy
- Best Practices Program
- Center of Excellence for Sustainable Development
- Million Solar Roofs Initiative
- Office of Industrial Technologies Clearinghouse, The
- Rebuild America

U.S. Department of Health and Human Services
- Administration for Native Americans Grants
- Capacity Building Among American Indian Tribes
- IHS Sanitation Facilities Construction Program
- Improving the Capability of Indian Tribal Governments
- Mitigation of Environmental Impacts to Indian Lands Due to Department of Defense Activities
- Office of Community Services - Grant Programs

U.S. Department of Housing and Urban Development
- Community Development Block Grant Program (ICDBG) - Idaho
- Indian Community Development Block Grant Program

U.S. Department of Interior
- Abandoned Mine Land Reclamation Program
- Acid Mine Drainage Grant
- Land & Water Conservation Fund Grants to States

U.S. Fish & Wildlife Service
- Alaska Coastal Conservation Grants
- Chehalis Fisheries Restoration Program
- Clean Vessel Act Grant Program
- Coastal Grant Program
- Cooperative Endangered Species Conservation Fund
- Fish Screen Construction Program

Greenspaces Program
Habitat Conservation - Partners for Fish and Wildlife Program
Habitat Conservation - U.S. Fish and Wildlife Service Coastal Program
Habitat Conservation Plan Land Aquisition Grants Program
Habitat Conservation Planning Assistance Grants - Cooperative Endangered Species Conservation Fund
Hatfield Restoration Program
Jobs-in-the-Woods Program
National Coastal Wetlands Conservation Grant Program
National Wildlife Refuge Challenge Cost Share Program
Neotropical Migratory Bird Conservation Act Grants Program
North American Wetlands Conservation Act Grants Program
Partnerships for Wildlife
Private Stewardship Grant Program
Puget Sound Program
Recovery Land Acquisition Grants - Cooperative Endangered Species Conservation Fund
Refuges and Wildlife - North American Waterfowl Management Plan
State Wildlife Grants
Washington State Ecosystems Conservation Program

U.S. Fish and Wildlife Service
Landowner Incentive Grant Program - (Non - Tribal)

U.S. Forest Service
Economic Action Programs
Forest Land Enhancement Program - Idaho
Forest Land Enhancement Program - Washington
Forest Legacy Program - Cooperative Forestry Assistance Program
Forest Legacy Program - Washington
Forest Stewardship & Stewardship Incentive Program
Forest Stewardship Program
Mini-Grants Assistance Program
Rural Community Assistance Program
Stewardship Incentive Program
Urban & Community Forestry Program
WACERT Process

U.S. General Services Administration (GSA)
Doing Business with the Federal Government (GSA)

U.S. Geological Survey
State Partnership Initiative

USDA - Rural Development
Agricultural Cooperatives Technical Assistance
Community Facilities Direct and Guaranteed Loans and Grants for Rural Areas - Idaho
Community Facility Loan and Grant Program
Emergency Community Water Assistance Grant Program
Guaranteed Business and Industry Loans
Guaranteed Water and Waste Disposal Loans
Intermediary Relending Program
Rural Alaskan Village Water and Waste Disposal Grants
Rural Business Enterprise Grant Program

Rural Business Loan Fund
Rural Economic Development Loan Program
USDA Water and Waste Disposal Grants
USDA Water and Waste Disposal Loans
Water and Waste Disposal Direct and Guaranteed Loans and Grants for Rural Areas - Idaho
Water and Waste Disposal Loan and Grant Program

State - Idaho

Idaho Department of Agriculture
- Container Recycling Operation Program (CROP)
- Idaho OnePlan Program
- National Organic Certification Cost-Share Program - Idaho
- Noxious Weed Cost-Share Program
- Pesticide Disposal Program

Idaho Department of Commerce
- Community Development Block Grant Program (ICDBG) - Idaho
- Idaho Gem Community Implementation Grants

Idaho Department of Environmental Quality
- Drinking Water Revolving Loan Fund - Idaho
- Nonpoint Source Implementation Grant (319) Program - Idaho
- Planning Grant Program for Drinking Water Facilities - Idaho
- Planning Grant Program for Wastewater Facilities - Idaho
- Water Pollution Control State Revolving Loan Fund - Idaho

Idaho Department of Fish & Game
- Habitat Improvement Program (HIP)
- Project WILD - Idaho
- State Wildlife Grants Program - Idaho
- Wildlife Conservation and Restoration Program (WCRP)

Idaho Department of Lands
- Arbor Day Grants
- Community Transportation Enhancement (CTE) Grant
- Forest Land Enhancement Program - Idaho
- Forest Legacy Program - Idaho
- Hazardous Fuels Treatment Grants
- Urban & Community Forestry (UCF) - Program Development Grant
- Urban & Community Forestry (UCF) - Tree Planting & Care Grant
- Urban & Community Forestry Program - Idaho
- Western Wildland Urban Interface (WUI)

Idaho Department of Parks and Recreation
- Land and Water Conservation Fund - Idaho
- Motorbike Recreation Fund
- Off-highway Vehicle Programs
- Recreational Trails Program - Idaho
- Snowmobile Registration Fund
- Waterways Improvement Grants

Idaho Department of Water Resources
- Energy Conservation Loan Program
- Idaho Water Resource Board Funding Programs

Idaho Office of Species Conservation
- Idaho Wolf Depredation Compensation Program

Idaho Soil Conservation Commission
- Natural Resource Conservation Tax Credit
- Resource Conservation and Range Development Program (RCRDP) Loans
- Water Quality Program for Agriculture (WQPA)

Idaho Transportation Department
- Congestion Mitigation and Air Quality Improvement Program - Idaho
- Enhancement Program
- Transportation Equity Act for the 21st Century (TEA-21) - Idaho

Idaho Water Resources Research Institute
- Water Resources Research Institute

University of Idaho
- Project WET - Idaho

State - Washington

Interagency Committee for Outdoor Recreation
- Athletic Facility Account Program
- Boating Facilities Program
- Firearms and Archery Range Recreation
- Non-Highway & Off-Road Vehicle Activities Program
- Riparian Habitat Program
- Salmon Recovery Funding Board
- Washington Wildlife and Recreation Program (WWRP)

Transportation Improvement Board (TIB)
- FEMA Match Program
- Small City BRAC Match Program
- Small City Pedestrian Safety and Mobility Program
- Small City Program (SCP)
- Urban Pedestrian Safety and Mobility Program

Private / Foundation Sponsors

A Territory Resource (ATR)
- A Territory Resource (ATR)

Acorn Foundation
- Common Counsel Foundation (Acorn Foundation)

American Farmland Trust
- Farm Legacy Program

American Land Conservancy
- American Land Conservancy Program

American Water Works Association Research Foundation (awwaRF)
- American Water Works Association Research Foundation (AwwaRF)

American Wildlands
- American Wildlands

Andrew Mellon Foundation
    Conservation and the Environment Program
ARCO Foundation, The
    ARCO Foundation
Barker (Donald R.) Foundation
    Barker (Donald R.) Foundation
Bay Foundation, The
    Bay Foundation, The
Ben & Jerry's Foundation
    Ben & Jerry's Foundation
Bikes Belong Coalition
    Bikes Belong Coalition
Bonneville Environmental Foundation
    Bonneville Environmental Foundation Watershed Program, The
    Renewable Energy Program
Braemar Charitable Trust
    Braemar Charitable Trust
Brainerd Foundation
    Communications & Capacity Building Program - Brainerd Foundation
    Endangered Ecosystems Program
Bullitt Foundation
    Bullitt Foundation (Rivers, Wetlands, Estuaries, and Marine Ecosystems Grant Program), The
C. Giles Hunt Charitable Foundation
    C. Giles Hunt Charitable Trust
Captain Planet Foundation
    Captain Planet Foundation
Cascade Natural Gas Foundation
    Cascade Natural Gas Foundation
Charla Richards Kreitzberg Charitable Foundation
    Charla Richards Kreitzberg Charitable Foundation
Collins Foundation
    Collins Foundation Environmental Program, The
Compton Foundation
    Compton Foundation Environmental Grants, The
Conservation Alliance, The
    Conservation Alliance Grants
Conservation Fund, The
    Conservation Fund, The
    Kodak American Greenways Award
Defenders of Wildlife
    National Stewardship Initiatives: Conservation Strategies for U.S. Land Owners
Diack Ecology Education Program
    Diack Ecology Education Program
Doris Duke Charitable Foundation
    Doris Duke Charitable Foundation, The
Ducks Unlimited
    Ducks Unlimited
    Matching Aid to Restore States Habitat (MARSH) - Ducks Unlimited

U.S. Habitat Projects
Earth Force, Inc.
Earth Force, Inc.
Educational Foundation of America
Educational Foundation of America, Environmental Grant Program, The Environmental Program
Evergreen Community Development Association
Evergreen Community Development Association
Evergreen Rural Water of Washington
Evergreen Rural Water of Washington Technical Assistance and Training
First Nations Development Institute (FNDI)
First Nations Development Institute
FishAmerica Foundation
FishAmerica Grant Program
Flintridge Foundation
Flintridge Foundation's Conservation Program
FMC Corporation and The National Fish and Wildlife Foundation
FMC Corporation Bird and Habitat Conservation Fund
For the Sake of the Salmon
Technical Assistance Directory (TAD)
Watershed & Community Support
Friends of Paul Bunyan Foundation
Friends of Paul Bunyan Foundation
Fund for Wild Nature
Fund for Wild Nature Grant Program
General Electric Foundation
General Electric Foundation
Gifts In Kind International
Gifts In Kind International
Greenville Foundation
Greenville Foundation Environment Funding
Groundwater Foundation, The
Groundwater Foundation, The
Henry M. Jackson Foundation
Henry M. Foundation (Environmental and Natural Resource Management Program)
Home Depot Corporation
Home Depot Coporate Contributions Programs
Homeland Foundation, The
Homeland Foundation, The
Homer Foundation, The
Homer Foundation, The
Hugh and Jane Ferguson Foundation
Hugh and Jane Ferguson Foundation, The
Idaho Fish and Wildlife Foundation
Idaho Fish and Wildlife Foundation
Idaho Forest Products Commission
Project Learning Tree - Idaho
Teachers Grant Program

Izaak Walton League
    Save Our Streams Program
Jackson Foundation, The
    Jackson Foundation, The
Jessie Smith Noyes Foundation
    Sustainable Agriculture Program
Kongsgaard-Goldman Foundation
    Environmental Protection and Conservation Program
L.J. and Mary C. Skaggs Foundation
    L.J. and Mary C. Skaggs Foundation, Environmental Education Grant Resource
Laird Norton Endowment Foundation, The
    Laird Norton Endowment Foundation
Lamb Foundation
    Lamb Foundation Grants
Land Trust Alliance
    Land Trust Alliance-Northwest Program
Laura Jane Musser Fund
    Laura Jane Musser Fund
Lawrence Foundation
    Lawrence Foundation, The
Lazar Foundation, The
    Lazar Foundation, The
Mountaineers Foundation
    Mountaineers Foundation Environmental Program, The
Nathan Cummings Foundation
    Nathan Cummings Foundation Grant Program, The
National Association of Development Organizations (NADO)
    National Association of Development Organizations
National Congress for Community Economic Development (NCCED)
    National Congress for Community Economic Development
National Congress of American Indians (NCAI)
    National Congress of American Indians
National Economic Development and Law Center (NED&LC)
    National Economic Development and Law Center
National Environmental Education & Training Foundation
    NEETF Challenge Grant Program
National Fish and Wildlife Foundation
    Challenge Grants
    Community Salmon Fund
    Migratory Bird Conservancy
    National Fish and Wildlife Foundation in partnership with Natural Resources Conservation Service
    National Fish and Wildlife Foundation, The
    Natural Resources Conservation Service: Conservation on Private Lands
    Nature of Learning, The
    Pathways to Nature Conservation Fund
    Pulling Together Initiative
National Forest Foundation
    Community Assistance Program (CAP)

National Forest Foundation Matching Awards Program
National Foundation for Integrated Pest Management Education
Pesticide Environmental Stewardship Grants
National Geographic Society
Expeditions Council Grants
National Geographic Society
Conservation Trust
Grants for Scientific Field Research and Exploration
National Geographic Society Education Foundation
Grosvenor Grant Program
Teacher Grants
Venture Fund
National Natural Resource Conservation Foundation
National Natural Resources Conservation Foundation
National Science Foundation - Division of Environmental Biology
Water and Watersheds
National Wildlife Federation
National Wildlife Federation
Native American Fish & Wildlife Society
Native American Fish & Wildlife Society
Nature Conservancy, The
Nature Conservancy, The
Patagonia
Patagonia Environment Grants
Paul G. Allen Forest Protection Foundation
Paul G. Allen Forest Protection Foundation, The
Pew Charitable Trusts
Pew Charitable Trusts Environmental Program, The
PGE Foundation
PGE Foundation
Pheasants Forever
Pheasants Forever
Phillips Petroleum Company
Phillips Petroleum Company
Plum Creek Foundation
Plum Creek Foundation Grants
Public Welfare Foundation
Public Welfare Foundation - Environment Grants
REI
REI Conservation and Outdoor Grants
River Network
Watershed Assistance Grants
Rockefeller Family Fund
Rockefeller Family Fund (Environment Grants Program)
Rocky Mountain Elk Foundation
Rocky Mountain Elk Foundation
Rural Community Assistance Corporation
RCAC - Technical Assistance and Training
Ruth H. Brown Foundation

Ruth H. Brown Foundation
Ruth Mott Fund
Ruth Mott Fund
Seventh Generation Fund
Seventh Generation Fund
Skaggs Foundation, The
Skaggs Foundation, The
Strong Foundation for Environmental Values, The
Strong Foundation for Environmental Values, The
Training Resources for the Environmental Community (TREC)
Training Resources for the Environmental Community (TREC)
Treasure Valley Land Trust
Treasure Valley Land Trust
Trout Unlimited
Embrace-A-Stream, Education Project
Embrace-A-Stream, Research Project
Embrace-A-Stream, Resource Project
Turner Foundation
Turner Foundation Environmental Grant Programs
Wal-Mart Foundation
Local Wal-Mart Environmental Grant Program, The
Washington Water Trust, The
Washington Water Trust
WaterWatch
WaterWatch
Weyerhaeuser Company Foundation
Weyerhaeuser Company Foundation
Wilburforce Foundation
Wilburforce Foundation
Wildhorse Foundation
Wildhorse Foundation
William and Flora Foundation
William and Flora Hewlett Foundation
William C. Kenney Watershed Protection Foundation
William C. Kenney Watershed Protection Foundation

# Appendix 3.6. Watershed Protecting Transformations in Malheur County Farming Practices 1980-2004 (Shock et al. Third Draft, May 25, 2004)

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**Introduction**

Malheur County occupies Oregon's southeastern corner. Both the Malheur River and Owyhee River, tributaries of the Snake River, drain the area. The largest city, Ontario, is only 56 miles from Boise, Idaho, but 377 miles from Portland, Oregon. There are only 31,300 inhabitants in this arid county, mostly concentrated in the towns situated in the area of intensive agriculture. Rainfall is far less than crop water needs, averaging only 10 inches per year at the lower elevation sites, with frequent occurrence of drought. Rainfall is distributed mostly in the colder months when plant growth is restricted by freezing temperatures.

The county covers 6,352,000 acres, of which 94% is rangeland and 4% is irrigated cropland. Agricultural industries in Malheur County consist of developed intensive crop production, crop processing, extensive cattle operations, and confined animal feeding. The discussion here focuses on practice changes in the areas of intensive crop production.

Irrigation water comes largely from snow melt and runoff from rangelands. Reservoirs capture the seasonal runoff at elevations higher than irrigated cropland. Water flows via canal systems to farms by gravity. The region was developed predominantly using furrow irrigation systems prior to 1940. Fields are generally small and rectangular consistent with the development of furrow irrigation at that time. The field size and the design of the water delivery system makes conversions to other systems costly or impractical. Sixteen irrigation districts manage the reservoirs, canals, and water. The Owyhee Irrigation District, Vale Oregon Irrigation District, Warm Springs Irrigation District, and the Owyhee Ditch Company are the larger districts (1).

Many changes have occurred in farming practices in Malheur County since 1980. The following sections of this report describe the practices of the late 1970's, research into changes in those practices to improve production efficiency while ameliorating associated environmental problems, and implementation of the new practices in Malheur County.

## I. Agricultural Practices in the Early 1980's

### I. A. Water and Soil Use Practices

From 1978 through 1980 the Malheur County Court under the leadership of Judge Ray Hirai evaluated water quality problems related to non-point source pollution in Malheur County, and set about trying to solve these problems (2). The effort had ample participation by Malheur County citizens. The county study a "Two-Year Sampling Program, Malheur County Water Quality Management Plan" demonstrated water quality problems with phosphorus, nitrate, sediment load, and bacteria and set out a series of Best Management Practices (BMP) to address the problems. Various agencies cooperated with Malheur County in making the study.

The Malheur County Soil and Water Conservation District (SWCD) was given the lead to implement the plan to reduce non-point pollution, but the SWCD was given no resources to do so. No state, state agency, or federal funding was found to assist with the implementation of the plan or the improvements recommended by the plan. The county judge following Ray Hirai was E.M. Seuell, who was not particularly interested in the program and provided no funding. Neither the OSU experiment station nor the extension service were involved in demonstration or education on these issues at the time. Consequently, improvements in the field proceeded at a slower pace, fueled only by private investments and work by the Soil Conservation Service (SCS).

From 1980 through 1985, Herb Futter recalls that the mind set was still that surface erosion was something that you had to have, a necessary evil of irrigation. Crop productivity was increasing through the use of better varieties, improved weed control, and enhanced disease control, along with chemical fertilizer inputs, and these changes were masking the degradation of the soil from surface erosion.

Irrigation systems were dominated by surface flood irrigation in meadows and pastures from dirt ditches and surface furrow irrigation from dirt and concrete ditches. Siphon tubes were used to deliver the water from the ditch to the irrigation furrows. Fields had been leveled, but not with laser leveling. Gated pipe, turbulent fountain weed screens, PAM, and straw mulch were not used.

Soil was prepared in the fall after harvest and in the spring. Spring soil preparation tended to compact and dry the soil. Since efficient weed control was becoming established through the adoption of herbicides in the 1970's, this innovation was already leading to fall bedding of the soil (conserving winter soil moisture and protecting the soil from physical damage when the soil was worked wet in the spring) and leading to the adoption of environmentally sound crop rotations. Crop rotations include onions (*Allium cepa*), sugar beets (*Beta vulgaris*), wheat (*Triticum aestivum*), corn (*Zea mays*), beans (*Phaseolus vulgaris*), potatoes (*Solanum tuberosum*), alfalfa (*Medicago sativa*), alfalfa grown for seed, spearmint (*Mentha spicata*), peppermint (*Mentha piperita*), and other crops.

Prior to the advent of modern herbicides, growers were confined to using the same land for row crops year after year. In those days onions were raised in the same fields year after year. This was due to the fact that onion fields were kept fairly weed free. Onions cannot compete well with weeds. There was insufficient labor to hire to weed the onions so the family did all the weeding. Once the fields were kept fairly weed seed free, onions were planted in the same fields year after year. The onion yields and size would decline considerably with repeated planting as root disease organisms proliferated. Onions are a high user of nitrogen fertilizer, and supplying this need probably caused nitrogen to leach into the vadose zone and the shallow aquifers.

The only rotation crops used with onions were sugar beets and potatoes. Potatoes and sugar beets could also benefit from the dominance over weeds which had been established in the onion fields. High rates of nitrogen were also applied to sugar beets. Growers were paid by the ton, so growers disregarded the low percentage of sugar in highly fertilized beets and tried to achieve maximum tonnage per acre. Alfalfa, wheat or corn could have helped use up the excess or carry over nitrogen following these row crops, but they were not used until the advent of effective herbicides which allowed growers to rotate crops and use most of the fields at their disposal for row crops.

The herbicide Dacthal (DCPA) was widely used in Malheur County by onion and alfalfa seed growers to control a wide spectrum of weeds. Several chemicals such as Dacthal were applied at the full broadcast rate, which was 12 lb per acre broadcast. Groundwater became contaminated with nitrate and the breakdown products of DCPA (3).

Irrigation scheduling was based on the calendar and grower intuition and experience. No soil moisture measurement tools were used.

**I. B. Fertilizer Use**

After World War II the availability of chemical fertilizer was not a problem. More row crops were planted due to the increase in demand and higher commodities prices created by the war effort and the strong economy following the war. Due to high demand and commodity prices, more farmers switched from cereal crops to row crops, crops that were fertilized at higher nitrogen rates.

During this period farmers with experience using various blends started formulating their own special mixes of fertilizer. No soil analysis or follow-up plant tissue testing of petiole or root samples were taken. Each grower had his own special blend of fertilizer for onion, potatoes and sugar beets. Up through the early 1980's it was common practice for farms to have their secret crop mix made up of 1000 to 1500 lb of 16-16-16 per acre for fall fertilizer. A lot of these fall fertilizer mixes contained 150 to 200 lb/acre of nitrogen, which were followed up in the spring with another 150 to 300 lb/acre of nitrogen sidedressed. Due to relatively high commodity prices, excess nitrogen was applied, trying to achieve maximum yields.

Fertilizer was applied in the fall. Two of the main reasons for fall applications were that the fertilizer acted as a soil conditioner to help mellow the crust that builds up during the winter months and fall application helped avoid soil compaction from spring broadcast fertilizer application and other spring tractor work.

Fertilizer rates were determined by the growers financial condition and yield aspirations, not based on carefully identified crop needs.

Published fertilizer guides appear to be based on yield maximization, with little thought as to the fate of excess nutrients.

**I. C. Fate of Crop Residues**

Crop residues from growing wheat and sweet corn and growing and processing sugar beets were largely recycled. Beet pulp was recycled into cattle feed. Manure from dairies was recycled onto farm ground.

Alfalfa seed screenings, the by product of processing alfalfa seed, were hauled to the landfills for burial due to environmental regulations against their traditional use as an animal feed supplement. Alfalfa seed screenings constituted 16 percent of local land fill volume in the 1980's. Potato processing waste was fed to cattle, but the residual sludge from processing was trucked to holding ponds where it was stored and accumulated. Cull onions were buried in shallow pits. Spent mushroom compost from growing mushrooms was largely deposited in a growing pile outside of Vale.

**I. D. Labor considerations**

Ample labor was usually available to help conduct supplemental weeding and make onion harvests.

**I. E. Contradictions, problems, and opportunities**

By the end of the 1970's, environmental needs for irrigated agriculture in the Treasure Valley included the reduction of soil loss and nutrient loss from crop land, improvement in irrigation efficiency, the reduction of nutrient loss to groundwater, preservation of soil structure, and the transformation of agricultural chemical use so that very low rates of agricultural chemicals would be required. Where chemical products were required, they needed to degrade quickly without off site effects. Reduced and timely tillage could reduce the physical damage to the soil that was resulting from cultivation.

The reduction in sediment and nutrient loss could help retain agricultural productivity and reduce the contaminate load to streams rivers, and reservoirs. Irrigation-induced losses of phosphorus (P) and sediment were documented problems (2). Increases in irrigation efficiency would facilitate reductions in irrigation-induced erosion and nitrate leaching. Re-examination of fertilization recommendations and refinement of soil and plant tissue sampling and application techniques could redirect fertilization toward only satisfying plant nutrient needs and economical crop responses. Innovations in the development of integrated pest management and the use of short half life agricultural chemistry could reduce the chemical load to off site targets.

In 1985 three of us (Herb Futter, Lynn Jensen, and Clint Shock) came to the conclusion that there was a systematic over-application of N fertilizer. This conclusion was based on the amount of N applied to each crop in a typical crop rotation and the amount of N contained in the harvested crops from the same rotation (4). Without any access to resources to address the N application issue an indirect approach was considered. Research and demonstration trials conducted for entirely different purposes were very carefully fertilized using soil tests and tissues sampling. Relatively high yields could be obtained with relatively low N inputs, demonstrating better N use efficiency. These trials could start to change grower perceptions and practices.

Nitrogen management and irrigation management are closely linked, and trying to manage one without the other becomes self-defeating. Nitrogen only leaches when excess water is applied and conversely excess water can only leach if substantial amounts of nitrate is available to be leached from the soil profile. The goal is to have enough nitrogen available to maximize crop growth, but not excess, and enough water in the soil profile to keep crop growth adequate without pushing too much water through the soil profile. Nutrients are washed off the field when ample amounts of water mover across and off the field with substantial force to move soil off the field.

**II. Research, Demonstrations, and Adoption**

Over the last two decades, a wide range of research and demonstration efforts have been planned and conducted to improve production efficiency and ameliorate associated environmental problems. With each initiative there were few road maps prior to the start of that initiative which indicated how beneficial each potential new practice would be. Starting on each project, it was difficult to foresee the extent to which a new practice would be adopted. Part of the unknown of each new practice was how it would eventually modify crop production, product quality, or the ease of farming. Alternatively, a new practice could be too much trouble or too costly.

Too many variables influence the adoption of innovations to provide 20/20 vision into the future. Incentives toward change include decreased costs, improved productivity, improved crop quality, eligibility for cost share programs, and attitudes of stewardship. Disincentives for change are practices which increase costs, reduce productivity, increase risk or uncertainty, require large capital outlays, or involve substantial red tape. Extremely low margins in farming can force the minimization of inputs, including site specific management to remediate or minimize environmental effects of farming.

The research and demonstration discussed below have positive environmental benefits and have been adopted by some or most growers.

**II. A. 1. Efficiency of furrow irrigation and irrigation-induced erosion**

A wide array of practices were investigated to improve the efficiency of furrow irrigation and reduce irrigation-induced erosion. These included laser leveling fields, mechanical straw mulching, gated pipe, alternate furrow irrigation, surge irrigation, modified surge, PAM, sedimentation basins and pump back systems, and turbulent fountain weed screens

II. A. 1. a. Laser leveling

Prior to the 1980's, fields had been leveled by conventional means. Fields were surveyed, staked, and soil was moved about within a field by farm tractor powered equipment. Fields with slopes of 0.6 to 0.7 or more feet per hundred feet required too much water to irrigate due to excessive runoff and resulted in too much soil erosion. Fields with slightly irregular slopes had parts which required long furrow irrigation durations, and also had flat spots with excessive water infiltration which resulted in excessive deep leaching. Crop plants growing on steeper spots were subject to yield and quality loss from water stress. Plants growing on flatter spots were subject to loss from ponded water and decomposition.

Dressing fields with laser leveling to a slope of 0.3 to 0.4 feet per hundred feet provided immediate benefits for surface irrigation. Herb Futter was able to show less soil was lost from the field and the field irrigated much more uniformly. The uniformity of irrigation allowed for the conservation of water, less leaching in the wetter parts of the field, and improved crop performance. During the early 1980's ASCS would not fund laser leveling, but starting in the latter half of the 1980's they did participate in cost share based on Herb Futter's results.

From 1985 through 1999 approximately 4500 acres of cropland have been laser leveled through cost share programs, improving irrigation efficiencies. Efficiency increases of 15 to 20 percent have been obtained. The practice is widely accepted by growers at their own initiative to the point that the practice now seldom receives cost share incentives.

II. A. 1. b. Demonstrations of the use of straw mulch to reduce erosion

In the early 1980's Malheur County growers Vernon Nakada and Joe Hobson were applying wheat straw mulch by hand to reduce irrigation-induced erosion. One method of reducing soil movement within the field and loss of sediment and nutrients off the field is to use mechanical straw mulching techniques (5, 6, 7, 8, 9, 10). The process of using straw mulch on fields is not a new concept. In fact, the hand mulching of onions and other various crops has been used for many years. Spreading the mulch by hand can be extremely expensive, so there was a need for another cost effective way to spread mulch.

Joe Hobson, a neighbor of the Malheur Experiment Station, realized the great time and effort necessary to hand-apply straw mulch. Joe Hobson started to build the mechanized mulcher in Ontario in the mid 1980’s to help reduce mulching costs. His mechanical mulcher made the spreading of mulch economically feasible for farmers. Several variations of his original idea are used in the Treasure Valley. Early mechanical mulching trials starting in 1985 demonstrated effectiveness reducing erosion (5) and improving sugar beet yields (6).

There are many different factors to take into consideration when mechanically spreading mulch. None of these factors had been evaluated. The size, type, and rate of mulch application determines the costs and benefits of spreading. Another financial consideration is the initial start-up cost of purchasing a mechanical mulcher versus renting one, and the cost of labor to run the mechanical mulcher. These factors play a major role for the grower's cost-benefit analysis (11, 12).

Mechanical straw mulching improved onion yield and size in furrows that were compacted by tractor wheel traffic (9, 11). Five replicated trials were conducted between 1988 and 1995, in commercial fields and at the experiment station.

In the 1991 trial, onion yield was unaffected in the commercial field. The mulch was applied at a rate of 650 lb per acre. The same year trial at the experiment station in a field with 3 percent slope showed that straw mulch increased onion yield by 64%. The increase was through both jumbo and colossal onions, and decreased the yield of mediums. In the 1995 experiment station trial in the same field with 3 percent slope, similar results were obtained with a 74% onion yield increase. In both of the trials conducted at the experiment station, wheel-compacted furrows were irrigated. The experiment station rate in 1991 was 800 lb of mulch per acre, and was 560 lb of mulch per acre in 1995, with split applications of straw.

During the trials at the experiment station, water runoff, infiltration, irrigation efficiency, and water use efficiency of the onion crop were measured in addition to onion yield and grade responses. The correlation for the increase in onion yields and straw mulch is attributed to reduced water runoff, increased lateral water movement, and improved soil moisture. The straw mulch placed in the furrows caused more water to move laterally into the beds as a result of slow water movement at the furrow bottom and the higher level of water in the furrows.

The measurements in onion fields showed mechanical straw mulching had conservation benefits by reducing soil erosion and irrigation water runoff (5, 6, 7, 8, 9, 10). Synthetic materials such as polyacrylamide (PAM) can control erosion and enhance water infiltration in irrigation furrows. A single application of straw mulch is apparently as effective as repeated applications of PAM in reducing erosion (13). Mechanically applied straw was more effective than PAM in increasing water infiltration and maintaining soil water potential, hence straw was more effective in increasing onion yields.

Straw mulch was also related to benefits in potato fields (14).

From 1985 to 1999 growers applied straw mulch to approximately 4000 acres through cost share funds.

II. A. 1. c. Introduction of gated pipe

Gated pipe was introduced to allow more uniform irrigation on many surface irrigation sites. The water set in each furrow can be less than with siphon tubes, and allows surface irrigation with conservation of water, reduced irrigation induced erosion, and less leaching potential. Gated pipe also can facilitate the eventual adoption of surge irrigation.

Gated pipe was first used in a substantial way in Malheur County in 1977, a year of severe drought. The 80 miles of fiberglass pipe arrived too late to do much good that year. The project was promoted by the SCS and was cost shared by the ASCS. The fiber glass pipe proved to have poor durability outdoors in the sunlight.

More durable plastic gated pipe was introduced and supported by cost share programs. From 1985 to 1999 growers have converted the delivery systems from open ditches to gated pipe on approximately 60,000 acres of cropland. The decrease in water use on these systems is 35-40%.

II. A. 1. d. Surge irrigation

Surge irrigation is a conservation practice that has been thoroughly developed and tested by the University of Nebraska and valve manufacturers, but still remains one of the lesser known and lesser used methods in the Treasure Valley of southeastern Oregon and southwestern Idaho. Surge Irrigation can reduce irrigating costs through lower water use and reduced labor to irrigate. Surge irrigation reduces the total amount of irrigation water applied, excess water infiltration, and runoff water losses. Surge irrigation helps reduce the amount of sediment lost from furrow-irrigated fields.

Surge irrigation uses a surge controller butterfly valve placed in the center of the top of the field with gated pipe leading out of the valve going both directions along the top of the field. In fields with some side slope, the surge valve can be placed in the corner of the field, and extra pipe used to distribute the water. The valve works by oscillating water from one side of the valve to the other at decided intervals. (In conventional irrigating systems the water flows continuously for the irrigation set.) The alternating flow of water on each side of the valve causes an intermittent wetting and soaking cycle in the irrigated furrow. This causes soil particles to settle to the bottom of the furrow and can reduce the water intake rate of the soil. With a reduced intake rate the water can advance down the furrow faster giving the field a more uniform water application, while requiring less water for an adequate irrigation. One of the major drawbacks of surge irrigation is the cost involved in switching irrigation systems. When a field needs to be re-leveled and the surface irrigation system redesigned, the benefits of surge are most definitely worth looking into.

Surge valves have controllers which allow the grower to choose the durations of the irrigation oscillations from one side of the field to the other.

Studies done at the Malheur Experiment Station on surge irrigation have shown significant benefits with regard to increased irrigation efficiency, yield maintenance while using less water, reduced nitrogen leaching in some fields, and reduced sediment loss (15, 16, 17, 18). Costs of components have been estimated (19).

A 1990 trial "Surge irrigation of 'Bliss' spring wheat" showed that surge irrigated furrows tended to finish more uniformly than conventional furrows irrigated solely with gated pipe, and conventional irrigation and surge irrigation had equivalent yields (15). Over the entire irrigation season, surge used half the amount of water of conventional irrigation. The trial had one third of a field irrigated using conventional furrow irrigation with gated pipe. The remaining two thirds were irrigated using gated pipe with a surge valve placed in the center of the of the gated pipe, oscillating water between the two thirds. During the first irrigation water in 18 out of 112 (16%) surge irrigated furrows failed to reach the end of the furrow, while in the conventional furrows, 22 out of 56 furrows failed to reach the end (39%).

A 1991 trial on a grower's field "The effect of surge irrigation on onion yield and quality, irrigation efficiency, and soil nitrogen losses" showed that 71 percent of the water applied with surge irrigation soaked into the soil, where only 50 percent of the water soaked in with conventional irrigation (16). Based on the hours of applied water and the flow rate, surge irrigation only required 57 percent of the water volume needed using conventional furrow irrigation for the entire irrigation season.

In the report "Surge irrigation of wheat to increase irrigation efficiency and reduce sediment loss, 1993", 'Treasure' spring wheat was grown using conventional furrow irrigation and surge irrigation on 12 one-half-acre plots (17). Both systems were operated simultaneously five times during the season. Conventional irrigation applied 24.7 ac-in/ac of water with runoff of 5.6 ac-in/ac and infiltration of 19.1 ac-in/ac. Surge irrigation applied 12.0 ac-in/ac with 1.7 ac- in of runoff and 10.3 ac-in/ac of infiltration. Average grain yield under both systems was 128 bu/ac with no significant difference in grain quality. Surge irrigation reduced the loss of sediment in the runoff by 70 percent. Season long sediment losses averaged 1383 lb/acre with conventional irrigation and 406 lb/acre with surge irrigation.

In the 1994 trial "Water savings through surge irrigation", 'Stephens' winter wheat was grown using conventional furrow irrigation and surge irrigation on 12 one-half-acre plots (18). Both systems were operated simultaneously four times during the season. Conventional irrigation applied 26.5 ac-in/ac of water with runoff of 0.8 ac-in/ac and infiltration of 25.7 ac-in/ac. Surge irrigation applied 13.7 ac-in/ac with 0.5 ac-in/ac of runoff and 13.1 ac-in/ac of infiltration. Average grain yield was 95.0 bu/ac with conventional furrow irrigation and 98.7 bu/ac with surge irrigation with no significant difference in grain yield or quality. Season long sediment losses averaged 131 lb/acre with conventional irrigation and 51 lb/acre with surge irrigation.

How can an irrigation system be changed to surge irrigation? If a gated pipe system is already in place, changing the current system to surge could be relatively easy and low-cost with many benefits, if there is not too much side fall in the field. All that would be needed would be a surge control valve, and added pipe to connect to the valve. Fields with substantial side fall can be adapted to surge irrigation by placing the valve at the corner of the field where water enters and have a transmission pipe parallel the gated pipe down the first half of the field.

II. A. 1. e. PAM to reduce irrigation-induced erosion

Polyacrylamide is a synthetic water-soluble polymer made from monomers of acrylamide. It binds soil particles to each other in the irrigated furrow. Soil particles in suspension are bound together making them larger and water has a harder time washing them out of the field. Water-soluble polymers like PAM have been known to benefit soil properties for a long time. Recently they have gained renewed attention for their use in reducing irrigation-induced erosion, now that the cost of applying PAM has become economically feasible. Other uses of polymers like PAM include treatment of municipal water supplies, food packaging, adhesives, a boiler water additive, film former in the imprinting of soft-shell gelatin capsules, adjuvants in the manufacturing of paper and paperboard, and the list goes on and on.

After Soil Science published a set of papers that introduced water-soluble polymers as soil conditioners (20), the Monsanto Chemical Company spent about 10 million dollars producing and marketing the water-soluble polymer Krilium during the 1950's. Krilium was not adopted by commercial agriculture. Although Krilium was able to reduce soil erosion and other problems associated with furrow irrigation run-off, it was too expensive to justify applying it on fields and the recommended application rates were just too high to be economically feasible. Since then, more extensive research has been done identifying water-soluble polymers for agricultural use and low, cost-effective application rates.

PAM is highly effective in reducing soil erosion off of fields and can increase water infiltration into irrigated furrows (21, 22, 23, 24, 25, 26, 27). PAM has been shown to significantly reduce soil erosion by 90-95 percent when applied to irrigation water. Increases in infiltration rates vary from 20-60 percent from trials and experiments listed below in the "links" section. The increased use and distribution of polyacrylamide products in the past few years has brought down product prices, making PAM a more economical BMP option (28). PAM's many forms and application techniques make integration into the farmer's irrigation routine smooth and relatively easy once the initial set-up is complete. Relatively low-cost, high reduction of irrigation-induced erosion and soil loss, ease of use and integration, make Polyacrylamide a best management practice worth looking into by any agricultural operation.

How is PAM applied and what forms does it come in for application? PAM's three most common forms are dry granules, solid blocks (cubes), and emulsified liquids. The application method of PAM chosen depends on the form of PAM selected. The use of dry granular PAM into irrigation water is facilitated by the use of an augured metering system and excellent mixing and thorough dissolving before the PAM reaches the irrigated furrows. PAM blocks (or cubes) are usually placed in wire baskets that need to be secured to the edge of the ditch to avoid washing of the blocks down the ditch. Liquid PAM can be metered directly from the container into the irrigation ditch, directly into the furrow, or through a pipe line or injector pump.

Dry granules of PAM can be applied either by dissolving directly in the irrigation ditch before it hits the furrow, or applied directly in the furrow using what is known as the "patch method". In order for the PAM to dissolve properly in the irrigation ditch it must have proper agitation. Unlike sugar or salt which dissolve fairly quickly in water, granular PAM needs to be agitated thoroughly in order for it to dissolve. If not agitated, PAM globules form, and in time the globules can float down the furrow with little effect on the furrow erosion. A way to make sure the applied PAM is dissolved is to have a drop structure in the irrigation ditch to add turbulence to the water before it hits the furrow. Another tip to achieve desired dissolving is to place the applicator close to the point where the irrigation water first hits the ditch. In a concrete ditch, tins or boards will provide sufficient turbulence. In a earthen ditch a drop dam works nicely.

The "patch method" involves placing PAM at the point in the furrow where the water first hits; applying it for a length of about 3-5 feet down the furrow to reduce the risk of the PAM becoming buried in the furrow or washing down the furrow with little to no effect. The patch method creates a sort of gel-slab at the top of the furrow where the water slowly dissolves the PAM and carries it down the furrow.

PAM blocks are usually placed in wire baskets in flowing ditches at turbulent points. The blocks slowly dissolve, releasing small amounts of PAM into the water. Of the three forms, PAM blocks may not perform as well as well as liquid or granular PAM in furrow irrigation. PAM blocks, however, have been useful for treating settling ponds to accelerate water clarification and promote flocculation. They can also be used to dose concentrated runoff areas on fields that otherwise cause uncontrolled erosion.

Emulsified PAM (special liquid PAM solutions) can be applied like the granular form into irrigation ditches or into furrows using the patch method. Emulsified PAM doesn't require quite the vigorous mixing as the granular form, but still needs adequate mixing for dissolving. Emulsified PAM is more voluminous than dry forms, but is easier to dissolve and is the only form of PAM that should be used for sprinkler irrigation systems, due to greatly reduced the risk of clogging the lines.

In an experiment done at the Malheur Experiment Station in 1995, tests on two different application techniques of PAM (liquid and granular) showed both reduced sediment loss and increased water infiltration into the soil (26). The experiment was designed to determine if granular PAM could be as effective at reducing erosion in furrows when applied starting at the beginning of the head ditch (where it has not yet thoroughly dissolved) as when applied to the furrows further down the head ditch. Since applying granular PAM tended to be easier for farmers to handle rather than liquid PAM, research needed to be done to determine whether or not there was a significant difference between the two. The two forms of PAM were supposed to be applied at similar rates, but liquid PAM ended up being applied at a rate of 0.9 lb/acre and the granular PAM at a rate of 1.8 lb/acre. The difference was caused by the changes in volume of water flowing in the head ditch during the experiment and by other changes in irrigation management on the commercial farm. For soil erosion the check furrows lost 322 lb/ac of sediment off of the field in the runoff water during a single irrigation. Furrows irrigated with granular PAM lost 7 lb/ac of sediment off of the field, while those irrigated with the liquid solution of PAM lost 104 lb/ac. Remember though, the granular PAM was applied at a rate double the liquid.

In increasing water infiltration, the check furrows lost 37.5 percent of the water as runoff and 62.5 percent was infiltrated. Out of the total water applied treated with granular PAM, 26.5 percent was lost as runoff and 73.3 percent of the water infiltrated into the soil. Out of the total water treated with liquid PAM, 29.1 percent was lost as runoff and 70.8 percent of the water infiltrated. Granular PAM used as a "patch" was effective to control the loss of sediment and increase water infiltration.

Since the recommended rate of PAM in water is around 10 ppm to be effective for reduced soil erosion when the water is first advancing through the field, trial and error for each field is necessary with different irrigation rates and applicators. Economic considerations for the use of PAM have been developed for Malheur County (28). From 1990 to 1999 irrigation systems serving approximately 3500 acres of cropland have been treated with PAM via cost sharing.

II. A. 1. f. Sedimentation basins and pump back systems

Some of the first sedimentation basins promoted by the SCS in the county were more demonstration-education systems. They demonstrated to grower the dimensions of their irrigation-induced erosion problem. Many functional sedimentation basins with pump back features were built in the late 1980's and 1991 and 1992 with active participation of the SCS, ASCS, and SWCD. From 1990-1999 cost share assistance has been provided for approximately 15 tail-water recovery sediment basin systems with water savings of 0.5 ac-ft/ac irrigated under each system.

II. A. 1. g. Demonstration of weed screens

With trash in the water, gates in gated pipe have to be set wider open and larger siphon tubes have to be used to help assure that the trash passes through the gate or tube. Under the circumstances of trashy water, more water has to be set on a field than is really necessary, hence more water is present in many furrows than required to irrigate the row. The extra water promotes irrigation induced erosion and excessive leaching of nitrate to groundwater. The cleaner the water, the greater accuracy that gates and siphon tubes can be set, with assurance that the furrow irrigation will continue to run as set.

Herb Futter of the SCS visited the AS field day in Kimberly, ID and was impressed by at turbulent fountain weed screen (bubbler weed screens) demonstrated by J.A. Bondurant. Mr. Bondurant donated a portable weed screen to Herb and he installed it at the Malheur Experiment Station through the cooperation of Dwayne Buxton. The second screen at the experiment station in 1984 was on the main water supply of the station, and it was excellent for demonstration purposes, but it was insufficient in allowing adequate water to irrigate the station. During the winter of 84-85 the water delivery system was rebuilt with a much larger weed screen at the experiment station. In 1986 three mobile small screens built and were installed at the station on gated pipe delivery lines. These smaller screens were highly visible near other trials and helped show the advantages.   Adoption of weed screens after Herb Futter used the screens at the Malheur Experiment Station in a 1985 Field Day to promote the use of bubbler weed screens to remove weed seed and trash from irrigation water.  Growers started building and installing weed screens on their own, with fabrication by local irrigation dealers.  Especially noteworthy were the efforts of Dale Cruson in Ontario, who gave a big boost to screen adoption by manufacturing many of the screens.

In 1990 cost sharing was implemented to promote weed screens.  By 1999 the practice had become wide spread enough that cost share incentives are only being used in large scale projects where the size of the weed screen might be cost prohibitive.

**II. A. 2. Changes in irrigation systems**

II. A. 2. a. Sprinkler irrigation

Prior to 1985, very little sprinkler irrigation was being done on row crop ground in Malheur County.  Herb Futter had a gravity pressured system designed in the mid 1980's for the South Board of Control to serve about 20 growers.  The demonstration project was envisioned capturing the potential energy of the water in high elevation canals to provide pressurized sprinkler irrigation at lower elevations without pumping.  It was an ambitious project, but it did not get off the ground.  Dick Tipton visited Herb when he was working on the South Board of Control project.  Dick Tipton spearheaded a large scale demonstrating project sponsored by the SCS, SWCD and ARS on Morgan Avenue demonstrated the potential to use sprinkler irrigation for a range of crops.  Alfalfa, small grains, pasture, and sugar beets were successfully grown by the project.  Other gravity pressured systems were built.  In 2002-2003 a gravity pressured system to power sprinkler irrigation was installed by the South Board of Control and cooperating growers.

Research and demonstrations were conducted in 1987 and 1988 to compare the efficiency of sprinkler irrigation to surface irrigation and the effectiveness of sprinkler irrigation in producing better quality potatoes.  Water was used more efficiently and potato quality was improved through the use of sprinkler irrigation (29).  Solid set sprinkler systems were a means to cool the potato plant during hot weather and decrease water and nutrients form the plant's root zone.  From 1990-1999 approximately 16,000 acres of cropland were converted from furrow irrigation to sprinkler irrigation through cost share programs.

Micro sprinklers have been used effectively in experiments (30) and in growers fields for poplar production.

II. A. 2. b. Drip irrigation

Starting in 1992, drip irrigation, sprinkler irrigation, and furrow irrigation were compared for onion bulb production on sites that were difficult to irrigate (31, 32, 33). Drip irrigation was very promising in terms of bulb yield, bulb quality, water use efficiency, and apparent N fertilizer use efficiency. The success of these efforts prompted further research later to optimize the irrigation criteria for drip-irrigated onions (34), determine the duration of irrigation sets (35) and use ideal plant populations and N fertilizer rates with drip irrigation (36, 37, 38, 39).

Even though the concept of drip irrigation is relatively new in the region, by 2004 approximately 3,000 acres of onions are drip-irrigated in Malheur County and adjoining areas of Idaho. Preliminary work on other crops has examined potato variety performance with drip irrigation (40, 41), irrigation criteria for drip-irrigated potato, and potato plant populations and planting configurations under drip (42). Drip irrigation can be used effectively for poplar production (43, 44, 45) and alfalfa seed production (46, 47).

**II. A. 3. Irrigation scheduling**

Growers have irrigated using one of several criteria: intuition, calendar days since the last rainfall or irrigation, crop evapotranspiration, or soil water. Measurements of soil water or crop evapotranspiration provide objective criteria for irrigation management.

In 1984 irrigation scheduling was based exclusively on intuition and a calendar, the number of days. since the last irrigation. Although growers had tried to use tensiometers, no instruments were used to measure soil moisture to assure that irrigations were applied at the right time. Watermark soil moisture sensors Model 200 were introduced at the Malheur Experiment Station in 1986, but due to placement in the middle of furrow-irrigated beds at 6 inches depth, the readings were erratic due to the uncertainty of the wetting front from the furrow irrigation to uniformly reach the sensors. Starting in 1987 we started placing the sensors 4 inches from the middle of the bed and centered 8 inches deep, a location in the root zone of the potato that always got wet when the potatoes were furrow-irrigated.

II. A. 3. a. Comparative performance of soil moisture monitoring devices.

In 1987 and 1988, studies were initiated comparing various soil moisture monitoring techniques. Tensiometers were compared with Watermark soil moisture sensors (GMS), neutron probes, and gravimetric measurements (48). Work in 1991-1994 compared GMS to tensiometers, gypsum blocks, and gravimetric soil water content (49, 50). Also from 1991-1994 innovative new GMS designs were evaluated at the Malheur Experiment Station. In 2001 and 2002 GMS were compared to AquaFlex, Gopher, Gro-Point sensors, Measure-Point, Tensiometers, Neutron Probe and gravimetric soil moisture calculations (51). Work in 1987 through 1991 demonstrated the usefulness of GMS for irrigation scheduling for potatoes.

The use of GMS proved to be helpful for irrigation scheduling in Malheur County (52), especially with site specific calibrations (48, 49). Sensor placement was studied for potatoes (53) and other crops. For the purposes of crop research, GMS readings could readily be automated and used to control irrigation (54, 55). These automated systems used expensive data loggers and peripheral equipment too costly for most growers.

Lower cost logging of GMS has been accomplished by numerous companies. These systems proved to be effective and reasonably easy for growers to use (56, 57, 58). Automated data loggers to record soil water conditions are now used frequently in drip irrigated onion.

II. A. 3. b. How irrigation scheduling has evolved

Soil water can be measured by the methods that determine the soil water content or the soil water potential. Soil water content is the amount of water per volume of soil or weight of dry soil. Soil water potential is the force necessary to remove the next increment of water from the soil.

Different measurement methods have particular strengths and weaknesses. For example the gravimetric method is very accurate, but it is very slow and many samples are needed for each field and site specific interpretations are necessary.

The use of soil water potential measurements with tensiometers or granular matrix sensors provides a measurement analogous to the force (suction) necessary to extract water from the soil. The force is transmitted from the atmosphere through the plant to the roots.

Until recently growers had only tensiometers to accurately measure soil water potential.

Growers have often been unwilling to properly manage tensiometers. Granular matrix

sensors (Watermark Soil Moisture Sensor Model 200SS, Irrometer Co., Riverside, CA), a relatively new product on the market, could provide growers with an accurate and stable means to determine soil water potential for Malheur County soils in eastern Oregon. At the Malheur Experiment Station, we have successfully automated GMS to control drip irrigation.

Granular matrix sensors (GMS) represent an option for measuring soil water to schedule irrigation. Irrigation of crops highly sensitive to water stress, like potatoes, onions, and many other horticultural crops require precision irrigation scheduling, determining both irrigation frequency and duration.

Granular matrix sensor technology reduces the problems inherent in gypsum blocks (i.e., loss of contact with the soil by dissolving, and inconsistent pore size distribution) by use of a granular matrix mostly supported in a metal or plastic screen. Granular matrix sensors operate on the same electrical resistance principle as gypsum blocks and contain a wafer of gypsum imbedded in the granular matrix . The electrodes inside the GMS are imbedded in the granular fill material above the gypsum wafer. The gypsum wafer slowly dissolves, to buffer the effect of salinity of the soil solution on electrical resistance between the electrodes. According to Larson (59), particle size of the granular fill material and its compression determines the pore size distribution in GMS and their response characteristics.

For many soil types, growers have found that GMS are a useful tool to schedule irrigations. as plants use water from the soil, the soil dries and water is drawn out of the sensor. Sensor resistance increases. Upon irrigation or rainfall, the GMS takes up water and the resistance decreases.

GMS can substitute for tensiometers in irrigation management when irrigation criteria based on soil water potential have been established. Because GMS do not require periodic maintenance during the growing season, they are ideally suited for sensing soil water potential to automatically start an irrigation system as we have been doing since 1995. GMS have advantages of low unit cost and simple installation procedures, similar to those used for tensiometers. Data acquisition with GMS can be remote from the measurement site by use of electrical wires, so the plants and soil at the measurement site remain relatively undisturbed.

Tensiometer and GMS are used in the following way. Starting in 1988, after the initiation of a successful research program at the Malheur Experiment Station, GMS soil water potential readings made in growers fields were used to schedule irrigations. In the beginning the potato extension specialist, Lynn Jensen lead the program. The program has evolved to the point where 87 Malheur County potato fields were monitored in 1995 by the Soil Water Conservation District under the management of

Ron Jones. The cost is paid for by the growers. Actual readings are made by student

summer labor using a Model 30KTCD digital meter (Irrometer Co., Riverside, CA).

Six to twelve GMS are used to characterize the soil water potential in each field.

An area of the field are chosen by the grower based on irrigation experience. Sometimes both a typical area and a difficult (usually drier) area are chosen. Six GMS are distributed widely across each area and each GMS is connected by up to 150 ft of 18 gauge speaker wire to terminal strips. All sensors in a given area are wired to a single location for rapid reading. For each area, all but one of the sensors are installed at 8 inch depth (depth to the top of the sensor) in the shoulder of the potato hill and a single sensor is installed at the 16 inch depth. Responsive GMS placement had been determined (53).

Sensors are read daily at about the same time of day and the soil water potential data is plotted daily. Copies of the data plotted stay in a news paper box at the site and with the person making the readings. The data is plotted for immediate interpretation and use by the grower. The average readings at 8 inch m depth and the single reading at 16 inch depth in each area is plotted. Also the soil water potential of the driest sensor at 8 inch depth is plotted. The graphs are designed to help the grower to irrigate at -50 kPa avoiding to let the soil dry beyond -60 kPa.

In sprinkler-irrigated fields, information from the 16 inch depth helps avoid over irrigation which would keep the deeper part of the soil profile saturated. Irrigating at the correct time is achieved by not allowing the soil in Malheur County, Oregon to become drier than -60 kPa. Irrigation with the right amount of water is possible using sprinkler irrigation, by only applying the amount of water necessary to refill the soil's water holding capacity in the root zone.

As the experimental trials went forward, Lynn Jensen started demonstrating the effectiveness of these scheduling practices on grower fields through funding from the USDA. This effort was later expanded by Ron Jones of the SWCD through funding from the Oregon DEQ. Eventually the Malheur County Potato Growers Association directed the program in conjunction with their potato integrated pest management program until the growers were familiar enough with the program to conduct irrigation scheduling on their own.

The original program involved using extension and 319 grant funds to hire students to install, read and graph the sensors on a daily or every other day basis. Irrigation refill points were marked on the graph so a grower would know when the next irrigation was needed. After two years of providing the services through agents, the participants were asked to pay half of the costs for the program. Two years after that the total cost of the program was provided through user fees.

The advent of the Hansen Meter, where a series of Watermark Sensors could be attached to the meter and would then be read and graphed three times per day eliminated the need for students to manually read and graph soil moisture. The process was simplified to the point that a grower could readily install the sensors and meter, and track soil moisture with a minimum of training. Currently most soil moisture monitoring is being conducted by growers, especially those using drip irrigation.

II. A. 3. c. Determination of the ideal criteria for irrigation

Irrigation scheduling consists of applying the right amount of water at the right time. With water stress sensitive crops, growers have incentives to make irrigation scheduling work well. For example, potatoes have a low tolerance for water stress. Tuber market grade, tuber specific gravity, and tuber processing quality for French fries are all closely related to even low levels of water stress during tuber bulking. All these potato characteristics are closely related to the maintenance of soil water potential within a narrow range of values. Incentives to growers for precise irrigation scheduling include the following:

1. Under-irrigation leads to a loss in market grade, tuber quality, and contract price.

2. Over-irrigation leads to a loss in water, electricity for pumping, leaching of nitrogen, and wastes time. Over-irrigation increases crop N needs, fertilizer costs, and nitrogen losses to groundwater. Soil losses can be aggravated.

3. Under-irrigation and over-irrigation can occur during the same season in a given field.

***Relation of GMS readings to potato quality***

Potato yields and quality can improve with control of soil water. Moderate water stress causes little damage to potatoes before tuber initiation (60) but during tuber development, small amounts of water stress result in decreased tuber grade, decreased specific gravity, or increased incidence of dark-end fry colors (61, 62, 63, 64). Research supported by the Oregon Potato Commission and completed by Eric Eldredge in his October 1991 Ph.D. thesis proved that a single, short duration water stress can lead to a reduction in tuber grade and dark fry colors. While these results are of critical importance to potato growers and processors, growers cannot easily implement these experimental results without quick and reliable field determination of soil water potential.

Work by Lynn Jensen and others has proven that GMS sensors are useful in managing soil water for potato production in Malheur County. When the soil was maintained moist the rest of the growing season, Eric Eldredge proved that a single episode of water stress as measured by GMS did not reduce Russet Burbank tuber yield, but tuber grade and specific gravity were reduced and dark-ends were increased (62, 63). A single episode of water stress where GMS readings became drier than -60 kPa or drier was associated with a progressive loss in U.S. No. 1 tubers, increases in U.S. No. 2 tubers, and losses in tuber solids. A single episode of GMS readings in the range of -100 kPa or drier was associated with increased incidence of USDA #3 and #4 dark-ends (61, 63). These guidelines for quality tuber production on silt loam soil would need to reevaluated so that they are useful in other soil types and climatic situations.

***Relation of GMS readings to the responses of onion and poplar trees***

Furrow-irrigated onions lost yield and grade when the soil was allowed to become drier than -27 kPa between irrigations (65). Drip-irrigated onions lost yield and grade when the soil was allowed to become drier than -20 kPa between irrigations (34), and this wet criterion needed to be maintained to the end of the irrigation season (66). Poplar trees were sensitive to the loss of tree growth with soil water drier than -25 kPa, as determined by GMS (30).

II. A. 3. d. Crop evapotranspiration; the checkbook method

Crop evapotranspiration is a fancy word for the consumptive use of water. Consumptive water use is composed of evaporation of water off of the soil surface and transpiration of water through plant tissue to the air. Crop evapotranspiration is calculated using a specialized weather station or an atmometer. Excellent estimates of crop water use can be provided by automated weather stations and local knowledge about when crops emerged, how quickly they developed, and when they matured.

Due to the absence of a local station for evapotranspiration measurements, we installed an AgriMet station in 1992 at the Malheur Experiment Station. The annual maintenance costs are paid by the agricultural experiment station. The data are especially useful for sprinkler an drip irrigation. The grower needs to be concerned with keeping a checking account balance of the estimated evapotranspiration and the measured rainfall in the potato fields.

In 1996 we established a Malheur Experiment Station world wide web site and put the water use estimates on the internet at **http:// www.cropinfo.net**. We put the daily crop water use estimates on a computer bulletin board long before there was much grower interest. The daily evapotranspiration estimates are provided on the AgriMet and station web sites.

The use of the check book method is pretty straight forward, but the grower has to have access to the following information:

1. A local weather station estimating potato crop ETc based on the crop's coefficients and correct crop development data,
2. A rain gauge placed in each production field or group of closer adjacent fields,
3. A good estimate for the allowable depletion of water for each soil.

Acquiring all three of these needed pieces of information is feasible. The potato plant's water use is well known given weather data and the stage of development. But someone manually or automatically must calculate the daily potato ETc at each important weather station location. The allowable soil water depletion for potatoes can be calculated by extension agents, crop consultants, and growers. The calculation requires knowledge of the potato plants' effective rooting depth in a given soil and that soil's water retentive characteristics in the range where the potato plant does not suffer water stress. Potatoes are very sensitive to water stress, and caution is needed to avoid over estimation of a soil's allowable depletion.

**II. B. Nutrition Management**

Nitrogen fertilizing practices have changed in Malheur County. These changes have come about due to the research and outreach / demonstration projects completed by the OSU Malheur Experiment Station (MES), the OSU Cooperative Extension Service (CES), Malheur County Soil & Water Conservation District (SWCD), National Resource Conservation Service (NRCS), the Malheur Watershed Council, the Owyhee Watershed Council, United States Department of Agriculture programs such as Environmental Quality Improvement Program (EQIP) administered by the Farm Service Agency (FSA) and NRCS, and others. The economics of fertilization and the cooperation of the local fertilizer dealers have played an important roles in these changes. These changes would not have occurred without cooperative the financial and educational help from many partners, including. Some of those partners include EPA, DEQ, CES, MES, ODA, SWCD, Farm Service Agency (FSA), NRCS, the watershed councils, and the local fertilizer dealers.

The improvements in nutrient management can be summarized as reducing the amount of nitrogen fertilizer used, budgeting the nitrogen, and utilizing deep- rooted crops planted in rotation with shallow-rooted crops (Shock et al. 1993, 1988a, 2000a). A brief description of each practice follows:

(a) Reducing the amount of nitrogen fertilizer used – The amount of nitrogen fertilizer can be reduced through determination and utilization of optimal:

- timing,
- placement, and
- rate of fertilizer application (36, 37, 38, 39, 67).

(b) Budgeting the nitrogen – Budgeting the nitrogen allows a better match of the amount applied to the amount used by the crop. To do this, the growers incorporate:

- soil testing results,
- plant tissue testing results, and
- nitrogen mineralization into the budget (39, 68, 69, 70, 71, 72).

(c) Utilizing deep rooted crops – Utilizing deep rooted crops (e.g., sugar beets and wheat after onions and potatoes) allows the deeper rooted crops to recover residual soil nitrate and mineralized nitrogen (68, 69, 70).

Very little, if any, nitrogen is now applied in the fall because fall nitrogen is more apt to be leached and interfere with crop seeding establishment . Soil samples are now commonly analyzed prior to any fertilization application; and the amount of residual nitrogen in the soil nitrate and ammonium is factored into the total amount of fertilizer to be applied to the next crop. Fertilizer applications are typically applied in the spring, with a split application starting in March and ending in July. After the plants reach a prescribed size certain maturity, tissue samples are taken to see if more nutrients are needed for the plant to continue to be productive through reach full maturity. Petiole samples are taken from potato and sugar beet, root samples are taken from onion, and flag leaf samples are taken from wheat.

The Ontario HUA Final Report indicates that nitrogen application rates had been reduced by 1997 (73). The report also indicates nitrogen is being applied more efficiently and at rates closer to plant needs. Since 1990, information and education activities targeting awareness of how much nitrogen is needed for crops as well as more efficient application methods have resulted in dramatic increases in practices such as soil testing, petiole testing, side dressing, banding, split applications and converting from fall to spring nitrogen applications. Field acres where nutrient management practices are being applied steadily increased throughout the seven-year period of the HUA project from less than 5,000 in 1991 to over 44,000 acres by 1997; representing approximately 28% of the 157,000 acres in the HUA (73, 74).

Since wheat and sugar beets are deeply rooted and are grown in rotation with shallow rooted crops such as onion and potato, the deeply rooted crops might have the potential to recover residual nitrate left in the soil. Sugar beets following onion fertilized with 200 lb N/acre or more, required little or no N fertilizer. When these small plot observations were demonstrated on a large scale in grower's fields, the same reality emerged. Beets often required no additional N fertilizer.

Sugar beets, wheat, and barley were proven efficient scavengers of naturally occurring plant available-N at the station and in "on farm" trials (68, 69, 70). Where sugar beets or wheat followed onions receiving 200 lb N/ac, yields were high without any N fertilizer during the crop year. Recoverable sugar or wheat grain yields were higher following onions that received 200 lb N/ac than following onions that received 400 lb N/ac (sugar beets and wheat were not fertilized in these trials). We are showing that reduced N in Treasure Valley growers fields will maintain wheat yields and increase sugar yields.

Research at the station and "on farm" trials proved that crops grown in Malheur County without N fertilizer consistently obtained more natural N from the soil environment than predicted by soil tests. Conventional nitrate soil analyses greatly underestimate the natural available-N supply to plants. The discrepancy in estimate is not caused by nitrate analysis errors, but by major naturally available-N sources not routinely calculated in fertilizer recommendations (39, 67, 68, 69, 70, 71, 72). These natural sources turn out to be very important in Malheur County. They include:

a) Organic matter mineralization, ranging from 50 to 250 lb N/ac,

b) Ammonium-N in the crop root zone, ranging from 5 to 200+ lb N/ac,

c) Previous crop residue decomposition, ranging from -10 to 60 lb N/ac, and

d) N in the irrigation water, ranging from 2 to 60+ lb N/ac.

Large amounts of naturally occurring available-N complicate N fertilizer recommendations because we don't know how to predict them and use them in fertilizer recommendations. These natural N sources are generally not included in Pacific Northwest fertilizer guides. We are conducting "on farm" N mineralization research and introducing an available-N accounting approach to growers. We hope to reduce crop production costs, increase profits, and reduce nitrate leaching. Since large natural N supplies can occur, crop responses to N fertilizer may be small. Some of the growers are adjusting N application rates downward.

Efficient use of soil nitrate and the other available N sources listed above depends on irrigation being roughly in balance with crop water needs so that nitrate leaching is minimal or only moderate. We have worked intensively to determine soil moisture criteria for irrigating potatoes and onions. The goal is the right amount of water added at the right time. Dozens of growers have adopted the soil moisture criteria and soil moisture sensors. Irrigation management has improved and is continuing to improve. This methodology is spreading across southern Idaho from west to east on areas of silt loam soils.

***Summary of N Management Practices***

Fertilizer and chemical application practices in Malheur County have changed significantly over the past 22 years. In the early 80’s it was common practice for farms to have their secret crop mix made up of 1000 to 1500 lb of triple 16 per acre for fall fertilizer. A lot of these fall fertilizer mixes contained 150 to 200 lb/acre of nitrogen, which were followed up in the spring with another 150 to 300 lb/acre of nitrogen sidedressed.

In the mid 80’s farmers started soil sampling and tailored their fertilizer rates according to the soil sample recommendations. This cut down on the amount of fertilizer applied in the Fall. In the Spring, they put the rest of their fertilizer needs on by sidedressing three times. Farmers also started banding all the post emergent chemicals on onions. Dacthal was applied banded at 4-6 lb per acre.

In the early 1990’s farmers cut out all fall nitrogen except for the nitrogen required to break-down crop stubble. The remainder of the fertilizer was spoon fed over three sidedress applications determined by petiole sampling before each application. Dacthal herbicide application was cut out all together.

Today, one acre grids are being soil sampled in the fall to determine what each acre's fertility needs are. GPS technology is used to help variable fertilizer applicators apply only what each acre's needs are. Nitrogen is put on in very limited amounts, just enough to keep the carbon to nitrogen ratio in line to break-down stubble. In the Spring, petiole sampling is done to determine fertilizer needs and then sidedressing small amounts of fertilizer three times to spoon feed the crop.

These two practices are closely linked, and trying to manage one without the other becomes self-defeating. Nitrogen only leaches when excess water is applied and conversely excess water can only leach if nitrogen is available to be leached from the soil profile. The goal is to have enough nitrogen available to maximize crop growth, but not excess, and enough water in the soil profile to keep crop growth adequate without pushing water through the soil profile.

There are some obvious and some not so obvious methods of dealing with these two issues. First, nitrogen management. Ideally, having just enough nitrogen available in the soil solution to meet the plants immediate needs would be an ideal goal. Practically speaking, that is not possible, but growers have made great strides towards this goal. For example, onion growers have gone from applying all of their nitrogen in the fall, where it is subject to leaching by winter rains or early irrigations. Nitrogen is now applied with a small amount as a starter, then sidedressed two or three times during the growing season. The first irrigation has the most potential to leach because of the high infiltration rate and dry subsoil. Applying nitrogen after the first irrigation dramatically reduces the potential to leach. This technique has allowed onion growers to reduce nitrogen applications by 25% without reducing yield or quality. The money spent in additional sidedress applications is offset by the nitrogen saved.

### II. C. Use of Crop Residues

Organic agricultural wastes are recycled foe their nutrient and soil conditioning benefits. Potato and onion wastes from processing facilities were not being utilized as fertilizer until recently. Nitrogen release curves were developed for potato and onion sludge by local OSU extension and research. These materials are now being used in partial substitution for commercial fertilizers. Following testing by the Malheur Experiment Station and Oregon Trail Mushrooms (Vale, Oregon) alfalfa seed screenings were no longer hauled to the land fills, but are being used as an ingredient in the compost to grow mushrooms. Spent mushroom compost is no longer accumulating, but is being utilized as a soil conditioner, largely for landscape purposes. Animal manures from confined animal feeding operations are being used extensively for their nutrients in crop and pasture production, through well defined nutrient management plans.

### II. D. Cultural Practices

#### II. D.1. Tillage Practices

For the Treasure Valley silt loam soils, fall bedding conserves winter soil moisture and fall soil tillage operations helps preserve soil tilth --- because spring tillage occurs when the soil profile is wet and damages soil structure. Tillage practices are evolving towards fewer tractor passes.

#### II. D. 2. Weed Control

Weed control practices have been developed to be compatible with fall bedding.

#### II. D. 3. Transformations in agricultural chemical use

Agricultural chemistry and its use has been transformed in the entire Snake River plain. From the inception of modern agriculture through the 1950's, little attention was paid to the persistence and unintended effects of pest control problems. In recent decades the pesticide industry has been transformed by the adoption of products with much narrower specificity and short half lives. With three quarters of a million cultivated and irrigated acres in the Treasure Valley in Idaho and Oregon, we know of no currently used agriculture pesticide that is reaching the streams, rivers, or groundwater.

Onion is one of the most important irrigated crops in this valley. Onions compete poorly with weeds and efficient weed control is essential to maintain an economically viable onion industry. DCPA (sold as Dacthal) is an effective herbicide to control weeds in onion fields and was commonly used. DCPA metabolites, however, have been found in shallow aquifers underlying parts of the intensively farmed areas of Malheur County, Oregon (3, 75).

All pesticides sold or distributed in the U.S. must be registered by the United States Environmental Protection Agency (EPA), based on scientific studies showing that they can be used without posing unreasonable risks to people or the environment. Because of advances in scientific knowledge, the law requires that pesticides that were registered before November 1, 1984 be re-registered to ensure that they meet the current, more stringent, standards.

DCPA was first registered as a pesticide in the U.S. in 1958 as a selective preemergence herbicide for weed control on turf grasses. Following a June 1987 evaluation, EPA issued a Registration Standard for DCPA in June 1988. Based on human health risk assessment calculations summarized in the November 1998 DCPA Reregistration Eligibility Decision document, EPA concluded that “DCPA and its metabolites do not currently pose a significant cancer or chronic non-cancer risk from non-turf uses to the overall U.S. population from exposure through contaminated drinking water”.

In 1990, a third of growers using DCPA were banding the product on the uncultivated parts of the bed, saving 2/3rds of the DCPA expense (76). We examined banding and substitution of DCPA. Due to concerns about residues of DCPA & metabolites in surface water and sediment runoff from furrow-irrigated crop land, as well as through deep percolation through the soil profile, intensive studies were conducted to trace the fate of DCPA & metabolites losses with banding or broadcast of DCPA. This work was conducted in 1991, with results distributed to the growers at that time and documented by Shock et al. in 1998 (77). Without straw mulch, DCPA & metabolites in transported sediment was 33% less when banded than when broadcast; and 41% less in surface water runoff. For both banded and broadcast applications, straw mulch reduced DCPA & metabolites losses in transported sediment by about 90%. Straw mulch also reduced DCPA & metabolite losses in surface water runoff by 30% for banded application and by 50% for broadcast application. The benefits of straw mulch were primarily through reductions in soil erosion and runoff volume.

Even without a product to substitute for DCPA, it was possible to lower the amount of chemical loading by banding DCPA in a narrow band directly where the onions would grow, rather than broadcast DCPA over all of the soil surface. The area of soil between the banded DCPA did not need the product because weeds were controlled there by cultivation. Growers were quick to adopt the banding of DCPA, because costs were reduced with no loss in weed control.

Conclusions from these studies included that omitting DCPA or banding DCPA during onion production immediately reduced the losses of DCPA residues through downward leaching or runoff. Additional research at the MES demonstrated that other products with shorter half-lives could control weeds in onions on a wide range of sites at lower cost (78, 79). The use of DCPA was no longer necessary. With the registration of pendimethalin (sold under the trade name of Prowl) in about 1993 or 1994, growers rapidly switched to pendimethalin because it was lower in cost, more effective, and did not have the undesirable environmental effects of DCPA. DCPA inventories in Malheur County were depleted by the 1998-growing season. One objective of the

Ontario HUA had been to reduce DCPA application by 30%. Surveys conducted by the Malheur Extension Service showed that this goal was easily met by the end of 1997.

Instrumental in the adoption of DCPA were the "on farm" demonstrations by Lynn Jensen of OSU Cooperative Extension, who demonstrated the general effectiveness of pendimethalin and it's ability to control dodder. This was an easy sell. The loss of DCPA market share by may have been a factor in the end of its manufacture in the US. The work conducted by Jensen and Stanger was supported by the Idaho Eastern-Oregon Onion Committee. Both the adoption of banding over broadcast DCPA and the substitution of pendimethalin for banded DCPA took place at the voluntary initiative of growers.

Zeneca took over ISK in about 1997, and they may have decided to discontinue DCPA production at that time. Manufacture of DCPA continues in Japan. Although there were still stocks of DCPA around to buy and apply in the US in 1997, use had dropped to almost nothing, and the groundwater trends were already evident. Groundwater has been monitored over the past decade through the efforts of the ODEQ, the Malheur County SWCD, and NRCS employees in Ontario. The DCPA and DCPA residue analyses were conducted by the ODA Laboratory Services Division in Portland under the leadership of Norma Corristan. The overall downward trends in the groundwater are now unmistakable (1).

### II. D. 4. Reductions in Hand Labor

Labor has become less available and more costly, forcing growers to rely more extensively on mechanical and chemical means of weed control. The relative value of farm products to the consumer price index and input costs has continued to decline (1), forcing economies of many kinds.

## III . Notes on the Implementation of New Practices

The primary method of water application for Treasure Valley crops is furrow irrigation.

Furrow irrigation is a method that is fairly easy to use, has been used for many years, and has some large advantages associated with it when applied to certain crops. In the past hundred years, large investments have been made in the effort to improve furrow irrigation. The use of field leveling, control structures, and water conveyance techniques, are just a few examples of the progress that has been made and is being made.

Many BMPs have been implemented in the Northern Malheur County GWMA that are protective of groundwater quality. Some of this progress is documented in the Ontario Hydrologic Unit Area (HUA) Final Report 1990 - 1997 (73).

Major changes in agricultural practices have occurred since groundwater contamination was identified in the Malheur River area in the late 1980s. The method of nitrogen application in this area has been changed. Reduced nitrogen loading has been accomplished by changes in the timing and the application of nitrogen as well as the rate of application. Plant tissue and soil sampling have also played a major role in modifying practices for the application of nitrogen and other nutrients, enabling producers to apply only the amount of nutrient needed and only when that nutrient is needed. Changes in irrigation management practices have also occurred that increase the protection of groundwater quality.

Table 3-1 identifies the extent of specific implemented practices between 1990 and 1997 for groundwater protection, surface water protection, erosion protection, irrigation water management, and animal waste management through SWCD and NRCS programs. Other improvements have occurred before and after this time. Activities conducted exclusively through private efforts are not included.

| **Best Management Practice** | **Extent of Implementation** |
|---|---:|
| Conservation Cropping Sequence | 27,5764 acres |
| Grasses & Legumes in Rotation | 1,231 acres |
| Irrigation Water Management | 46,891 acres |
| Pasture / Hay Land Management | 676 acres |
| Pasture / Hay Land Planting | 285 acres |
| Nutrient Management | 44,010 acres |
| Waste Utilization | 1,670 acres |
| Soil Testing | 35,595 acres |
| Fertilizer Application Timing | 21,324 acres |
| Tissue Analysis | 19,098 acres |
| Split Application of Nitrogen | 15,125 acres |
| Banding of Nutrients | 7,625 acres |
| Surge Irrigation | 160 acres |
| Irrigation Scheduling | 18,053 acres |
| Sprinkler Irrigation | 6,737 acres |
| Filter Strip | 618 acres |
| Tail Water Recovery System | 16 systems |
| Irrigation Land Leveling | 1,587 acres |
| Straw Mulching | 5,490 acres |
| Polyacrylamide (PAM) | 16,725 acres |
| Sediment Basins | 8 basins |
| Irrigation Water Conveyance – Ditches | 117,646 feet |
| Irrigation Water Conveyance - Pipe | 373,178 feet |
| Structures for Water Control | 330 structures |

| | |
|---|---|
| Weed screens | 386 structures |
| Waste Management System | 11 systems |
| Waste Storage Structure | 4 structures |
| Waste Treatment Lagoon | 2 lagoons |
| Waste Storage Pond | 5 ponds |

***Number of Producers Adopting Farm Plans***

Water quality farm plans are viewed as a set of progressive steps utilizing BMPs that lead to implementation of a Resource Management System. Plans are periodically reviewed and updated to include the newest BMPs available. Nearly all water quality plans written in the HUA include irrigation water management, nutrient management, and pesticide management as basic plan recommendations. Additional practices are included on a case-by-case basis and plans are tailored to individual farm requirements.

The number of water quality farm plans completed through the seven-year period of the HUA project and beyond indicates continued interest and involvement by the local growers. The total number of plans completed is as follows: 9 plans by 1991, 39 plans by 1992, 69 plans by 1993, 98 plans by 1994, 121 plans by 1995, 146 plans by 1996, and 156 plans by 1997. The 157 plans completed by 1997 represent approximately 44,000 acres, or about 28% of the total irrigated acres in the GWMA.

From 1997 through 2000, 65 new water quality farm plans were completed (averaging 12 to 15 per year).

***Shortage of Federal Support for Farm Plans***

Numerous growers seek cost share support for adoption of farming practices with positive environmental effects. Although approximately 70 and 170 applications were filed in Malheur County during the last two years, less than 10 percent of growers seeking cost share support have garnered support. It is probable that even more producers would apply if the probability of success were greater. Both profitability of agricultural production and scarcity of public resources currently limit the adoption of new farming practices.

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