RECLAMATION

Managing Water in the West

Final Feasibility-Level Special Study Report

Odessa Subarea Special Study

Columbia Basin Project, Washington

Prepared in cooperation with:

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Columbia-Cascades Area Office
Yakima, Washington

State of Washington
Office of Columbia River
Department of Ecology
Wenatchee, Washington

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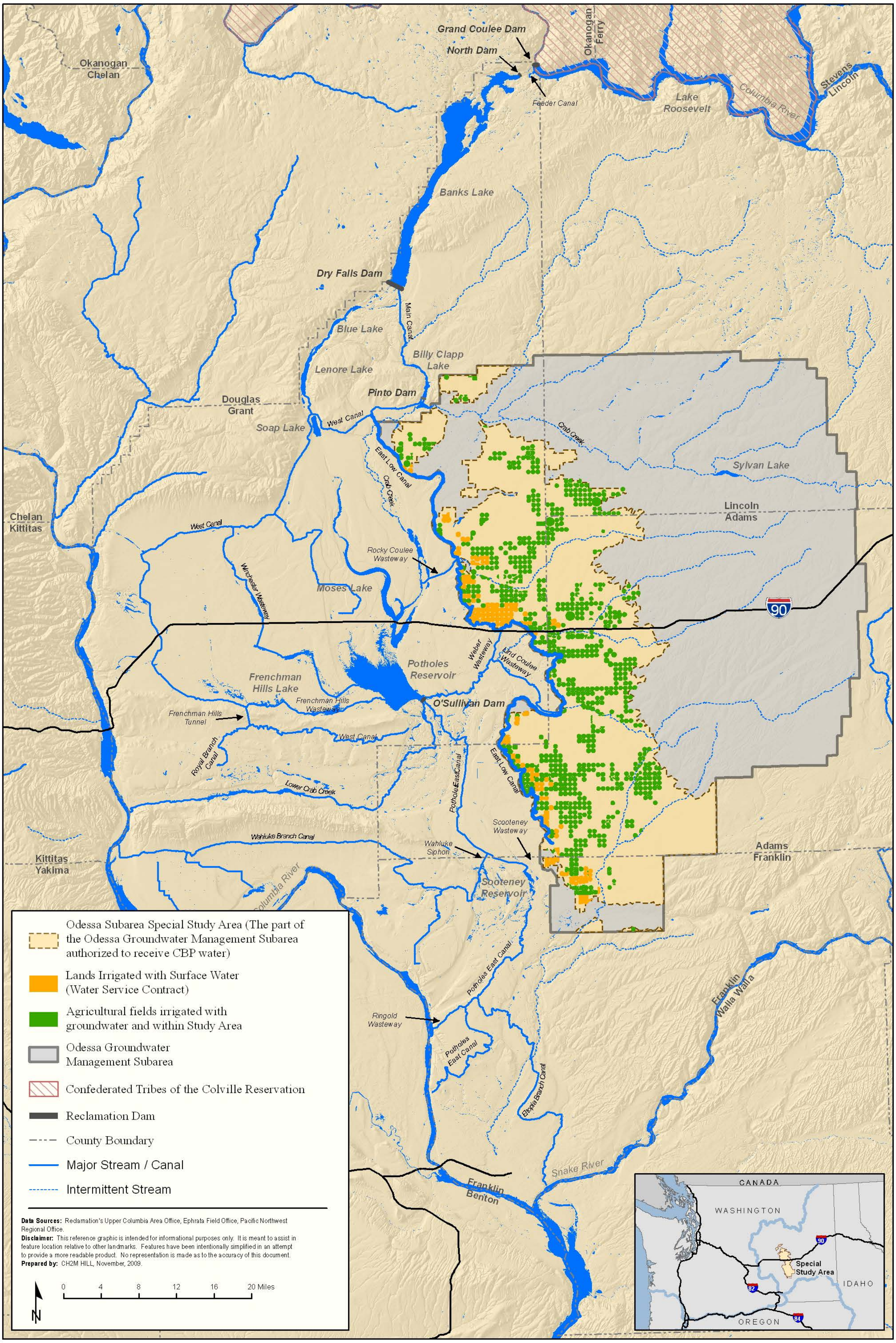
Mission Statements

The Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

The mission of the Department of Ecology is to protect, preserve and enhance Washington's environment, and promote the wise management of our air, land and water for the benefit of current and future generations.



Odessa Subarea Special Study
Columbia Basin Project, Washington

Location Map

Acronyms and Abbreviations

2008/2010 BiOp	*Supplemental Consultation on Remand for Operation of the Federal Columbia River Power System (FCRPS), 11 Bureau of Reclamation Projects in the Columbia Basin and ESA Section 10(a)(1)(A) Permit for Juvenile Fish Transportation Program*
amsl	above mean sea level
BCA	benefit-cost analysis
BCR	benefit-cost ratio
BRBC	Black Rock Branch Canal
BPA	Bonneville Power Administration
CBP	Columbia Basin Project
Corps	U.S. Army Corps of Engineers
CSRIA	Columbia Snake River Irrigator's Association
CRP	Conservation Reserve Program
cwt	hundredweight
EA	Environmental Assessment
ECBID	East Columbia Basin Irrigation District
Ecology	Washington State Department of Ecology
EIS	Environmental Impact Statement
ELC	East Low Canal
EOM	end of month
ESA	Endangered Species Act of 1973, as amended
FCRPS	Federal Columbia River Power System
FDR	Franklin D. Roosevelt Lake (Lake Roosevelt)
FERC	Federal Energy Regulatory Commission
FONSI	Finding of No Significant Impact
gpm	gallons per minute
GWMA	Columbia Basin Ground Water Management Area
IMPLAN	IMpact analysis for PLANning
ITA	Indian Trust Asset
Management Act	Columbia River Water Resource Management Act
Management Program	Columbia River Basin Water Resource Management Program
M&I	municipal and industrial
MAF	million acre-feet
MOA	Memorandum of Agreement
MOU	Columbia River Initiative Memorandum of Understanding (2004)

MW	megawatts
NASS	National Agricultural Statistics Service
NEPA	National Environmental Policy Act
NFI	net farm income
NMFS	National Marine Fisheries Service
NRA	national recreation area
NRCS	Natural Resources Conservation Service
O&M	operation and maintenance
Odessa Draft EIS	*Odessa Subarea Special Study Draft Environmental Impact Statement*
Odessa Final EIS	*Odessa Subarea Special Study Draft Environmental Impact Statement*
Odessa Subarea	Odessa Ground Water Management Subarea
OWRD	Oregon Water Resources Department
P&Gs	*Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*
PASS	Project Alternative Solutions Study
RMP	Resource Management Plan
POS	Plan of Study
psi	pounds per square inch
QCBID	Quincy-Columbia Basin Irrigation District
RCW	Revised Code of Washington
Reclamation	Bureau of Reclamation
ROD	Record of Decision
SCBID	South Columbia Basin Irrigation District
SEPA	State Environmental Policy Act
Secretary	Secretary of the Interior
SRSP	Steamboat Rock State Park
State	State of Washington
Study	Odessa Subarea Special Study
Study Area	Odessa Subarea Special Study Area
TERO	Tribal Employment Rights Ordinances
USDA	U.S. Department of Agriculture
Service	U.S. Fish and Wildlife Service
VRA	Voluntary Regional Agreement
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources
WSPRC	Washington State Parks and Recreation Commission

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Chapter 1: Location, Purpose, and Authority

This chapter provides an introduction and background and describes the location, purpose, scope, objectives of the Study, and the Study authority.

The Bureau of Reclamation, Washington State Department of Ecology, and Columbia Basin Project (CBP) irrigation districts are conducting the Odessa Subarea Special Study (Study) to investigate the continued phased development of the CBP to replace groundwater currently used for irrigation in the Odessa Ground Water Management Subarea (Odessa Subarea) with CBP surface water.

Since the CBP is an authorized project, a special study was done as opposed to a feasibility study; however, analyses were prepared at a feasibility level. This feasibility-level Special Study Report is prepared in compliance with the requirements of the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies* (U.S. Water Resources Council, 1983) (P&Gs). The P&Gs represent the main set of project evaluation guidelines for Federal water management agencies. This report presents a discussion of the formulation of alternatives, a description of the alternatives considered, and the results of the P&Gs-specific analyses.

Information in this Special Study Report is based on a variety of sources, including the Odessa Subarea Special Study Final Environmental Impact Statement (Odessa Final EIS).

Technical reports containing the feasibility-level drawings and cost estimates are available at http://www.usbr.gov/pn/programs/ucao_misc/odessa/

Further background information is available at the following websites:

- Washington State Department of Ecology Office of Columbia River, Odessa Subarea Special Study: http://www.ecy.wa.gov/programs/wr/cwp/cr_odessa.html

- Reclamation's Pacific Northwest Region, Columbia-Cascades Area Office, Odessa Subarea Special Study: http://www.usbr.gov/pn/programs/ucao_misc/odessa/

1.1. Location

The Columbia Basin Project is a multipurpose water development project in the central part of the State of Washington (State), east of the Cascade Range. The CBP is located in

Grant, Adams, Walla Walla, and Franklin Counties, with some northern facilities located in Douglas County (see Frontispiece for location map).

The key structures, Grand Coulee Dam (which forms Franklin D. Roosevelt Lake) and the John W. Keys III Pump-Generating Plant, are on the mainstem of the Columbia River about 90 miles west of Spokane. The Keys Pump-Generating Plant pumps water from the Columbia River into the Feeder Canal that extends to Banks Lake, an off-stream equalizing reservoir of the CBP. Other irrigation facilities are the Main, West, East High (as part of future phased development), and East Low canals, O`Sullivan Dam, Potholes Reservoir, and Potholes Canal. There are over 300 miles of main canals, about 2,000 miles of laterals, and 3,500 miles of drains and wasteways on the Project. The irrigation portion of the CBP begins at the head of the Grand Coulee and extends 152 miles to the confluence of the Snake and Columbia Rivers. The Columbia River forms the western boundary of the CBP near the City of Quincy and the project extends east 60 miles to near the Cities of Odessa and Lind.

The CPB irrigates about 671,000 acres with an average annual diversion of 2.65 million acre-feet (MAF) as measured at the Main Canal from 2000 to 2004. Up to 67 different crops are grown, with more than a half billion dollars of crop value each year, including alfalfa, potatoes, apples, and vegetables. In addition to irrigation, the CBP provides power production, flood control, municipal water supply, recreation, and fish and wildlife benefits. Irrigation return flows from the CBP are discharged into the Columbia River through wasteways, creeks, and groundwater seepage.

Three irrigation districts and other miscellaneous lands receive CBP water:

- Quincy-Columbia Basin Irrigation District (QCBID): serves 247,122 acres
- East Columbia Basin Irrigation District (ECBID): serves 152,000 acres
- South Columbia Basin Irrigation District (SCBID): serves 232,000 acres
- Miscellaneous parcels: 39,878 acres

1.1.1 Odessa Subarea

The Odessa Subarea is in the eastern part of the CBP and overlaps the CBP boundaries. In 1967, the Washington Legislature designated the Odessa Subarea as a ground water management area because of groundwater level declines resulting from pumping (Washington Administrative Code [WAC] 173-128A, *Odessa Ground Water Management Subarea*). Lands within the Odessa Subarea which are eligible for surface water from the CBP form the Odessa Subarea Special Study Area (Study Area) for this Special Study Report (see Frontispiece location map).

1.2. Purpose, Scope, and Objectives

The purpose of the Study is to evaluate alternatives that would deliver surface water from the CBP to replace declining groundwater supply currently used for irrigation in the Study Area. This surface water would be provided as part of the continued phased development of the CBP and would come from existing surface water rights in the Columbia River system.

The Study is evaluating alternatives to replace groundwater supply with surface water to irrigate existing groundwater-irrigated acres. Reclamation can only deliver water to lands authorized to receive CBP water. As such, approximately 102,600 groundwater-irrigated acres in the Study Area are eligible to receive CBP surface water.

1.3. Authority

The Grand Coulee Dam Project was authorized for construction by the Act of August 30, 1935, and reauthorized and renamed in the Columbia Basin Project Act of March 10, 1943. Congress authorized the CBP to irrigate a total of 1,029,000 acres.

The 1943 Columbia Basin Project Act subjected the CBP to the requirements of the Reclamation Project Act of 1939. Section 9(a) of the Act of 1939 gave authority to the Secretary of the Interior (Secretary) to approve a finding of feasibility and thereby authorize construction of a project upon submitting a report to the President and the Congress. The Secretary approved a plan of development for the Columbia Basin Project (Reclamation, 1944), which was then transmitted as a joint report known as House Document No. 172[1] to the President and to the House Irrigation and Reclamation Committee in 1945, thereby satisfying these requirements (referred to in this document as "1945 feasibility report"). The Odessa Subarea Special Study is conducted under the authority of this Act, as amended, and the Reclamation Act of 1939.

Acting for the Secretary, Reclamation is authorized to implement additional development phases of the CBP as long as the Secretary finds it to be economically justified and financially feasible. In response to the public's concern about the declining groundwater supply in areas of the CBP and associated economic and other effects, Congress funded Reclamation to investigate the problem. The State is partnering with Reclamation by providing substantial funding and collaborating on interagency relationships, public outreach, and various technical studies.

Following the signing of the Columbia River Initiative Memorandum of Understanding (MOU), the State legislature passed the Columbia River Water Resource Management

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[1] When the Secretary recommended a project to Congress, the feasibility report and Reclamation's Regional Director's report were customarily printed as a House Document.

Act (Management Act; Engrossed Substitute House Bill [ESHB] 2860) in February 2006. The Management Act directs Ecology to aggressively pursue development of water benefiting both instream and out-of-stream uses through storage, conservation, and voluntary regional water management agreements (VRAs). Among the activities identified in the legislation, Ecology is directed to focus on “development of alternatives to groundwater for agricultural users in the Odessa subarea aquifer.” The Management Act also created a Columbia River Basin development account. Ecology’s participation in this Special Study is part of that program.

Ecology has been further directed by the Washington State Legislature to aggressively pursue new water supplies for instream and out-of-stream use. The Odessa Subarea is a high priority for the State, as it occurs first on the list of projects in the legislation concerning the allocation and development of water supplies (RCW 90.90.020, *Allocation and Development of Water Supplies*). In addition, Ecology is participating in this Special Study to provide support for State and local agency permitting decisions that will likely be necessary to implement a water delivery project.

Chapter 2: Need for Action

This chapter defines the problems, needs, and opportunities for plan formulation. The potential for alleviating problems and opportunities was determined during inventorying and forecasting water and related land resource conditions.

2.1. Problems and Opportunities

The Study is needed to evaluate and implement actions to avoid significant economic loss, in the near term, to the region's agricultural sector because of resource conditions associated with continued decline of groundwater supply in the Odessa Subarea.

2.1.1 Address Declining Groundwater Supply for Agriculture and Other Uses

Groundwater in the Odessa Subarea is currently being depleted to such an extent that water must be pumped from great depths. Most of the groundwater wells in the area are currently drilled to a depth of 800 to 1,000 feet, with maximum well depths as great as 2,100 feet. In addition, the groundwater level in wells continues to decline steadily. In nearly half of the production wells in the Odessa Subarea, groundwater levels have dropped by more than 100 feet and as much as 200 feet since 1981.

A continuous declining trend in measurements of groundwater levels, as shown in Figure 2- 1 by graphs of three representative wells of up to 180 feet over the past 30 years (with best available data). While not all wells have shown declines, the overall area of decline has spread and deepened over the past 30 years as wells have been drilled deeper. Public concern about the declining aquifers and associated economic and other effects has resulted in funding for Reclamation by Congress and funding for Washington State by the State legislature to investigate the problem. Figure 2- 2 shows a map of these declines.

Pumping water from such great depths has resulted in water quality concerns such as high water temperatures and sodium concentrations and has also resulted in expensive power costs. As a result of this groundwater decline, the ability of farmers to irrigate their crops is at risk. Domestic, commercial, municipal and industrial (M&I) uses, as well as water quality, are also affected. Those irrigating with wells, even of shallower depths, live with uncertainty about future well production. In the near term, the pumping efficiency of—and groundwater output from—production wells in the Odessa Subarea will continue to steadily decrease.

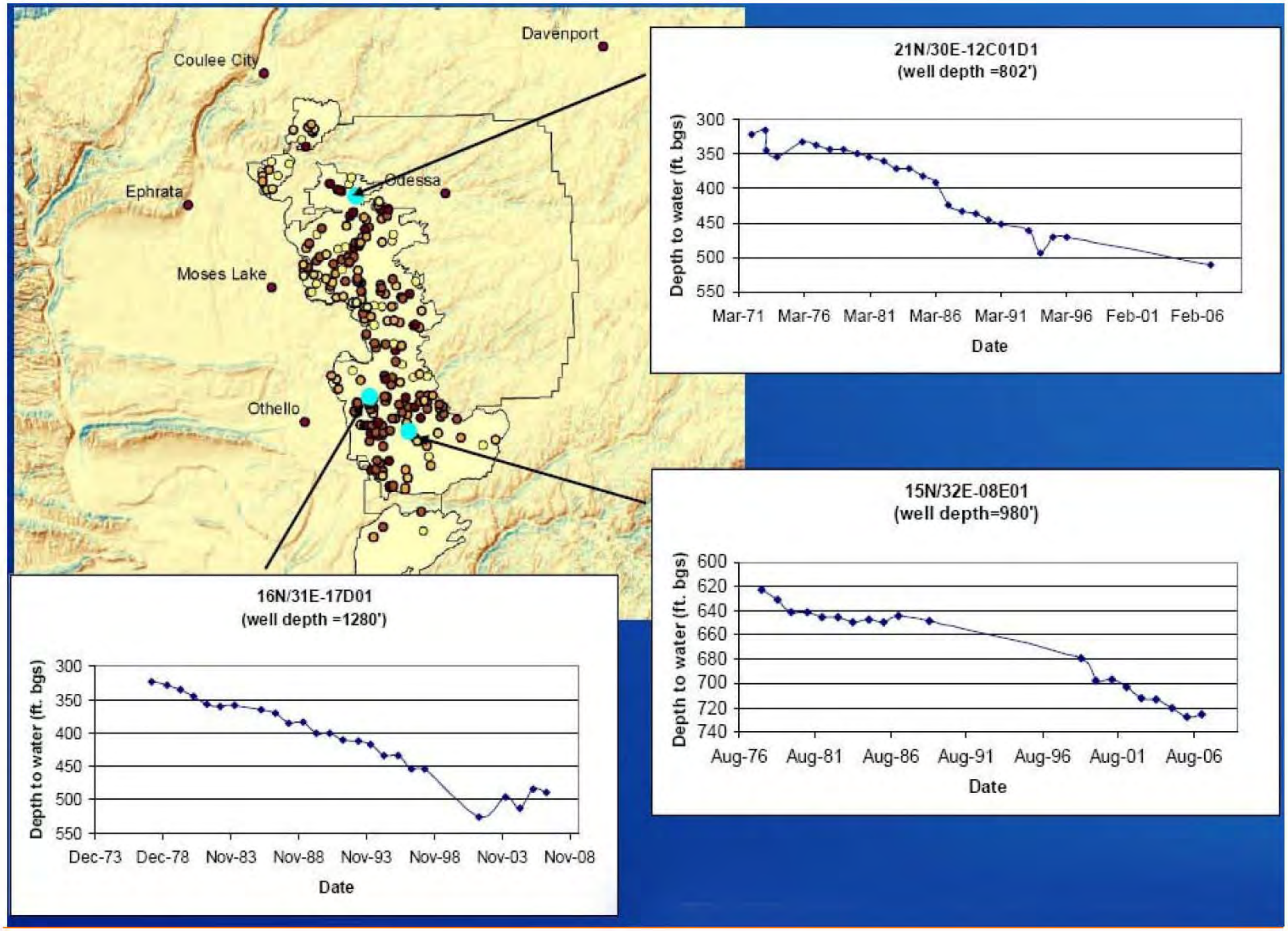

Figure 2- 1. Declining trend in measurements of groundwater levels in three example wells with best available data (Reclamation 2008 Appraisal)

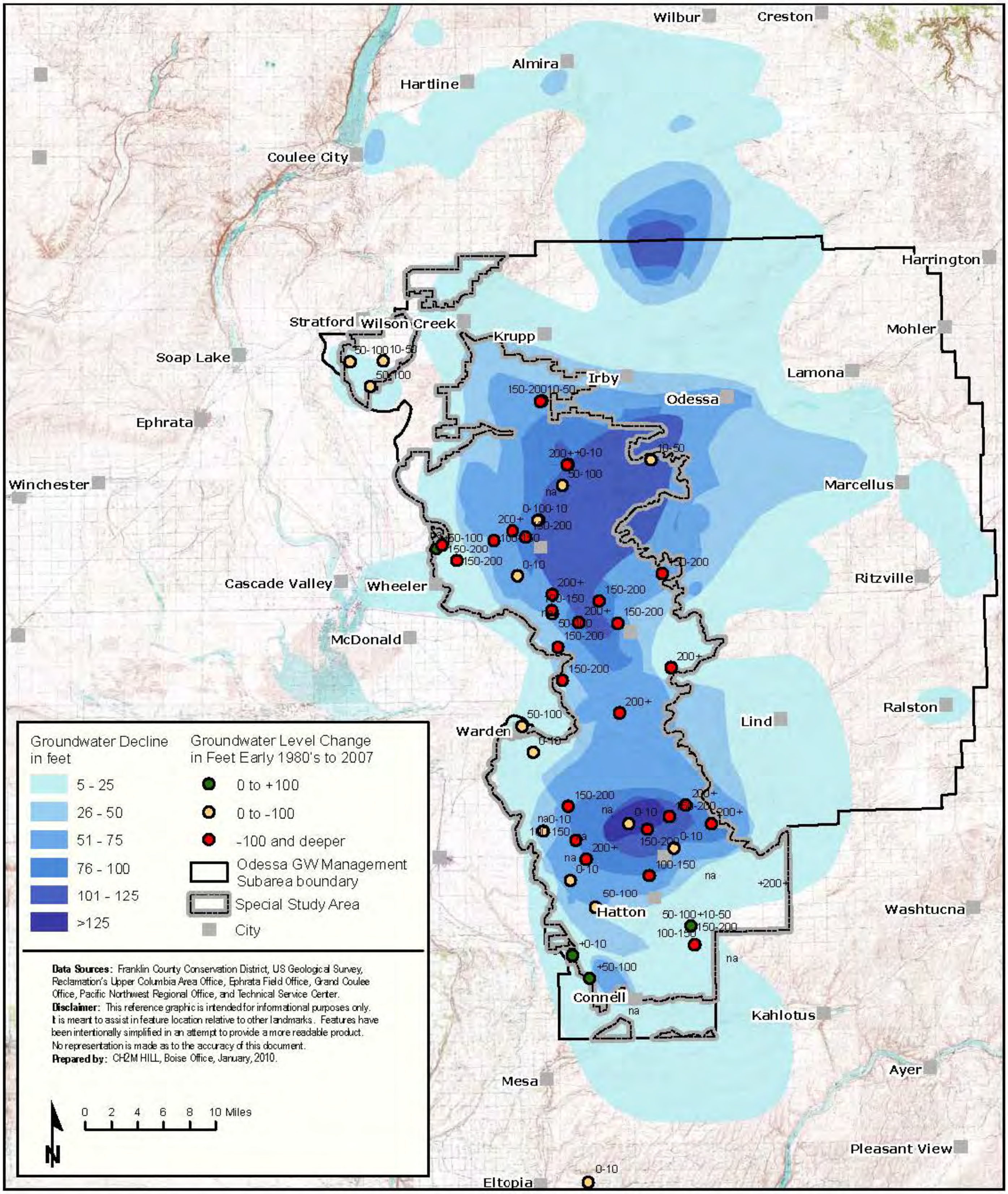

Figure 2- 2. Groundwater-level decline in aquifers of the Odessa Subarea (1981-2007)

Based on current trends, it is estimated that declining conditions will result in failure of the groundwater supply for most currently groundwater-irrigated lands in the Study Area as soon as 10-26 years (Reclamation 2012 Groundwater).

2.1.1.1. Irrigation Uses

The Columbia Basin Ground Water Management Area (GWMA) estimated that about 600 groundwater wells for irrigation exist in the Study Area. These wells have been classified into five levels that rank the wells from most dependable to least dependable. Level 1 (approximately 5 percent of all wells) and Level 2 wells (approximately 30 percent of all wells) are suitable for meeting the irrigation requirements of high water-use crops such as potatoes for an entire irrigation season. Level 3 and Level 4 wells (together, approximately 60 percent of all wells) may be able to meet irrigation requirements for part of the year, but would not be able to meet the irrigation requirements for high-water-use crops for an entire irrigation season. Level 5 wells (approximately 5 percent of all wells) are assumed to have been abandoned. Acres previously irrigated with these wells typically go into a dryland wheat rotation (GWMA, 2010 [Conditions]).

The Level 2, 3, and 4 wells in the Study Area have been declining in dependability over time. Aquifer levels have been dropping and farmers have been forced to deepen wells in order to sustain irrigated crop practices. These groundwater wells are expected to continue declining in dependability into the future, and farmers would progressively discontinue pumping altogether due to pumping costs and water quality concerns.

2.1.1.2. Municipal, Industrial, and Domestic Uses

Groundwater wells are also used to support municipal, industrial, and domestic uses in the Study Area. More than 80 percent of the public and domestic drinking water in the mid-Columbia Basin comes from groundwater. Similar to irrigation wells, the wells for municipal, industrial, and domestic uses are also at risk from dropping aquifer levels. For example, based on historical groundwater level data, water levels in some of the municipal and industrial wells have declined more than 100 feet in the past 30 years.

The municipalities in the area that use groundwater for public supply include Moses Lake, Warden, Othello, Ritzville, Connell, Odessa, Lind, Hatton, and Wilson Creek. According to the Ecology database of well logs <http://apps.ecy.wa.gov/welllog/>, there are a total of 18 wells in the Study Area that serve these municipalities (Ecology, 2010). These municipal wells range from about 700 to 1,000 feet in depth, and have yields ranging from 400 to 2,000 gallons per minute (gpm). Industrial users of groundwater in the Study Area include primarily food processing plants to produce frozen foods such as potatoes and beans. These facilities are located primarily in Othello, Warden, and Moses Lake. The Ecology database of well logs includes 19 wells in the Study Area that serve these industrial users. The wells used by these facilities range in size and depth, and are based on the water needs of the facilities. The wells range in depth from 100 to more than 1,000 feet. Several of the smaller wells produce around 100 gpm, but the larger, deeper wells produce up to 2,000 gpm.

Several hundred domestic wells have been drilled in the Study Area and are used for household water supply. These wells are typically completed in either the overburden sediments or the Wanapum Basalt unit, and are usually less than about 400 feet deep. As with the larger wells for irrigation, municipal, and industrial uses, the shallow domestic wells are also experiencing declining water levels in some areas. In these domestic wells, the shallow groundwater seeps downward through fractures and open boreholes into the declining deeper aquifers.

2.1.2 Address Declining Groundwater Supply for Agriculture and other Uses

Groundwater in the Odessa Subarea is currently being depleted to such an extent that water must be pumped from great depths. Most of the groundwater wells in the area currently are drilled to a depth of 800 to 1,000 feet, with maximum well depths as great as 2,100 feet. In addition, the groundwater level in wells continues to decline steadily. In nearly half of the production wells in the Odessa Subarea, groundwater levels have dropped by more than 100 feet and some by as much as 200 feet since 1981 (Figure 2- 2).[2] To date, some wells in the Study Area have been reported out of production, and the solution has generally been to drill a deeper well. However, studies show that deeper water may not be available, may be potentially unusable, and/or be too expensive to access in the future. As a result of this groundwater decline, the ability of farmers to irrigate their crops is at risk.

Those irrigating with wells, even of shallower depth, live with uncertainty about future well production. In the near term, the output from these wells in the Odessa Subarea will continue to decrease. If no action is taken, it is estimated that at the current rates of decline, about 55 percent of the wells in the Odessa Subarea would cease production by 2020.

2.1.3 Avoid Significant Economic Loss

Washington State University conducted a regional economic impact study assessing the effects of lost potato production and processing in Adams, Franklin, Grant, and Lincoln counties from continued groundwater decline. Assuming that all potato production and processing is lost from the region, the analysis estimated the regional economic impact would be a loss of about $630 million dollars annually in regional sales, a loss of 3,600 jobs, and a loss of $211 million in regional income (Bhattacharjee and Holland, 2005).

Since initiation of the Study, additional economic studies have been conducted that convey differing results. Depending upon the study assumptions, geographic scope, and sectors of

[2] The wells depicted in Figure 2-2 are only a subset of the total wells present in the Odessa Subarea. As explained further in Section 3.3 - *Groundwater Resources*, the wells shown are those from Ecology's database that have a reliable and consistent long-term record of water level measurements.

the economy included in each analysis, the level of projected economic impact varies. These studies capture a range of perspectives on economic impact and are described in Chapter 5.

2.2. Study Constraints

Legal influences, regulations, authorities, the goals and missions of all participants and the overall purpose of the action must be considered in the planning process. Operational requirements at Grand Coulee Dam and Lake Roosevelt that affect the timing of water withdrawals are constraints in this study and discussed in this section.

2.2.1 NMFS 2008/2010 FCRPS Biological Opinion

The Federal Columbia River Power System (FCRPS), as it relates to the *Supplemental Consultation on Remand for Operation of the Federal Columbia River Power System (FCRPS), 11 Bureau of Reclamation Projects in the Columbia Basin and ESA Section 10(a)(1)(A) Permit for Juvenile Fish Transportation Program* (NMFS 2008/2010) (2008/2010 BiOp), is comprised of 14 multipurpose hydropower projects on the mainstem Columbia and lower Snake rivers and other major tributaries.[3] Collectively, they provide about 30 percent of the electricity used in the Pacific Northwest. Reclamation and the U.S. Army Corps of Engineers (Corps) own and operate the dams in the FCRPS.

The Corps, BPA, and Reclamation (collectively known as the Action Agencies) operate the FCRPS in accordance with the NMFS 2008/2010 Biological Opinion on the Operations and Maintenance of the Federal Columbia River Power System (2008/2010 FCRPS BiOp). The BiOp affects the timing and amount of water that is available for the Odessa Subarea through operational constraints at Grand Coulee Dam and Lake Roosevelt. In addition, the Columbia River Fish Accords, a series of agreements among the Action Agencies, several Columbia River Tribes, and the States of Idaho, Montana, and Washington, also affect operations of the FCRPS.

Table 2- 1 lists some of the constraints under the BiOp and goals under the Fish Accords that are particularly applicable to the Proposed Action. Future operations of the any selected action alternatives for the Odessa Subarea Special Study as a component of the CBP would be addressed in future FCRPS consultations.

[3] Whenever a Federal action may adversely affect listed species, the ESA requires that the action agency (the Corps, BPA, and Reclamation) formally consult with a consulting agency (in this case, NMFS) that evaluates the effects of the proposed action on the listed species. The evaluation is contained in a biological opinion.

Table 2- 1. Measures and constraints under the NMFS 2008/2010 BiOp

Agreement	Summary Description	Constraints on Odessa Study
Reasonable and Prudent Actions* (RPA)	Summarizes storage project operations for all types of water years. CBP operations at Grand Coulee Dam and Lake Roosevelt include drafting the reservoir to support salmon flow objectives during July and August with a variable draft limit of elevation 1278 to 1280 feet by August 31, based on the water supply forecast. Currently, the lower draft of elevation 1278 feet is to be limited to those years when the April-to-August runoff volume is less than 92 MAF (approximately 50 percent of the years of record) (Graves et al. 2007). This element of reasonable and prudent alternative Action 4 is subject to future evaluation and modeling (NMFS 2008/2010). Grand Coulee Dam and Lake Roosevelt will be operated to support salmon flow objectives during the spring as well. By operating to achieve an 85% probability of being at the April 10 Upper Rule Curve, it maximizes the water released from the project from April 10 through June.	Numerous other operations at Lake Roosevelt designed to benefit flow management for listed species: • Operate to achieve an 85% probability of being at the April 10 Upper Rule Curve. • Refill to elevation 1290 feet by about June 30. • May be used to help meet tailwater elevations below Bonneville Dam to support chum spawning and incubation. • Lake Roosevelt may be operated to help support flows for Priest Rapids. • Draft to elevation 1,280 or 1278 by the end of August (dependent on water supply forecast) to support flows in the lower river for juvenile fish migration • Draft up to an additional 1 to 1.8 feet by the end of August for the Lake Roosevelt Incremental Storage Releases Project. • Pumping into Banks Lake is reduced in August, resulting in a 5-foot drawdown to elevation 1565 feet by the end of the month. This leaves more water in the Columbia River during summer juvenile salmon migration.
Columbia Basin Fish Accords	On May 2, 2008, several MOAs, referred to as the Columbia Basin Fish Accords, were signed by the action agencies (Reclamation, Corps, and BPA) and the following:	The goal of these agreements is to acknowledge the substantive role of Tribes and States as managers of the fish resource, provide greater long-term certainty for fish

Table 2- 1. Measures and constraints under the NMFS 2008/2010 BiOp

Agreement	Summary Description	Constraints on Odessa Study
	• The Confederated Tribes of the Colville Reservation • Three of the Treaty Tribes (Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes of Warm Springs Reservation of Oregon, Confederated Tribes and Bands of the Yakama Nation) and the Columbia River Inter-Tribal Fish Commission • The State of Idaho • The State of Montana • An MOA was signed between the action agencies and the Shoshone-Bannock Tribes on November 7, 2008. • An MOA for Estuary Habitat was signed between the action agencies and the State of Washington on September 16, 2009.	restoration funding, support and enhance the actions contemplated in the NMFS BiOps for listed salmon and steelhead and improve their prospects for recovery, foster a partnership toward a mutual goal of protecting and recovering fish and wildlife, and provide for the parties to work together to assure the agencies' responsibilities under the ESA, Northwest Power Act, and Clean Water Act are satisfied. Additional MOAs are under negotiation between other Northwest Tribes.

*RPAs are from the 2008/2010 FCRPS BiOp (NMFS 2008/2010)

2.2.2 Columbia River Regulation

The construction and operation of dams and reservoirs on the river's mainstem and tributary streams, as well as system operations, have significantly impacted the annual flow patterns (hydrograph) of the Columbia River. Regulation of the system through the use of dams has compressed the river's annual discharge patterns as original high-season flows have decreased and low-season flows have increased.

Lake Roosevelt fluctuates seasonally and daily in response to a complex set of demands from irrigation and flood control to fish flows and hydropower. Within these constraints, Reclamation also strives to support recreational use by minimizing drawdowns during the recreation season. Figure 2- 3 illustrates historical drawdown in Lake Roosevelt. The deep drawdowns shown in 1969 and 1974 are due to construction of the third powerplant associated with the Grand Coulee Powerplant Complex.

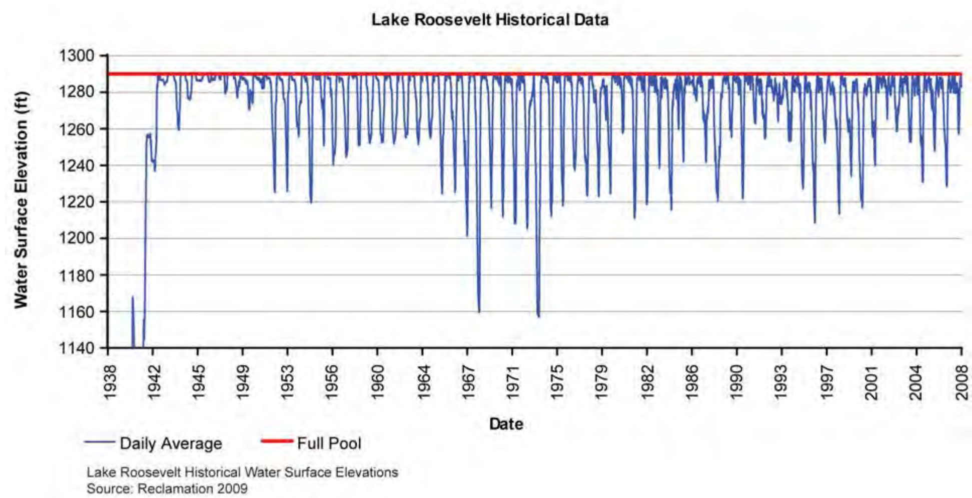

Figure 2- 3. Lake Roosevelt historical water surface elevations (source: Reclamation, 2009)

Similarly, Banks Lake operates within established constraints to meet water delivery contractual obligations, ensure public safety, and protect property, while striving to allow for recreational use (see Figure 2- 4). Banks Lake drawdowns generally begin approximately August 1. The irrigation season typically extends from mid-March through October. Since 2000, the reservoir has been drawn down 5 feet (to elevation 1,565 feet above mean sea level (amsl) to provide fish flow augmentation in the Columbia River through reduced pumping from the river. Larger drawdowns typically correspond with maintenance or weed control efforts.

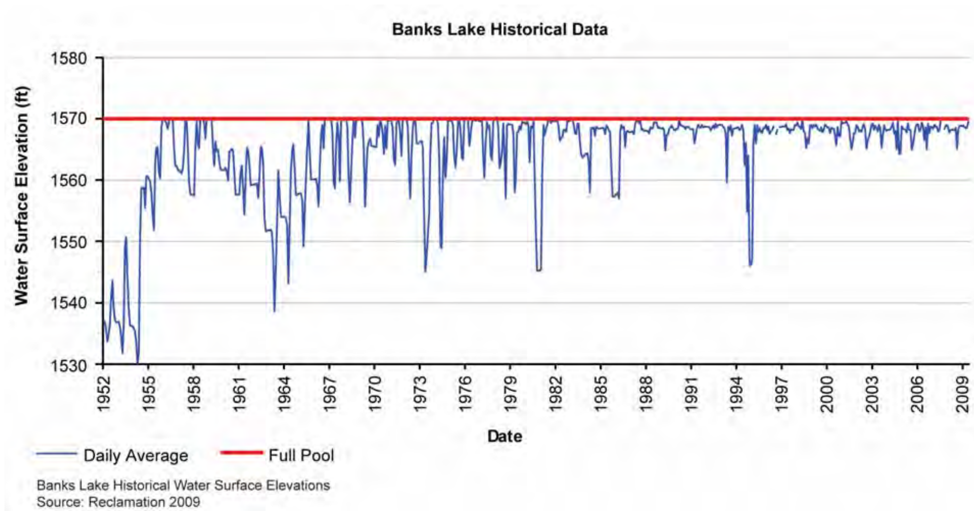

Figure 2- 4. Banks Lake historical water surface elevations (source: Reclamation, 2009)

Reclamation will need to divert more water from the Columbia River than current CBP diversions to provide a replacement water supply for the action alternatives. Table 2- 2 lists the acres to be served and the additional water needed. See Section 4.2.2 for information on hydrologic modeling.

Table 2- 2. Groundwater replacement range considered in this Special Study Report and associated surface water diversion

Groundwater Replacement Range	Groundwater Acres to be Replaced with Surface Water	Additional CBP Surface Water Diversion Needed (acre-feet)
Partial Replacement (based on enlarging and extending the East Low Canal system south of Interstate-90)	Approximately 57,000	138,000
Full Replacement (based on enlarging and extending the East Low Canal system south of Interstate-90 (I-90), and constructing a new East High canal system north of I-90)	Approximately 102,600	273,000
Modified Partial Replacement (based on enlarging the East Low Canal system south of I-90 to serve lands both north and south of I-90)	Approximately 70,000	164,000

Chapter 3: Plan Formulation

This chapter discusses the project background and subarea to demonstrate that the alternatives for the Odessa Subarea Special Study were developed in a systematic manner to ensure that all reasonable alternatives are evaluated via processes that conform to the P&Gs.

3.1. Background/Previous Investigations

The first half of CBP lands were developed primarily in the 1950s and 1960s, with some acres added until 1985. The 1945 feasibility report (Reclamation, 1944) anticipated a 70-year period of incremental development to complete the CBP to irrigate a total of 1,029,000 acres. It was anticipated that further incremental development of the CBP would depend on future needs and any irrigation of additional lands would use water from the Columbia River already reserved for the CBP.

To date, about 671,000 acres in the CBP have been developed. Prior studies examined the merits of continuing the incremental development of irrigated acreage in the CBP. However, for various reasons, additional development has not yet occurred. The State issued irrigation groundwater permits in the 1960s and 1970s in the Odessa Subarea as a temporary measure to provide irrigation water to these lands until the CBP was further developed. Local constituents have advocated that Reclamation investigate CBP development to replace groundwater with CBP water as a possible solution for issues associated with the declining aquifer.

Reclamation formally initiated the environmental process to consider the continued, orderly development of the CBP when it published a Notice of Intent to Prepare an EIS in the *Federal Register* in December 1983. A *Draft Environmental Impact Statement—Continued Development of the Columbia Basin Project, Washington (*Reclamation, 1989) was prepared.

The alternatives considered ranged from full development of the second half of the Project to a phased approach. Besides a No Action Alternative, two alternatives for continued development were analyzed and discussed:

- Complete the CBP as originally envisioned by providing irrigation service to an additional 538,600 acres; and
- Expand the CBP on a more limited scale by providing irrigation service to approximately 87,000 acres along the east bank of the East Low Canal.

In addition, a *Supplement to the Draft Environmental Impact Statement—Continued Development of the Columbia Basin Project, Washington* (Reclamation, 1993) was prepared to examine new information or analyze issues in more detail, including an anadromous fish plan, a fish and wildlife plan, and water withdrawal effects to Lake Roosevelt. The preferred alternative was to provide Project water to 87,000 acres near or adjacent to the East Low Canal within the East Columbia Basin Irrigation District (ECBID) and the South Columbia Basin Irrigation District (SCBID). Of these lands, 41 percent (35,700 acres) were lands currently irrigated using groundwater or with interruptible service and 59 percent (51,300 acres) were dryland farmed. Numerous reports and documents supporting the technical studies and economic analyses were also prepared. Because of the ESA and the decline in salmon stocks, both Reclamation and Ecology put a moratorium on any additional withdrawals from the Columbia River in June 1993. Therefore, the Continued Development Study was suspended and, in 1994, Reclamation placed this Study on hold. Around the same time, Reclamation placed a self-imposed moratorium on additional water withdrawals from the Columbia River because it was purchasing and leasing Snake River water to augment Snake and Columbia River flows to aid migrating anadromous fish. Reclamation lifted the moratorium in 2003 after a biological opinion addressing operations of the Federal Columbia River Power System, which includes the CBP, was issued.

Prior Reclamation investigations and activities in the CBP and their relationship to the Study and Final EIS are discussed below.

- Draft EIS Continued Phased Development (1989) – The Draft EIS (Reclamation 1989) described the potential beneficial and adverse impacts of the proposed continued development of the CBP. Two alternatives for continued development were analyzed and discussed: (1) complete the CBP as originally envisioned by providing irrigation service to an additional 538,600 acres, and (2) expand the CBP on a more limited scale by providing irrigation service to approximately 87,000 acres along the east bank of the East Low Canal.

- Supplemental Draft EIS (Fish Enhancement) (1993) – A Supplemental Draft EIS (Reclamation 1993 Supplement) was completed in September 1993 that mainly addressed fish and wildlife issues. Because of the ESA and the decline in salmon stocks, both Reclamation and Ecology put a moratorium on any additional withdrawals from the Columbia River in June 1993; therefore, the Continued Development Study suspended.

- Banks Lake Resource Management Plan (RMP) (2001) (Reclamation 2001) – The Banks Lake RMP was developed in response to the growing demand for recreational opportunities and visitor facilities while balancing resource protection and conservation objectives. The plan is designed to conserve, protect, and manage land and water resources under Reclamation's jurisdiction. Management guidance for Banks Lake determines, in part, the types of mitigation measures anticipated for Recreation Resources (see Section 4.14, Recreation, in the Odessa Final EIS.

- Banks Lake Drawdown EIS (2004) – The Final EIS (Reclamation 2004) describes and analyzes the environmental effects of drafting the reservoir an additional 5 feet for flow augmentation beyond elevation 1565 feet by the end of August. It compared the benefit to anadromous fish against the impacts on biological and recreation resources at Banks Lake.

3.2. Public and Agency Participation

To be responsive to State and local concerns, Reclamation contacted State agencies before initiating studies and provided opportunities for State, local, and public participation. Formulating alternatives that are responsive to the needs and desires of the American public requires direct public participation. Reclamation established a coordinated public participation program with willing agencies and groups and pursued public participation. Several agencies, entities, organizations, and groups participated in the Study. The degree of participation ranged from providing viewpoints and general observations to direct contributions to plan formulation. Specific input into the plan formulation is discussed in Section 3.3, Alternatives Formulation. The following paragraphs identify agencies and their contributions.

Washington State, Reclamation, and the CBP irrigation districts signed the Columbia River Initiative MOU in December 2004, to promote a cooperative process for implementing activities to improve Columbia River water management and water management within the CBP. The Odessa Subarea Special Study implements Section 15 of the MOU, which states, in part, "The parties will cooperate to explore opportunities for delivery of water to additional existing agricultural lands within the Odessa Subarea." The State provided a cost-share through an Intergovernmental Agreement between Ecology and Reclamation in December 2005 to fund this Study. Congress provided funding to Reclamation beginning in fiscal year 2005 to investigate opportunities to provide CBP water to replace groundwater use in the Odessa Subarea.

BPA, a cooperating agency in the preparation of the Odessa Final EIS, provided the basis for the energy analysis for the Study. BPA evaluated and summarized the regional supply and demand for energy in the Pacific Northwest in an annual 10-year forecast document called the *Pacific Northwest Loads and Resources Study* (commonly called the White Book) (BPA, 2011).

GWMA interviewed well operators in the Odessa Subarea for the Study concerning the current status of well use and performance from September to December 2009 (GWMA, 2010 [Conditions]). In January 2010, GWMA (2010 [Survey]) conducted an additional survey asking well operators in the Odessa Subarea to characterize the current status of their wells relative to the five status levels. In addition, GWMA provided groundwater data and cost estimates relevant to municipalities in the Odessa Subarea for the Study.

Reclamation contacted and solicited participation of other Federal, State, and local agencies; Tribes; national, regional and local groups; other affected groups; and individuals. Table 3- 1 lists legal requirements for consultation and/or actions taken to date. If an action alternative is selected for implementation, consultation will be completed prior to seeking construction authorization.

Table 3- 1. Consultation with/participation by other agencies and Tribes

Agency	Legal Requirements and Actions
NMFS	Section 7(a)(2) of the ESA requires Federal agencies to consult with NMFS when a Federal action may affect a listed marine and anadromous endangered or threatened species or its critical habitat. Reclamation obtained a listing of the threatened and endangered species that reside within the Study Area from the NMFS website.
State Historic Preservation Officer	The National Historic Preservation Act of 1966, as amended in 1992, requires that Federal agencies consider the effects that their projects have on historic properties.
U.S. Army Corps of Engineers (Corps)	Reclamation has ongoing coordination activities with the Corps in conjunction with their interests and responsibilities for wetlands. Reclamation will apply to the Corps or petition them for an exemption under Section 404 of the Clean Water Act.
U.S. Department of Agriculture	The Farmland Protection Policy Act of 1981 is intended to minimize the impact Federal programs have on the unnecessary and irreversible conversion of farmland to nonagricultural uses. The project does not change the use of land from farmland to an agricultural noncompatible use. Special siting of delivery pipes, canals, pumping facilities, and reservoirs were designed to limit impacts to on-farm improvements and protected soils.
U.S. Fish and Wildlife Service (Service)	Section 7 (a)(2) of the ESA (16 U.S.C. Section 1536), requires all Federal agencies to consult with the Service when a Federal action may affect a listed freshwater and/or threatened or endangered wildlife species or its critical habitat. The Fish and Wildlife Coordination Act (16 United States Code 661-667e, as amended) requires Federal agencies to coordinate with the Service when planning a new project or modifying existing projects so that wildlife resources receive equal consideration and are coordinated with other project objectives and features. The recommendations (Section IV) are contained in the U.S. Fish and Wildlife Service Coordination Act Report, which is available online at http://www.usbr.gov/pn/programs/ucao_misc/odessa.

Table 3- 1. Consultation with/participation by other agencies and Tribes

Washington Department of Fish and Wildlife (WDFW)	WDFW has conducted a series of biological studies to determine the effects of the Odessa action alternatives on wildlife throughout the analysis area and on the fishery in Banks Lake.
Tribal Consultation and Coordination	Executive Order 13175 establishes "regular and meaningful consultation and collaboration with Tribal officials in the development of Federal policies that have Tribal implications, to strengthen the United States Government-to-Government relationships with Indian Tribes, and to reduce the imposition of unfunded mandates upon Indian Tribes." Consultation between Reclamation and the Spokane Tribe of Indians, the Yakama Nation, the Confederated Tribes of the Colville Reservation, and the Confederated Tribes of the Umatilla Indian Reservation is ongoing. This consultation encompasses coordination related to all relevant laws, regulations, and Executive orders described in this chapter.
Agency	**Participation by Other Agencies**
Natural Resource Conservation Service (NRCS)	Originally established by Congress in 1935 as the Soil Conservation Service, NRCS has expanded to become a conservation leader for all natural resources, ensuring private lands are conserved, restored, and more resilient to environmental challenges, like climate change.
East Columbia Basin Irrigation District	The East Columbia Basin Irrigation District is a nonprofit quasi-municipality located in north central Washington State that operates and maintains a portion of the Columbia Basin Irrigation Project. The primary function of the Irrigation District is to deliver irrigation water to farm land located in the Columbia River Basin.
South Columbia Basin Irrigation District	The South Columbia Basin Irrigation District is a nonprofit quasi-municipality located in North Central Washington State that operates and maintains a portion of the Columbia Basin Irrigation Project. The primary function of the Irrigation District is to deliver irrigation water to farm land located in the Columbia River Basin.
Quincy Columbia Basin Irrigation District (QCBID)	The Quincy-Columbia Basin Irrigation District is a nonprofit quasi-municipality located in North Central Washington State that operates and maintains a portion of the Columbia Basin Irrigation Project. The primary function of the Irrigation District is to deliver irrigation water to farm land located in the Columbia River Basin.
Groundwater Management Area (GWMA)	The Columbia Basin Ground Water Management Area, or GWMA, is a grassroots, proactive, voluntary, local planning effort intended to lessen the need for mandated control measures through the creation of a groundwater management plan to reduce nitrate levels in the groundwater of the GWMA.
Washington State Water Resources Association	Washington State Water Resources Association is the coordinating agency for the irrigation districts in Washington State. The association has 35 irrigation district members, covering 1.1 million irrigation agricultural acres. The association is active in State and Federal water policy and legislative issues and affiliated with National Water Resources Association.

Table 3- 1. Consultation with/participation by other agencies and Tribes

Washington State Department of Health (DOH)	The DOH works with its Federal, state and local partners to help people in Washington stay healthier and safer. DOH programs and services help prevent illness and injury, promote healthy places to live and work, provide education to help people make good health decisions and ensure that the State is prepared for emergencies.
Washington State Potato Commission	The mission of the Washington State Potato Commission is to serve the potato growers of Washington State by facilitating the awareness and value of Washington State potatoes. The main functions of the Commission are to enhance trade opportunities, to advance environmentally sound production and cultural practices through research, and to represent the growers' interests in areas and issue relating to education, trade barriers, irrigation, transportation, and crop protection.

3.2.1 Appraisal-Level Public Participation

During the appraisal-level investigation, Reclamation held public information meetings and distributed mailings in October and November 2007 to individuals on its mailing list to present information and request comments. Reclamation received 84 written comments from State agencies; environmental, conservation, and nongovernmental organizations; State residents; and representatives for agriculture and recreation interests. Table 3- 2 lists meetings with publics and stakeholder groups.

Table 3- 2. Meetings held with interested parties during the appraisal-level investigation

Date of Meeting	Meeting With	Location
February 22, 2006	Public	Big Bend Community College, Moses Lake, Washington
October 11, 2006	Public	Big Bend Community College, Moses Lake, Washington
June 6, 2007	Columbia River Policy Advisory Group	Yakima, Washington
October 4, 2007	Colville Business Council, Colville River Water Management Program	Omak, Washington
October 23, 2007	Public	Big Bend Community College, Moses Lake, Washington
November 15, 2007	Washington Department of Fish and Wildlife	Ephrata, Washington
December 4, 2007	Confederated Tribes of the Colville Reservation	Nespelem, Washington

Many noted that partial development, which would rely on the existing CBP canal system, could not deliver a replacement water supply to sufficient acres to address the issues associated with the declining aquifer and would not be able to deliver water to lands south of I-90, an area where significant aquifer decline is occurring. Many suggested that Reclamation examine less expensive alternatives such as water conservation, water measurement, water markets, conversion to dryland farming, and reconstruction of wells, given the significant economic costs associated with constructing the water delivery alternatives. Others noted that construction costs were not significant when considering the current economic benefits of sustaining current agricultural production in the Odessa Subarea.

Most of the comments that were received opposed construction of a Lower Crab Creek reservoir because of concerns about possible impacts to fish, wildlife, recreation, infrastructure, and private property. Many advocated modifying operations at existing CBP reservoirs as the best approach to provide a replacement water supply because it would be more cost effective and would result in fewer environmental issues than constructing new dams and reservoirs.

3.2.2 Feasibility-Level and Odessa Draft EIS Public Participation

In addition to providing information to the public regarding the Study and EIS, Reclamation and Ecology also solicited responses regarding the public's needs, values, and evaluations of the proposed alternatives. Both formal and informal input has been encouraged and used in plan formulation.

3.2.2.1. Scoping Process

The public scoping process in support of the plan formulation was conducted in August and September 2008. The purpose of scoping includes:

- Identifying the significant issues relevant to the proposed action,
- Identifying those elements of the environment that could be affected by the proposed action,
- Formulating alternatives for the proposed action, and
- Determining the environmental documents to be prepared.

The scoping was conducted to seek comments and information from the public to identify potential issues related to planned Study actions and to help formulate the scope of the EIS analysis.

On August 21, 2008, a Federal Notice of Intent to Prepare an EIS and to conduct public scoping meetings was published in the *Federal Register*, Ecology issued a Determination of Significance and a request for comments on the scope of the EIS, and Reclamation sent an e-mail message to 190 mailing list recipients announcing that the Study Update was available on the Study Website, http://www.usbr.gov/pn/programs/ucao_misc/odessa/.

On August 25, 2008, Ecology provided notice of scheduled public scoping meetings to subscribers of its e-mail list for the Columbia River Basin Water Management Program. On August 26, 2008, Reclamation mailed copies of the Study Update, which included notification of the scoping process and meetings, to 243 mailing list recipients. Reclamation issued a news release to local media on September 2, 2008. On September 4, 2008, Ecology provided a reminder notice to subscribers of its e-mail lists, including those for the Management Program and the Reclamation Yakima River Basin Water Storage Feasibility Study. The Notice of Intent, Determination of Significance, news releases, and meeting notice are attached to the Scoping Summary Report (Reclamation, 2008 [Scoping]). The Scoping Summary Report is available upon request or can be accessed from the Odessa Subarea Special Study Web site: <http://www.usbr.gov/pn/programs/ucao_misc/odessa/>.

3.2.2.1.1 ***Public Scoping Meetings***

Reclamation and Ecology hosted two evening public scoping meetings, one at the Town of Coulee Dam Town Hall, Coulee Dam, Washington, on September 10, 2008, and one at the Advanced Technologies Education Center, Big Bend Community College, Moses Lake, Washington, on September 11, 2008. About 55 people attended the two scoping meetings. At the public meetings, Reclamation and Ecology presented the proposed alternatives and an overview of the National Environmental Policy Act (NEPA)/State Environmental Policy Act (SEPA) process, and provided opportunities for the public to identify issues and concerns associated with the Study.

3.2.2.1.2 ***Comments and Other Information Received from the Public***

In addition to comments received at the scoping meetings, written comments were accepted through September 19, 2008. Including those from the scoping meetings, 33 written comment documents were received. The documents included two requests to be added to the mailing list (no comments included) and one request to be removed from the mailing list for this Study. Substantive input ranged from brief comments or questions to detailed statements. Comments about how each of the resources should be analyzed led to the development of the indicators used to evaluate the effects of the alternatives on the resources. Many comments were quite broad and overlapped these categories.

Comments and questions focused on the following:

- **Facilities and Operation:** Effects of water withdrawal on Columbia River flows and reservoir operations; potential for water conservation measures and use of reclaimed water and conversion to dryland farming as alternatives; options for off-channel storage; hydropower losses because of additional water withdrawals; and use of a phased approach to implementation.

- **Natural Resources:** Effects of changes in Columbia River flows and reservoir operations on fish and wildlife, loss of wildlife habitat, and blockage of wildlife migration and local movements.
- **Recreation and Tourism:** Effects of changes in reservoir operations on recreation, tourism, and boater safety at Banks Lake.
- **Socioeconomics:** Exploration of various repayment options, preparing a thorough benefit-cost analysis, and exploring the economic effects of reduced tourism at Banks Lake.
- **Tribal Concerns and Environmental Justice:** Role of the Tribes in the project and Tribal influence; impacts on environmental justice.

3.2.3 Meetings Held with Interested Parties during the Special Study

Meetings held to provide information and answer questions about the Study, both prior to and during the NEPA/SEPA process, are listed in Table 3- 3.

Table 3- 3. Meetings held with interested parties during the Special Study

Date of Meeting	Meeting With	Location
March 1, 2008	Public	Coulee Corridor Big Event
March 26, 2008	Grand Coulee History and Columbia River Management Program	Coulee City, Washington
September 2, 2008	Ephrata Lions Club	Ephrata, Washington
September 10, 2008	Public Scoping Meeting	Coulee Dam, Washington
September 11, 2008	Public Scoping Meeting	Moses Lake, Washington
October 3, 2008	American Society of Farm Managers and Rural Appraisers	Moses Lake, Washington
October 7, 2008	Confederated Tribes of the Colville Reservation, Colville Indian Agency	Nespelem, Washington
October 28, 2008	WSU Tri-Cities ES/RP590 Class	Richland, Washington
November 6, 2008	Columbia Basin Development League	Moses Lake, Washington
January 22, 2009	Columbia Basin Crop Consultants Association	Ephrata, Washington
January 22, 2009	Columbia Basin Railroad	Yakima, Washington
February 12, 2009	Public	Coulee City Fire Hall, Coulee City, Washington
February 18, 2009	Columbia Basin Development League	Moses Lake, Washington
February 19, 2009	Columbia Basin Development League	Moses Lake, Washington

Table 3- 3. Meetings held with interested parties during the Special Study

Date of Meeting	Meeting With	Location
March 3, 2009	Employee Presentation Columbia River Management Program	Bureau of Reclamation Field Office, Ephrata, Washington
March 5, 2009	Columbia River Policy Advisory Group	Yakima, Washington
March 13, 2009	Lake Roosevelt Forum	Colville, Washington
March 16, 2009	Othello Rotary Club	Othello, Washington
March 18, 2009	Columbia Basin Development League	Moses Lake Fire Hall, Moses Lake, Washington
March 31, 2009	East Columbia Basin irrigation District	Ephrata, Washington
April 15, 2009	Columbia Basin Development League	Moses Lake, Washington
May 5, 2009	Audubon Society, Central Columbia Basin Chapter	Moses Lake, Washington
July 7, 2009	East Columbia Basin irrigation District	Bureau of Reclamation Field Office, Ephrata, Washington
September 2, 2009	East Columbia Basin irrigation District	Ephrata, Washington
July 10, 2009	U.S. Fish and Wildlife Service	Wenatchee, Washington
October 29, 2009	Columbia Basin Development League	Moses Lake, Washington
May 17, 2010	Washington Department of Fish and Wildlife	Ephrata, Washington
May 19, 2010	Columbia Basin Development League	Othello, Washington
June 16, 2010	Columbia Basin Development League	Moses Lake, Washington
June 29, 2010	U.S. and Washington Department of Fish and Wildlife	Yakima, Washington
July 15 & 16, 2010	U.S. and Washington Department of Fish and Wildlife	Yakima, Washington
August 10, 2010	CBP Irrigation Districts	Pasco, Washington
October 5, 2010	Colville Tribe	Nespelem, Washington
March 18, 2011	Spokane Tribe of Indians	Spokane, Washington
April 15, 2011	Confederated Tribes of the Colville Reservation	Yakima, Washington
April 29, 2011	Environmental Protection Agency	Telephone conference
May 18, 2011	Columbia Basin Irrigation Districts	Yakima, Washington
May 20, 2011	Confederated Tribes and Bands of the Yakama Nation	Yakima, Washington
May 22, 2011	Washington Department of Fish and Wildlife, U.S. Fish and Wildlife Service	Ephrata, Washington
June 23, 2011	Washington Department of Fish and Wildlife, U.S. Fish and Wildlife Service	Wenatchee, Washington
June 28, 2011	Columbia Basin Pumpers Group	Moses Lake, Washington

Table 3- 3. Meetings held with interested parties during the Special Study

Date of Meeting	Meeting With	Location
June 30, 2011	Columbia Basin Irrigation Districts	Ephrata, Washington
July 8, 2011	Washington Department of Fish and Wildlife, U.S. Fish and Wildlife Service	Wenatchee, Washington
August 16, 2011	Columbia Basin Irrigation Districts	Ephrata, Washington
August 30, 2011	Washington Department of Fish and Wildlife, U.S. Fish and Wildlife Service	Ephrata, Washington
September 22, 2011	Confederated Tribes of the Umatilla Indian Reservation	Pendleton, Oregon
September 29, 2011	Columbia River Policy Advisory Group	Ellensburg, Washington
October 18, 2011	Confederated Tribes of the Colville Reservation	Nespelem, Washington
October 24, 2011	Columbia Basin Pumpers Group	Moses Lake, Washington
October 27, 2011	Spokane Tribe of Indians	Wellpenit, Washington
November 1, 2011	Columbia Basin Development League	Moses Lake, Washington
January 11, 2012	Washington Department of Fish and Wildlife	Ephrata, Washington
February 6, 2012	Columbia Basin Pumpers Group	Moses Lake, Washington
February 10, 2012	Confederated Tribes of the Colville Reservation	Ephrata, Washington
May 16, 2012	Columbia River Policy Advisory Group	Ellensburg, Washington
June 7, 2012	McCain Foods	Othello, Washington
June 7, 2012	Columbia Basin Pumpers Group	Moses Lake, Washington
June 20, 2012	Washington Department of Fish and Wildlife	Yakima, Washington
July 3,2012	Washington Department of Fish and Wildlife, U.S. Fish and Wildlife Service	Wenatchee, Washington
July 26, 2012	Columbia River Policy Advisory Group	Ellensburg, Washington
August 7, 2012	Confederated Tribes of the Umatilla Indian Reservation	Mission, Oregon
August 16, 2012	Confederated Tribes of the Umatilla Indian Reservation	Mission, Oregon

3.3. Alternatives Formulation

3.3.1 Plan of Study

Reclamation began the Study in 2005. Reclamation provided the study background and purpose, described potential issues, outlined study steps and requirements, and identified required resources in the Odessa Subarea through the Odessa Plan of Study (Reclamation, 2006 [POS]) (POS).

3.3.2 Project Alternatives Solution Study

Reclamation completed a preappraisal-level investigation through the Project Alternative Solutions Study (PASS) in late in 2006. The investigation is documented in a report entitled, *Initial Alternative Development and Evaluation, Odessa Subarea Special Study* (Reclamation, 2006 [PASS]). The POS and the PASS provided the basis for the Odessa Special Study, and cover the same Study Area.

The Objectives Team and the Technical Team conducted the PASS together. The Objectives Team was comprised of various stakeholders in the Study area, including Federal and State agencies, local governments, Tribes, CBP irrigation districts, and groundwater irrigators. The Objectives Team developed study objectives that were used to rank alternative concepts.

The Technical Team was comprised of engineers, a hydrogeologist, a watermaster, irrigation district managers, and staff from Reclamation and Ecology. The Technical Team developed preliminary alternative concepts suggested by the public and examined in previous investigations, and ranked them using the study objectives developed by the Objectives Team. The Technical Team then recommended water delivery alternatives and water supply options for further study based on Study objectives. Table 3- 4 shows how these study objectives fall under the P&Gs' tests of viability. Alternatives that met the PASS study objectives would also meet these tests of viability:

- **Completeness** – The extent to which the alternative provides and accounts for all necessary investments and actions to implement the plan;
- **Effectiveness** – The extent to which the alternative alleviates the problems and accomplishes the objectives;
- **Efficiency** – The extent to which the alternative is cost effective in accomplishing the project objectives; and
- **Acceptability** – The workability and viability of the plan in terms of acceptance by Federal, State, and local governments and the public and compatibility with existing laws, regulations, and public policies.

Table 3- 4. Comparison of PASS study objectives with P&Gs' tests of viability

PASS Study Objectives	P&Gs' Tests of Viability
Retain the possibility of full CBP development in the future.	**Completeness –** The extent to which the alternative provides and accounts for all necessary investments and actions to implement the plan.
Replace all or a portion of current groundwater withdrawals for irrigation within the CBP portion of the Odessa Subarea with CBP surface water. Provide environmental and recreational mitigation and enhancements.	**Effectiveness –** The extent to which the alternative alleviates the problems and accomplishes the objectives.
Maximize use of existing infrastructure. Minimize potential delay in the Study schedule. Be conducive to development in phases for early and efficient implementation based on funding expectations, physical and operational constraints, and rate of groundwater decline.	**Efficiency –** The extent to which the alternative is cost effective in accomplishing the project objectives.
Address environmental concerns and interests, including NMFS Columbia River seasonal flow objectives and impacts to ESA-listed and other sensitive species. Address the potential impact to shrub-steppe habitat for ESA-listed species.	**Acceptability –** The workability and viability of the plan in terms of acceptance by Federal, State, and local governments and the public and compatibility with existing laws, regulations, and public policies.

Using input received from the public at a February 2006 public meeting and through written correspondence, as well as the information from previous related investigations, the PASS defined and evaluated alternative concepts and solutions to resolve problems posed by groundwater decline in aquifers of the Odessa Subarea.

The PASS identified four broadly-defined alternatives that combined various options for supply and delivery of surface water to replace groundwater for irrigation use in the Study area. These met the criteria in Table 3- 4 and were carried forward through an appraisal-level investigation.

3.3.3 Appraisal-Level Investigation

In March 2008, Reclamation completed the *Appraisal-Level Investigation Summary of Findings, Odessa Subarea Special Study* (Reclamation, 2008 [Appraisal]) of water delivery alternatives and water supply options that could provide a replacement surface water supply.

3.3.3.1. Alternatives Formulation

The investigation examined the engineering viability, developed preliminary cost estimates, and identified potential environmental and social issues. Four water delivery alternatives and six water supply options were evaluated. The appraisal-level alternatives were divided into alternatives for delivering water and options for storing a replacement water supply. Table 3- 5 lists the alternatives considered in the appraisal-level investigation.

Table 3- 5. Alternatives identified through the 2006 PASS process and considered in the 2008 appraisal investigation

Delivery Alternatives	
A	Full replacement of groundwater with a CBP surface-water supply for irrigation. Construct an East High Canal System reaching 140,000 eligible acres both north and south of I-90.
B	Full replacement by developing an East High Canal system to serve lands north of I-90, and expanding the capacity of the existing East Low Canal to serve 127,300 acres south of I-90.
C	Partial replacement to serve 70,100 acres using only the existing East Low Canal. North of I-90, lands would be served from available capacity in the existing canal without major modification. South of I-90, lands would be served by expanding the capacity of the canal system.
D	Partial replacement to serve 40,700 acres through existing capacity in the East Low Canal system without major modification.
Supply Options	
Banks Lake Drawdown	Draw down the existing reservoir to levels lower than current operations.
Banks Lake Raise	Raise the operational water surface of the reservoir by 2 feet by raising the crest of the two dams and allowing more storage.
Potholes Reservoir Reoperation	Adjust the timing of water storage in the reservoir by feeding some water in the fall, rather than in the spring, thus freeing up available water in the spring for use in the Study Area. Some modifications of the dam may also be required.
New Reservoirs	Build new reservoirs at Dry Coulee, Lower Crab Creek, and Rocky Coulee.

Refinements to the alternatives developed in the PASS included developing appraisal-level engineering designs and cost estimates, identifying specific groundwater-irrigated land areas to receive a replacement surface water supply, and calculating the number of groundwater-irrigated acres served and replacement water supply volumes for each alternative.

The appraisal-level investigation predominantly relied on existing data and included limited additional engineering, geologic, hydrologic, and hydrogeologic analyses to assess the technical feasibility of water delivery alternatives and water supply options and to develop preliminary cost estimates to allow comparison among alternatives. Engineering designs and cost estimates were based on previous studies and limited design data, including investigations of the East High canal system conducted in the 1960s and 1970s, construction drawings and geology logs from previous investigations, and drawings from construction of existing CBP facilities such as the East Low Canal. Limited additional data were developed (e.g., hydrologic modeling to simulate operations to help determine the sizing of canals and pumping plants). Reclamation, with the assistance of the Service, WDFW, and Confederated Tribes of the Colville Reservation, conducted a preliminary inventory of potential environmental and cultural issues and concerns.

The alternatives formulation process was conducted in three stages. Each successive stage was more detailed than the last to refine potential alternatives, assess their relative engineering and economic feasibility, and compare their relative performance in addressing the problems and opportunities, as described in Chapter 2 in the Final EIS.

The water delivery system for the Partial-Replacement Alternatives examined in the feasibility-level investigation was refined from the appraisal-level investigation's Water Delivery Alternatives C and D. The water delivery system for the Full-Replacement Alternatives examined in the feasibility-level investigations was refined from Water Delivery Alternatives A and B.

Reclamation reviewed the information developed during the appraisal-level investigation and considered public feedback to compare and evaluate the water delivery alternatives and water supply options. As mentioned above, completeness, effectiveness, efficiency, and acceptability were the basis for selecting alternatives and options for future investigation.

After the appraisal-level investigation and during the early work on the current feasibility-level studies, three adjustments were made to the range of supply options being considered. These included eliminating the Banks Lake Raise and the Potholes Reoperation options, and adding use of storage in Lake Roosevelt as an option.

The two sections below summarize the delivery alternatives and supply options that were considered but eliminated from further study.

3.3.3.2. Alternatives Considered But Eliminated From Further Study

3.3.3.2.1 Appraisal Alternative A

Although it would provide full replacement, Alternative A was eliminated because it was not economically feasible. It would involve substantially higher cost, longer implementation times, and greater potential for environmental impact when compared with Alternative B, without an increase in benefits. These disadvantages arose from the fact that Alternative A would require development of a new East High Canal system to serve lands south of I-90. By comparison, Alternative B would serve this area instead by expanding the existing East Low Canal. Expanding the East Low Canal to serve this area would cost considerably less than a new canal system, could allow earlier implementation because it would not rely on completion of the East High Canal system north of the highway, and would involve less land acquisition and other effects involved with developing new canals.

3.3.3.2.2 Appraisal Alternative C

Alternative C would use all available capacity in the East Low Canal to serve groundwater-irrigated lands in the Study Area; thus, SCBID could not receive water for additional lands, as originally planned. Further, Alternative C would not include the potential to provide full replacement of groundwater with CBP surface water for all eligible acreage in the Study Area. Alternative C would offer significantly less potential than Alternative B to meet the fundamental Purpose and Need. It would not substantially address the challenge of the groundwater decline in aquifers of the Odessa Subarea and would not avoid economic loss.

3.3.3.2.3 Appraisal Alternative D

Alternative D was eliminated from consideration for the same reasons as Alternative C. This option served the least amount (less than half) of irrigated acreage in the Subarea, especially when compared with Alternative B.

3.3.3.3. Water Supply Options Considered But Eliminated From Further Study

3.3.3.3.1 Banks Lake Raise

This supply option would raise the two dams that create Banks Lake by 2 feet, resulting in an increase of 2 feet in the reservoir full pool level and a gain of 50,000 acre-feet of additional storage. This option was eliminated from consideration because it was not viable due to cost concerns and the potential for significant impact to lands, facilities, and environmental resources. Problems associated with raising the Banks Lake pool level included:

- Most expensive among the options available for using existing reservoirs.

- Major relocations and modifications of infrastructure required, such as the Feeder Canal and State Highway 155.

- Potentially significant adverse impacts to existing developed land uses around the reservoir, such as Coulee Playland, Sunbanks Resort, Steamboat Rock State Park, and Coulee City Park.

- Potential for adverse impacts to the environment, such as increased acres of vegetation lost to inundation, increased erosion as vegetation is lost, wave action higher on the shoreline, and impacts to cultural resources around the reservoir.

3.3.3.3.2 *Potholes Reservoir Reoperation*

Use of storage in Potholes Reservoir would not be a reasonable or feasible alternative for providing CBP water to the Study Area primarily because this reservoir is too low in the CBP system, making its use technically infeasible to meet the purpose and need. In addition, the reservoir's role in providing flood storage and release is generally not compatible with reliably retaining water in storage at the time of year required to meet the additional irrigation needs in the Study Area.

3.3.3.3.3 *Lake Roosevelt Sole Supply*

This supply option would use storage from Lake Roosevelt by drawing it down when Columbia River flows are not available as the sole supply option for the Study Area. This option was eliminated from consideration because it is not a viable alternative. It would result in summer drawdown levels that conflict with other water management objectives at Grand Coulee Dam and Lake Roosevelt, making this option technically infeasible. It would also result in adverse impacts to recreation and shoreline environmental resources managed by the National Park Service and the Tribes.

3.3.3.3.4 *Dry Coulee and Lower Crab Creek Reservoirs*

Both of these potential locations for new reservoirs were eliminated from consideration as supply options because of substantial additional cost without additional benefits, making them economically infeasible and therefore, eliminating them from the list of viable alternatives. In addition, environmental impact concerns exist, as reported in the appraisal-level investigation report. Each of these reservoir options would involve substantially higher cost and greater potential for adverse environmental impact than the Rocky Coulee option.

3.3.4 Post-Draft EIS Delivery Alternatives Considered But Eliminated From Further Study

Subsequent to publication of the Draft EIS, Reclamation and Ecology received over 1,000 comments from the public, agencies, local governments and Tribes. Careful review and consideration of these comments, coupled with cost considerations and potential environmental impacts, led to the elimination of alternatives utilizing the proposed new Rocky Coulee Reservoir water supply source.

3.3.4.1. Feasibility Rocky Coulee Reservoir C and D

Alternatives 2C: Partial—Banks + Rocky, 2D: Partial—Combined, 3C: Full—Banks + Rocky, and 3D: Full—Combined were eliminated from further consideration in the the Odessa Final EIS. These partial and full groundwater replacement alternatives included the new Rocky Coulee Reservoir that would have been filled generally during the winter months while Columbia River flows were available for diversion. Rocky Coulee Reservoir would have been utilized to supply Project water on farmland during the summer and fall, when Columbia River flows are not available for diversion. This irrigation water storage facility offered a buffer to reservoir pool level impacts on the existing Banks Lake and Lake Roosevelt reservoirs. The new Rocky Coulee Reservoir would have inundated almost 3,000 acres impacting roads, farms, wildlife, and power delivery systems. Rocky Coulee Reservoir was estimated to cost over $300 million which would be in addition to the cost of each action alternative if this option would have been carried forward. Construction of a new reservoir would not be economically justified when existing storage is available in Banks and Lake Roosevelt to meet the need. The existing water supply, including Lake Roosevelt and Banks Lake reservoirs, were designed to serve over 1 million acres of irrigated farmland. Recreational benefits from the new Rocky Coulee Reservoir would be seasonal as the facility would be completely drawn down annually, eliminating most recreational benefit for much of the year. Comments received on the Draft EIS reflected strong concern for potential environmental impacts and added project cost associated with the construction of this seasonal water storage facility. Therefore, these alternatives are not considered reasonable or viable alternatives to the proposed action.

3.4. Relationship of Other Water and Related Resources Activities to Study

The Study and Final EIS are conducted within the framework of the State of Washington's Columbia River Basin Water Management Program (Management Program introduced previously) which was developed pursuant to the Management Act (RCW 90.90). The Management Program is described below in Section 3.5 and prior investigations and related activities in the CBP are described in Section 3.1 of this report.

3.5. Columbia River Basin Water Management Program

The major components of the Management Program include storage, conservation, and other measures intended to meet the legislative mandate of developing new water supplies to meet instream and out-of-stream needs. RCW 90.90 directs Ecology to focus efforts to develop water supplies for the Columbia River Basin to meet the following needs:

- Alternatives to groundwater pumping for agricultural users in the Odessa Subarea aquifer.
- Sources of water supply for pending water rights applications.
- A new uninterruptible supply of water for the holders of interruptible (junior) water rights on the Columbia River mainstem that are subject to instream flows or other mitigation conditions to protect streamflows.
- New municipal, domestic, industrial, and irrigation water needs within the Columbia River Basin.

In addition to funding and implementing major water supply projects, the Management Program includes administrative functions such as development of a project inventory, a water supply and demand forecast, and a data management system.

In 2007, Ecology prepared a SEPA Final Programmatic Environmental Impact Statement for the Management Program (Ecology 2007). The Management Program EIS was intended to describe and evaluate potential direct, indirect, and cumulative impacts associated with implementation of the Management Program, including policy.

The Management Program EIS also evaluated potential impacts associated with implementation of several early actions including the Lake Roosevelt Incremental Storage Releases Project and the Potholes Reservoir Supplemental Feed Route Project. Key components of the Management Program are summarized in the following text, with more detailed descriptions available in the Management Program EIS (Ecology 2007).

3.5.1.1. Storage

Under the State's Management Program, Ecology has been evaluating storage projects to augment water supplies for instream and out-of-stream uses. These projects include Columbia River mainstem and Columbia River tributaries and range from new surface storage facilities, modification of existing storage facilities, and groundwater (aquifer) storage. The most notable projects include the Sullivan Lake Project in northeast Washington and the Bumping Reservoir Enlargement, Wymer Reservoir, and Kachess Inactive Storage Projects in the Yakima River Basin being conducted in conjunction with Reclamation. Ecology has also initiated aquifer storage and recovery projects in the Kennewick, Wallula, and White Salmon areas. Ecology and Reclamation have been evaluating potential off-channel storage projects along the Columbia River mainstem at an appraisal-level. Those evaluations have considered siting large surface reservoirs at Crab Creek in southern Grant County, Goose Lake in Okanogan County, and Ninemile

Flats in Ferry County. The latter two sites are located within the Colville Reservation and the studies are being conducted in partnership with the Confederated Tribes of the Colville Reservation. Feasibility authorization has not been sought for any of the projects that are being investigated by the Management Program.

New storage facilities were contemplated at one point in the Odessa Subarea Special Study; however, the action alternatives identified in the Final EIS for the project rely upon the existing reservoirs for water storage. Since the action alternatives do not involve development of a new storage facility or facilities, the statutory allocation of two-thirds out-of-stream and one-third instream is not applicable to the Study. However, the State's Office of Columbia River is continuing to develop and implement numerous other projects that are intended to benefit instream flows in the Columbia River and its tributaries.

The statutory provision contained in RCW 90.90 for a two-thirds out-of-stream and one-third instream allocation of water pertains only to water supplies secured through the development of **new storage facilities** made possible with funding from the Columbia River Basin water supply development account. [emphasis added]

3.5.1.2. Conservation

Ecology is funding or conducting numerous conservation projects in the Columbia River Basin including efforts to improve efficiency at the irrigation district level and on-farm, improved municipal and industrial infrastructure, and pump exchanges (Figure 3- 1). The most significant conservation project undertaken as part of the Management Program is the Coordinated Conservation Program. Under this program, Ecology is partnering with the East Columbia Basin Irrigation District (ECBID), South Columbia Basin Irrigation District (SCBID), and Quincy Columbia Basin Irrigation District (QCBID) to pipe and line their delivery systems in the CBP. The water saved by these infrastructure improvements will be delivered to the Odessa Subarea. Since 2009, the Coordinated Conservation Program has resulted in approximately 10,800 acre-feet of water savings, which will provide replacement water for about 3,600 acres of groundwater irrigated land in the Odessa Subarea.

Figure 3- 1. Water conservation enables efficient use of existing resources

3.5.1.3. Inventory and Demand Forecasting

The Management Act (RCW 90.90) directs Ecology to develop a water supply inventory and a long-term water supply and demand forecast that is updated every 5 years. The first inventory and long-term water supply and demand forecast was released in November 2006. The inventory and forecast include conservation and water storage projects, a water rights inventory, a water use inventory, a long-term water supply forecast, and a long-term demand forecast. The water supply and demand forecast was updated in 2011 and documents the need for replacement of irrigation water from groundwater sources in the Odessa Subarea.

3.5.1.4. Early Actions

Ecology is implementing several early actions as part of the Management Program, including the Lake Roosevelt Project and the Potholes Supplemental Feed Route Project. These projects are described below.

- **Lake Roosevelt Incremental Storage Releases Project**. The Lake Roosevelt Incremental Storage Releases Project involves releases of water from Lake Roosevelt for multiple purposes. Under a service contract with Reclamation, Ecology has arranged for 25,000 acre-feet of water to be made available each year to improve municipal and industrial water supplies along the Columbia River mainstem. Thirty thousand acre-feet of water will be conveyed to the Odessa Subarea to replace groundwater on about 10,000 acres of existing irrigated land. Downstream of Grand Coulee Dam, 27,500 acre-feet of water will be available to enhance streamflows in the Columbia River to benefit fish. In drought years, an additional 33,000 acre-feet will be available to provide water to interruptible water rights holders; an additional 17,000 acre-feet will be available for instream flow augmentation. Ecology issued the Final Supplemental Environmental Impact Statement for the Lake Roosevelt Incremental Storage Releases Program in August 2008 (Ecology 2008), and Reclamation issued an Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) for the project in June 2009 (Reclamation 2009). Reclamation and Ecology began implementing the flow releases in September 2009. The project is expected to be fully implemented in 2013.

As part of the Lake Roosevelt Incremental Storage Releases Project, Ecology provided funds to Reclamation for the design of the Weber Siphon Complex. The work consisted of constructing the second barrel of the Weber Branch and Weber Coulee Siphons on the East Low Canal. Completion of the siphons alleviates a flow capacity bottleneck where the East Low Canal crosses I-90.

In April 2009, the Weber Siphon Complex was named an American Recovery and Reinvestment Act of 2009 (ARRA) project. Construction was completed in December 2011 and the Weber Siphon Complex was operational in March 2012.

- **Potholes Reservoir Supplemental Feed Route Project**. The purpose of the supplemental feed route project is to increase the reliability of transporting water from Banks Lake to Potholes Reservoir. While about two-thirds of the water used by the SCBID each year is provided by CBP return flows from the portion of the project that lies north of Potholes Reservoir, about one-third (about 330,000 acre-feet of water) must be conveyed directly from Banks Lake to Potholes Reservoir to make it available for use in the south. This water is known as “feed water.”

  Currently, most of the feed water is transported via the Main Canal south through the East Low Canal to Rocky Coulee Wasteway where it discharges into Upper Crab Creek near the north end of Moses Lake and Potholes Reservoir. Feeding is done early and late in the irrigation season when demand for irrigation water is low. At these times, the “unused” capacity in the East Low Canal is used to carry feed water to Potholes Reservoir. Changes in irrigation practices and increases in water demand have reduced the effectiveness of the existing feed route. As a result, Reclamation and Ecology initiated the Potholes Supplemental Feed Route Project.

  Reclamation prepared an EA and identified the Crab Creek and Frenchman Hills Wasteway feed route alternative as the preferred alternative for a supplemental feed route (Reclamation 2007 EA). The selected alternative would involve release of about 126,000 acre-feet of feed water each year from Billy Clapp Reservoir directly into the Crab Creek channel, then into Moses Lake and Potholes Reservoir. About 25,000 acre-feet of feed water would also be conveyed via West Canal to Frenchman Hills Wasteway and then to Potholes in the spring.

The supplemental feed route lies outside of the Odessa Ground Water Management Area and beyond the boundaries of the Study Area. However, East Low Canal capacity improvements that result from the project will help facilitate groundwater replacement efforts in the Odessa Subarea. Ecology funded improvements to the Frenchman Hills Wasteway in 2007 and has provided funding to Reclamation for land and easement acquisitions. Reclamation received funding under the ARRA for work on the Crab Creek portion of the feed route and completed work in 2011. It is anticipated that the feed route will be complete and in operation by 2014.

- **Columbia Basin Irrigation Districts Coordinated Conservation**. Ecology is partnering with the ECBID, SCBID, and QCBID to pipe and line their delivery systems in the CBP. In 2009, the irrigation districts lined and piped over 27,600 feet of canal and saved 2,521 acre-feet of water. In 2010, the irrigation districts installed 54,388 feet of pipe and saved of 2,929 acre-feet of water. In 2011, they lined and piped 77,969 feet of canal and saved 5,357 acre-feet of water. The water saved by these infrastructure improvements will be delivered to the Odessa Subarea. Since 2009, the Coordinated Conservation Program has resulted in approximately 10,800 acre-feet of water savings, which will provide replacement water for about 3,600 acres of groundwater irrigated land in the Odessa Subarea.

Chapter 4: Alternatives

4.1. Introduction

This chapter presents a description and summary comparison of the alternatives being considered to address the Problems and Opportunities discussed in Chapter 2. Alternative formulation is discussed in Chapter 3. This chapter is organized as follows:

Section 4.2: Summary of alternative descriptions, including related water resource management programs and activities.

Sections 4.3 through 4.5: More detailed alternative descriptions, including how CBP water would be supplied (that is, which reservoirs would be involved), and the facilities required to deliver surface water to groundwater-irrigated lands in the Study Area. Included with the description of required facilities is an overview of related construction timeframes and activities and how reservoirs would operate.

Sections 4.6 and 4.7: Summary of potential environmental consequences (details are presented in the Odessa Final EIS and in the four-account analysis in Chapter 5 of this Special Study Report).

Note that findings from the economic and financial analyses are in Chapter 5, "Four-Account Analysis."

4.2. Alternatives Overview

Section 4.2.1 – "Overview of Alternatives," describes the options for water delivery and water supply and indicates how those options were grouped into the seven alternatives analyzed in the Odessa Final EIS. Section 4.2.2 – "River and Reservoir Hydrologic Operational Changes Common to All Action Alternatives" describes what would change and how those changes were measured under different watershed conditions, such as average, wet, dry, and drought years.

A number of existing, interrelated water management programs, actions, and activities in the study region would be a part of all alternatives. Section 4.2.4 – *Water Management Programs and Requirements Common to All Alternatives* describes how the programs and laws in Chapter 1 would relate to the Study Alternatives.

4.2.1 Overview of Alternatives

Six action alternatives and a No Action Alternative are evaluated in the Study—two Partial Groundwater Irrigation Replacement (Partial-Replacement) Alternatives, two Full Groundwater Irrigation Replacement (Full-Replacement) Alternatives, and two Modified Partial Groundwater Irrigation Replacement (Modified Partial-Replacement) Alternatives:

1. No Action Alternative

2. Partial-Replacement Alternatives:
   2A. Partial—Banks
   2B. Partial—Banks + Lake Roosevelt (FDR)

3. Full-Replacement Alternatives:
   3A. Full—Banks
   3B. Full—Banks + FDR

4. Modified Partial-Replacement Alternatives:
   4A. Full—Banks
   4B. Full—Banks + FDR

4.2.1.1. Delivery Options

The six action alternatives fall into three groups based on how much surface water would be delivered and where it would be delivered to replace groundwater-irrigated acreage in the Study Area. Three delivery options with associated facilities, along with the No Action option, are listed below:

- No Action: No additional surface water supply would be provided from the CBP to replace groundwater-irrigated acreage in the Study Area. No new facilities would be built and no existing facilities would be expanded for this purpose. The only existing programs or activities that would address the declining groundwater conditions in the Study Area would be the incremental release from Lake Roosevelt (30,000 acre-feet to support agriculture in Study Area) and the Coordinated Conservation Program.

- Option 2—Partial Groundwater Irrigation Replacement: This delivery option focuses on enlarging and extending the existing East Low Canal and providing CBP surface water to approximately 57,000 acres currently using groundwater south of I-90 and developing a distribution system to deliver water from the canal to the farmlands (Figure 4- 1). No surface water replacement would be provided to most of the remaining groundwater-irrigated acres in the Study Area north of I-90. The total CBP surface water supply needed for the Partial-Replacement Alternatives would be approximately 138,000 acre-feet.

- Option 3—Full Groundwater Irrigation Replacement: This delivery option would provide CBP surface water to most groundwater-irrigated acreage in the Study Area (approximately 102,600 acres). Lands south of I-90 would be served by enlarging and extending the East Low Canal, as described for the Partial-Replacement Alternatives. Lands north of I-90 would be served by construction of the East High Canal system and developing a distribution system to deliver water from the canal to the farmlands, as shown on Figure 4- 1. The total CBP surface water supply needed for the Full-Replacement Alternatives would be approximately 273,000 acre-feet.
- Option 4—Modified Partial Groundwater Irrigation Replacement: This delivery option would provide CBP surface water to approximately 70,000 groundwater-irrigated acres in the Study Area both north and south of I-90. Lands south of I-90 would be served by enlarging the East Low Canal and developing a distribution system to deliver water from the canal to the farmlands, as described for the Partial-Replacement Alternatives, except the East Low Canal would not be extended, only enlarged. Lands north of I-90 would be served by the existing East Low Canal by developing a distribution system to deliver water from the canal to the farmlands. The total CBP surface water supply needed for the Modified Partial-Replacement Alternatives would be approximately 164,000 acre-feet.

4.2.1.2. Supply Options for the Action Alternatives

All surface water supplies for the action alternatives would be through diversion from the Columbia River using Reclamation's existing water rights for the CBP and existing storage reservoirs, Lake Roosevelt and Banks Lake. The surface water supplies would allow stored water to be used from the reservoirs during the irrigation season and the reservoirs would be refilled during the fall and winter. Spring diversions, when possible (April through June), would be used for direct delivery to the Study Area and refill storage at Banks Lake.

Stored water for delivery to the Study Area would be provided from either Banks Lake alone or Banks Lake and Lake Roosevelt (Figure 4- 1):

- Alternatives 2A, 3A, and 4A (Banks) would use storage in Banks Lake, exclusively.
- Alternative 2B, 3B, and 4B (Banks + FDR) would use storage in both Banks Lake and Lake Roosevelt.[4]

Quantity and Timing of Diversions

Two potential scenarios for diverting water from the Columbia River into the Study Area via Banks Lake are evaluated in the Final EIS for each action alternative:

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[4] The State of Washington has committed through agreements with the Confederated Tribes of the Colville Reservation and the Spokane Tribes of Indians to not seek further drawdown of Lake Roosevelt. Therefore, the State does not support Alternatives 2B, 3B, or 4B.

- **Spring Diversion Scenario**: This scenario is similar to that assumed in the Draft EIS except that the diversion in October through March would take place every year even when the flow objectives are not met in the Columbia River. The maximum amount of diversion in October was increased to 2,700 cfs and in addition, diversion up to 350 cfs could occur during November through March to refill Banks Lake and Lake Roosevelt. Diversions in April through June would be allowed from the Columbia River when flows exceed 135,000 cfs at Priest Rapids Dam, 260,000 cfs at McNary Dam, and there is adequate pump capacity to pump water from Lake Roosevelt to Banks Lake. This spring limitation is consistent with the previous analysis performed for the Draft EIS.

- **Limited Spring Diversion Scenario:** During informal ESA consultation (June 2012), it was suggested that Reclamation limit diversions in the spring (April through June) for direct delivery to the Study Area to periods when the Columbia River flow downstream of Grand Coulee Dam exceeds 200,000 cfs and there is adequate pump capacity to pump water from Lake Roosevelt to Banks Lake. Diversions in October of up to 2,700 cfs would be allowed and additional diversions up to 350 cfs could occur November through March to refill Banks Lake and Lake Roosevelt. This would be within the range of drawdown scenarios for Banks Lake and Lake Roosevelt presented in the Draft EIS and has been fully analyzed in the Final EIS. The flows for the Spring and Limited Spring Diversion Scenarios are summarized in Table 4- 1.

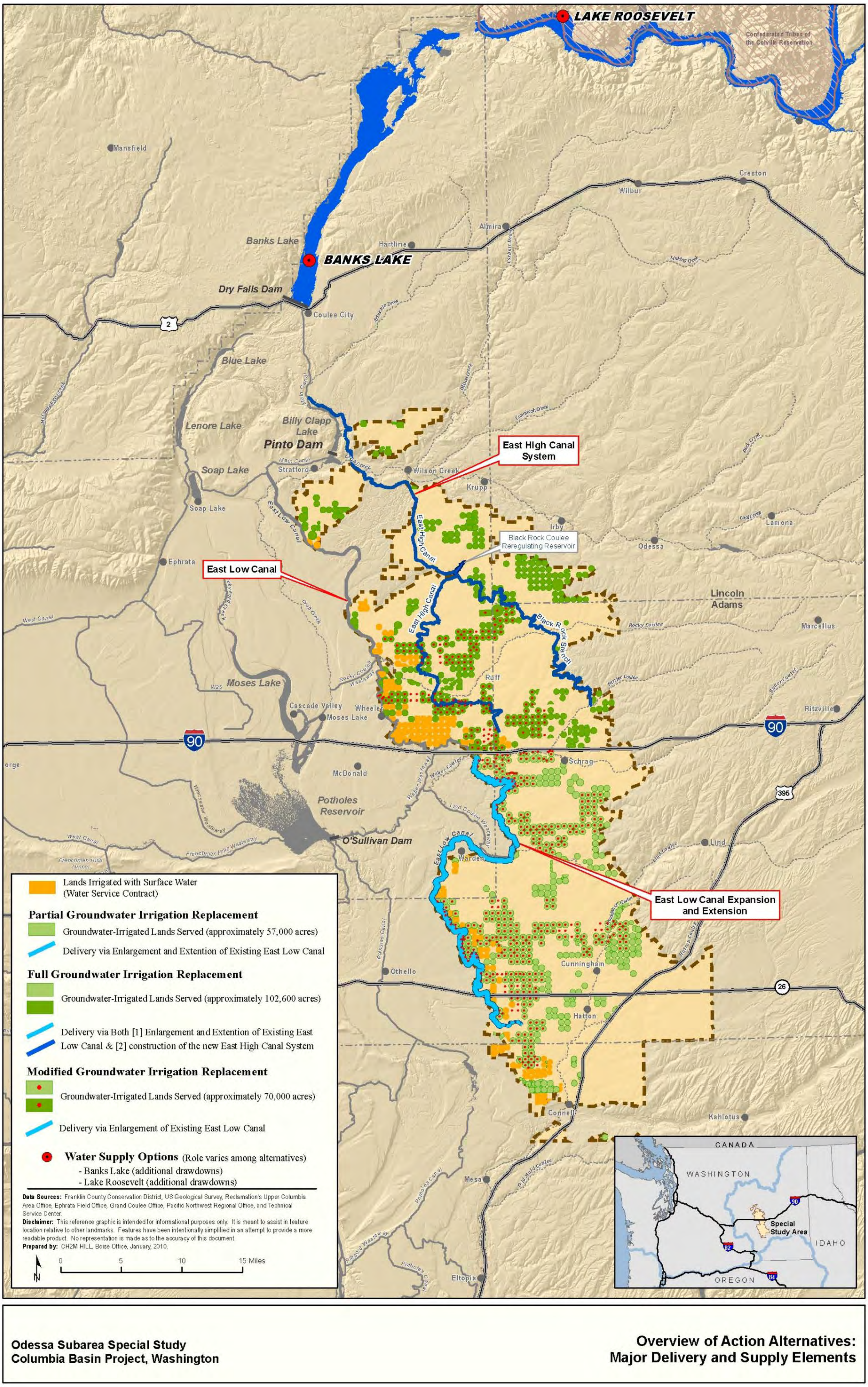


Figure 4- 1. Overview of action alternatives – major delivery and supply elements

Table 4- 1. Diversion scenario summary table

Diversion Scenario	Spring (April through June)	October	November through March
Spring	Diversions from Columbia River allowed when outflows exceed 135,000 cfs at Priest Rapids Dam, 260,000 cfs at McNary Dam, and there is adequate pump capacity at Lake Roosevelt.	Diversions up to 2,700 cfs.	Up to 350 cfs each month.
Limited Spring	Diversions from Columbia River allowed when outflows exceed 200,000 cfs* downstream of Grand Coulee Dam and there is adequate pump capacity at Lake Roosevelt.	Diversions up to 2,700 cfs.	Up to 350 cfs each month.

* This flow was not modeled as part of the Special Study; however, this occurs less than 10 percent of the years.

4.2.1.3. Action Alternatives—Delivery and Supply Combinations

Alternatives 2A and 2B would each provide partial groundwater irrigation replacement to approximately 57,000 acres south of I-90 through an enlarged and extended East Low Canal. The alternatives differ only in which of the two supply options would be used. Similarly, Alternatives 3A and 3B evaluate two different supply options that would each provide full groundwater irrigation replacement to approximately 102,600 acres both north and south of I-90. Approximately 57,000 acres south of I-90 would be served through an enlarged and extended East Low Canal, and approximately 45,000 acres north of I-90 would be served through a new East High Canal system. Alternatives 4A and 4B also evaluate two different supply options that would each provide partial groundwater irrigation replacement to approximately 70,000 acres. Approximately 45,000 acres south of I-90 would be served through an enlarged East Low Canal, and approximately 25,000 acres north of I-90 through the existing East Low Canal.

These six action alternatives are listed in Table 4- 2.

Table 4- 2. Alternatives overview

Alternative – Water Supply	Delivery Options (see also Figure 4- 1)
Alternative 2 – Partial Groundwater Irrigation Replacement	
2A – Banks Lake **2B – Banks + FDR**	• Current and ongoing Columbia River and CBP programs, commitments, and operations continue • Additional drawdown of Banks Lake (2A and 2B) and FDR (2B) • Approximately 57,000 acres of eligible groundwater-irrigated lands south of I-90 supplied with CBP surface water • Water delivered by enlargement and extension of the existing East Low Canal and construction of a distribution system
Alternative 3 – Full Groundwater Irrigation Replacement	
3A – Banks Lake **3B – Banks + FDR**	• Current and ongoing Columbia River and CBP programs, commitments, and operations continue • Additional drawdown of Banks Lake (3A and 3B) and FDR (3B) • Approximately 102,600 acres of eligible groundwater-irrigated lands supplied with CBP surface water • Water delivered south of I-90 by enlargement and extension of the existing East Low Canal and construction of a distribution system • Water delivered north of I-90 by construction of a new East High Canal system, with an associated distribution system
Alternative 4 – Modified Partial Irrigation Replacement	
4A – Banks Lake (Preferred Alternative) **4B – Banks + FDR**	• Current and ongoing Columbia River and CBP programs, commitments, and operations continue. • Additional drawdown of Banks Lake (4A and 4B) and FDR (4B) • Approximately 70,000 acres of eligible groundwater-irrigated lands provided with CBP surface water • Lands supplied with surface water replacement would be both north and south of I-90 • Water delivered by enlargement of the existing East Low Canal and construction of a distribution system

4.2.2 River and Reservoir Hydrologic Operational Changes Common to All Action Alternatives

The Columbia River would provide the surface water supply that would replace groundwater irrigation in the Study Area. Hydrologic modeling using HYDSIM, CBP-RW, and spreadsheet analysis was conducted to determine the potential changes in river flows and reservoir operations (drawdown and refill patterns) that would accompany implementation of the Partial-Replacement Alternatives (Alternatives 2A and 2B), the

Full-Replacement Alternatives (Alternatives 3A and 3B), the Modified Partial-Replacement Alternatives (Alternatives 4A and 4B), and the No Action Alternative. These models approximate flows and drawdown elevations, but the modeled outputs will most likely differ from real-time operations. Models are used to approximate and evaluate the potential impacts of the Proposed Action.

HYDSIM Model

Reclamation used output data from BPA's HYDSIM model for the FCRPS to determine the quantity of water available for diversion from the Columbia River for the CBP. The BPA model includes all significant United States Federal and non-Federal dams and the major Canadian projects on the mainstem Columbia River and its major tributaries. It is widely accepted as accurately simulating current operations of the Columbia River system. HYDSIM uses the current FCRPS system operating requirements for each project and historic hydrologic flow conditions. It contains a data set of runoff from 1929 through 1998 to determine impacts to various resources and obligations (such as irrigation, flood control, power, instream flow, other contract obligations, project authorizations, and biological opinions).

The HYDSIM model output includes information such as inflow, outflow, end-of-month reservoir elevations, power generation at each project, and monthly average flows at different target points on the Columbia River. The HYDSIM model splits the average monthly flows for the months of April and August so the first 15 days are separate from the remaining days of those two months. This is because April and August are dynamic months in which flows can change dramatically.

HYDSIM uses the Columbia River seasonal flow objectives established by NMFS, beginning with the 1995 FCRPS BiOp, at Priest Rapids, McNary, and Bonneville Dams. Flow objectives are used for planning and modeling purposes.

CBP-RW Model

A hydrologic simulation model of the CBP was used for this analysis. RiverWare (RW) software was used to develop a simulation model of the infrastructure downstream of the Feeder Canal on the CBP, referred to as the CBP-RW model. The CBP-RW model runs on a daily time step, simulating reservoirs, canal and lateral flows, farm deliveries, return flows, groundwater pumping and natural flows within the CBP. The model was calibrated using observed reservoir elevation and surface flow data from 1996 to 1998. The calibrated CBP-RW model was used to simulate a selected combination of the proposed water conveyance and supply options and was run for the period 1929 through 1998.

Spreadsheet Analysis

A spreadsheet analysis was used to compute the interaction of Lake Roosevelt and Banks Lake storages and downstream Columbia River flows. The spreadsheet analysis integrated the No Action Alternative conditions from the HYDSIM model with the increase in diversions for the Study Area from the CBP-RW model. The results were compared to determine the effects of each alternative on Banks Lake and Lake Roosevelt storages and Columbia River flows.

Modeling Assumptions and Results

Modeling for this Study used four representative water year scenarios, or hydrologic conditions, within the watershed:

- Wet year: 1982 was selected as being representative of these conditions; approximately 10 percent of all water years are this wet or wetter and 90 percent drier.
- Average year: 1995 was selected as being representative of these conditions; approximately 50 percent of water years would be wetter and 50 percent drier.
- Dry year: 1998 was selected as being representative of these conditions; approximately 15 percent of water years would be this dry or drier and the remaining 85 percent of years would be wetter.
- Drought year: 1931 was selected as being representative of these conditions; approximately 5 percent of water years would be this dry or drier and approximately 95 percent of years would be wetter.

Using historical data to model future hydrologic and system operation patterns assumes that future hydrologic conditions will be similar to past hydrologic conditions (i.e., the 1929 to 1998 period of record). Section 4.2 – *Surface Water Quantity* in the Odessa Final EIS (Reclamation 2012) describes the hydrologic record used for modeling and how specific years within the period of record were selected to represent the four future hydrologic conditions.

In all water-year conditions, the greatest drawdown of reservoirs would occur at the end of August when there is flow augmentation in the Columbia River. Figure 4- 2 and Figure 4- 3 show the end-of-August drawdowns and associated pool elevations projected for Banks Lake for the No Action Alternative and the six action alternatives under wet, average, dry, and drought conditions with the Spring Diversion Scenario and the Limited Spring Diversion Scenario, respectively. Figure 4- 4 and Figure 4- 5 provide this same information at Lake Roosevelt for the three action alternatives that use Lake Roosevelt storage with the Spring Diversion Scenario and the Limited Spring Diversion Scenario.

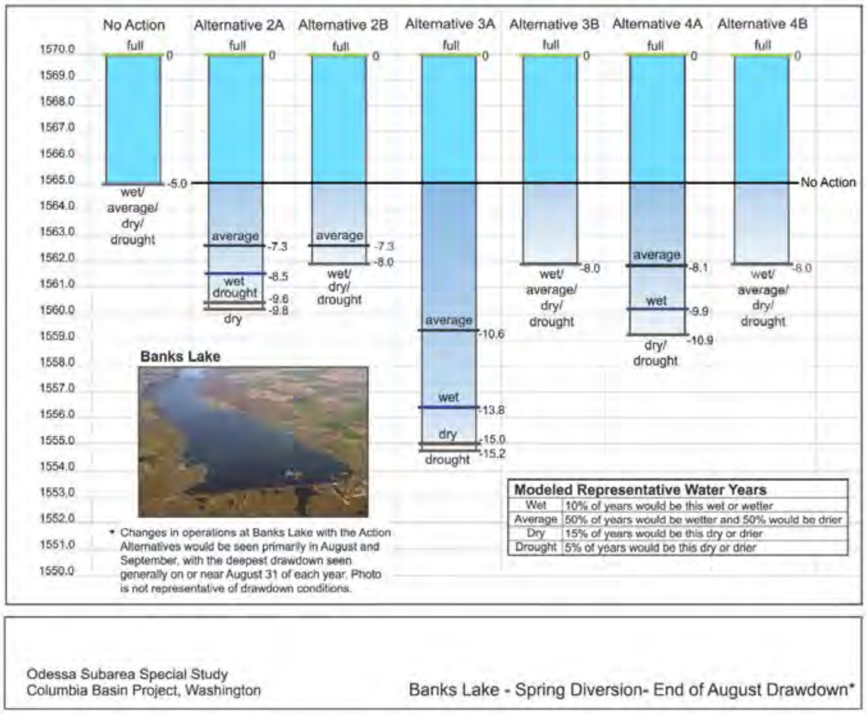


Figure 4- 2. Banks Lake – Spring Diversion Scenario – end of August drawdown

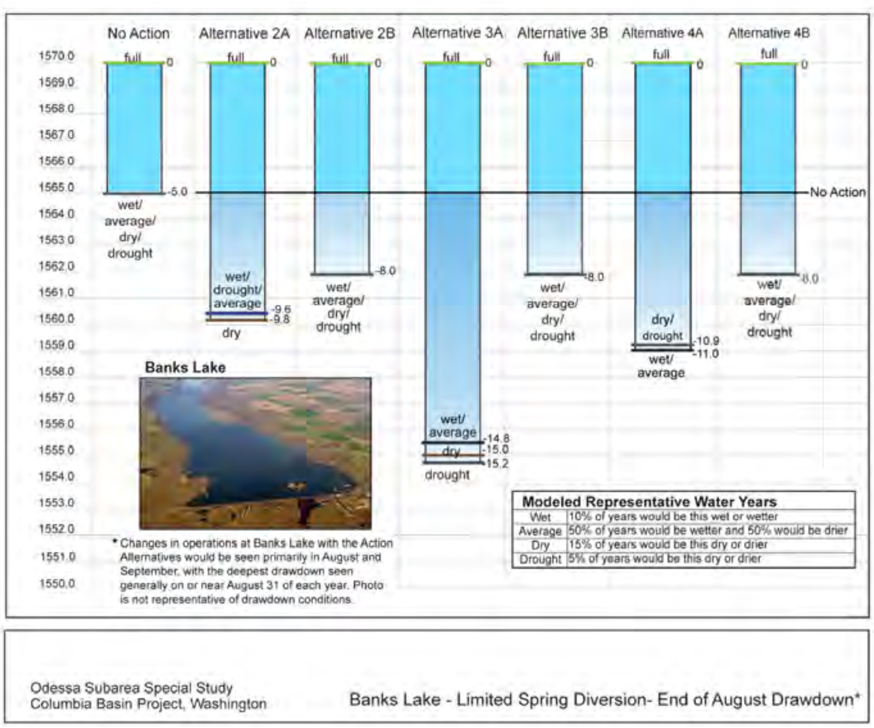


Figure 4- 3. Banks Lake – Limited Spring Diversion Scenario – end of August drawdown

With the exception of July and August, modeling in the Draft EIS was initially based on diversions from the Columbia River when flows were in excess of BiOp flow objectives, which included diversions in spring. Based on input during informal ESA consultations, the Final EIS diversion looked to two diversion scenarios, Spring and Limited Spring as previously described. The diversions were limited to 2,700[5] cfs in October, with the balance in November through March not to exceed 350 cfs (Section 4.2 – *Surface Water Quantity* in the Odessa Final EIS [Reclamation 2012] describes the diversion scenarios).

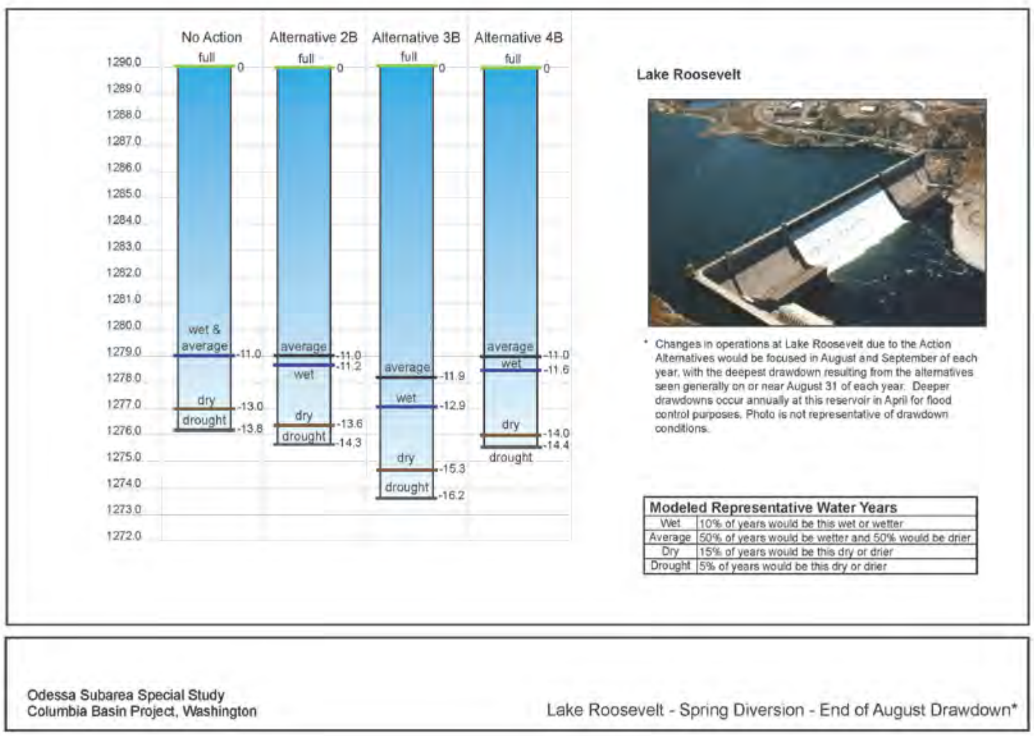


Figure 4- 4. Lake Roosevelt – Spring Diversion Scenario – end of August drawdown

[5] All cfs values reflect a monthly average pumping rate necessary to produce a certain volume of water. For example, 100 cfs per month reflects pumping a volume of approximately 6000 acre-feet per month. This volume could easily be pumped from Grand Coulee in one day with no immediate change in the flow in the Columbia River. Pumps will generally be run at times when electricity is least valuable.

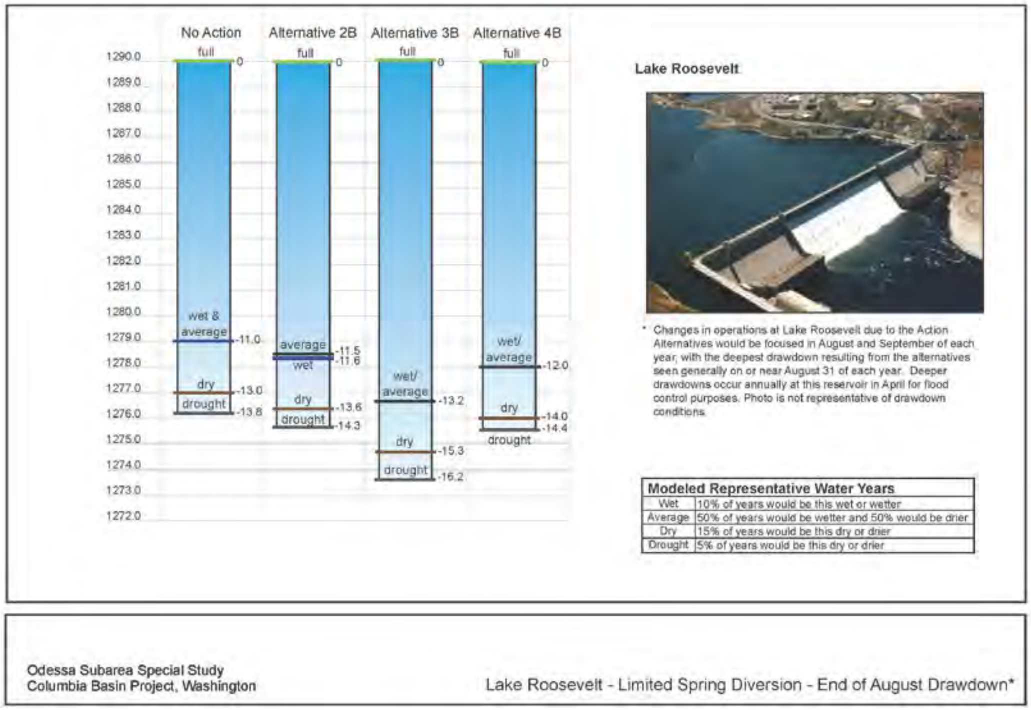


Figure 4- 5. Lake Roosevelt – Limited Spring Diversion Scenario – end of August drawdown.

How Would the Columbia River System be Changed by the Alternatives?

None of the six action alternatives in the Final EIS would result in a significant change in Columbia River flows. Water management programs and constraints are in place (i.e., the 2008/2010 FCRPS BiOp) for the river to protect the resource values associated with the mainstem of the Columbia River, including ESA-listed fish species in the river. These would continue to be met in the spring and summer as a first priority in all hydrologic conditions. There could be minor flow diversions from November through March, but these minor decreases would not impact operations for protection of fall Chinook or chum.

Providing CBP surface water to lands in the Study Area would require changing reservoir operations during and immediately after the irrigation season at Banks Lake for all action alternatives and at Lake Roosevelt, for Alternatives 2B, 3B, and 4B. At both reservoirs, these changes would mean increased drawdowns—and therefore, lower pool levels—when compared with the No Action Alternative. In all cases, the pool levels would reach their minimum elevations at the end of August.

4.2.3 Water Management Programs and Requirements Common to All Alternatives

Water management within the Columbia River Basin is complex and is reflected in all of the alternatives, including the No Action Alternative. Delivery of irrigation water, flows in the Columbia River to support fish and environmental objectives and meet water rights, hydropower objectives, navigation, and flood control operations are all carefully timed throughout the year to meet numerous, interrelated water demands and priorities in the region.

A number of programs and requirements of this water management system relate directly or indirectly to the alternatives being considered for groundwater-irrigated lands in the Study Area and would be common to all of the alternatives, including No Action. The most relevant of these programs and requirements, with brief descriptions of each provided in the following paragraphs, are:

- Operations at Lake Roosevelt and Banks Lake
- CBP irrigation water supply, including master water service contracts in the Study Area
- Columbia River Basin Water Management Program, and
- Coordinated Conservation Program.

4.2.3.1. Operations at Lake Roosevelt and Banks Lake

The water supply for the CBP is stored behind Grand Coulee Dam in Lake Roosevelt. Congress originally authorized the Grand Coulee Project for irrigation, navigation, flood control, and hydropower. Since the original authorization, recreation and fish management have been added to the authorized purposes of the dam and reservoir. Storage and delivery of water to meet irrigation, municipal, and industrial uses are authorized Project purposes.

To supply the CBP, water from Lake Roosevelt is lifted through the John W. Keys III Pump-Generating Plant (Keys Pump-Generating Plant) approximately 280 feet to the Banks Lake Feeder Canal, which flows 1.6 miles to the Banks Lake equalizing reservoir (Figure 4- 6). Banks Lake is a storage facility formed by two dams: North and Dry Falls (Figure 4- 7 and Figure 4- 8). Banks Lake is designed to serve as a reregulation reservoir for the irrigation portion of the CBP, and is used as the forebay for pumped storage operations when the Keys Pump-Generating Plant is being used to generate electrical power. Water is delivered to CBP lands through the Main Canal headworks and a low-head powerplant in Dry Falls Dam at the southern end of Banks Lake (Figure 4- 9).

Figure 4- 6. Banks Lake Feeder Canal with Lake Roosevelt in background and Banks Lake in the foreground

Figure 4- 7. Banks Lake and North Dam

Figure 4- 8. Banks Lake, Dry Falls Dam, and the Main Canal

Figure 4- 9. Main Canal Headworks and Powerplant at Dry Falls Dam

Lake Roosevelt

Reclamation currently operates Grand Coulee Dam and Lake Roosevelt for flood control, hydropower generation, irrigation, municipal and industrial supply, fish and wildlife, and recreation. Operations are coordinated with BPA and the Corps, and State, Tribal, and Federal fish and wildlife agencies.

At full pool, the surface elevation of Lake Roosevelt is 1,290 feet amsl and has an active capacity of 5.23 MAF. Lake Roosevelt receives large amounts of runoff from its tributaries with enough runoff to fill the reservoir several times in an average water year. The minimum operating pool elevation of Lake Roosevelt is 1,208 feet amsl.

Lake Roosevelt is typically drafted and refilled twice during the year—a deeper draft occurs in winter and early spring for system flood control and a shallower draft occurs in July and August to provide flow augmentation water for ESA-listed fish in the river downstream. Operations under the No Action Alternative are included in the description of the No Action Alternative in Section 4.4. in this report). The primary considerations that shape these operations are summarized in Table 4- 3. Except where noted, these existing operations would continue unchanged under all Study alternatives.

Table 4- 3. Operational considerations of Grand Coulee Dam and Lake Roosevelt

Operational Goal	Description
Flood Control	Lake Roosevelt is operated under a series of “rule curves” that regulate the amount of drawdown. In late winter and early spring, flows are released from the reservoir to allow room to store upstream runoff and manage flood risk downstream. In an average water year with normal precipitation, the reservoir can be drawn down 50 feet or more. The level of drawdown is based on the volume water supply forecast and other factors. The reservoir typically refills about June 30.
ESA-listed Fish	Grand Coulee Dam is operated to help shape streamflows downstream to support ESA-listed fish. In the Columbia River system, 13 species of salmon and steelhead and 2 resident fish species are listed as threatened or endangered. NMFS and the USFWS have developed Biological Opinions that include objectives for Columbia River operations to benefit and protect these species. The two agencies review annual water management plans developed by Reclamation, Corps, and BPA to assist in meeting fish objectives. Grand Coulee Dam is operated to help with chum salmon below Bonneville Dam from November 1 to April 10, for fall Chinook below Priest Rapids Dam from November through May, and for other ESA-listed salmon and steelhead from April 10 to August 31. Under the Lake Roosevelt Incremental Storage Releases Program, operation of Grand Coulee Dam was modified to include additional instream flow augmentation. These releases draw down Lake Roosevelt by an additional 1 foot in nondrought years and 1.8 feet during drought years by the end of August. One-third of this draft is for instream flows to benefit fish. In addition, there are green sturgeon, eulachon, and leather back turtles that are part of the FCRPS consultation, but are primarily found in the estuary (see Section 3.11 – *Wildlife).*

Table 4- 3. Operational considerations of Grand Coulee Dam and Lake Roosevelt

Operational Goal	Description
CBP Irrigation Supply	Each year, about 2.65 MAF is pumped from Lake Roosevelt to Banks Lake to supply irrigation water, generally from March through October.
Hydropower	In addition to seasonal fluctuations, Lake Roosevelt releases fluctuate daily for hydropower production. Grand Coulee Dam has four powerplants, including the Keys Pump-Generating Plant, and 33 turbines with a maximum generating capacity of 6,809 megawatts (MW).
Lake Roosevelt Incremental Storage Releases Program	The most recent substantive set of changes to operations at Grand Coulee Dam and Lake Roosevelt result from this component of the Management Program. This component drafts Lake Roosevelt is drafted an additional 1 foot in nondrought years and 1.8 feet in drought years by the end of August. Releases are being made to benefit agriculture, municipal and industrial users, Columbia River mainstem interruptible water right holders, and instream flows. Each year, 30,000 acre-feet go to the Study Area, 25,000 acre-feet go to meet municipal and industrial needs, and 27,500 acre-feet to augment instream flows above flow objectives (82,500 acre-feet total). An additional 50,000 acre-feet are released during drought years, with 33,000 acre-feet of that release providing relief for interruptible water right holders and 17,000 acre-feet supplementing instream flows. Within the Study Area, construction of the Weber Siphon was the primary facility modification necessary to deliver the 30,000 acre-feet of supply to the Study Area. This modification was completed in early 2012.
Secondary Considerations	Within existing operational limitations, Reclamation strives to operate Lake Roosevelt to make boat launches and marinas accessible, and beaches and campgrounds usable. Lake levels at or above 1280 feet amsl are maintained during the summer recreation season as much as possible. Management for non-ESA-listed fish is also a secondary consideration for the overall operation of the reservoir. For example, every attempt is made to refill Lake Roosevelt to a minimum elevation of 1283 feet by the end of September to benefit resident fish spawning. This operation is coordinated with the Tribes.

John W. Keys III Pump-Generating Plant

Construction of the Grand Coulee Pumping Plant (renamed John W. Keys III Pump-Generating Plant [Keys Pump-Generating Plant]) began in 1946. Six pumping units, each with a capacity to pump approximately 1,350 cubic feet per second (cfs), initially were installed in the plant to lift water 280 feet from Lake Roosevelt to the 1.6-mile-long feeder canal for delivery into Banks Lake. The plant was designed to accommodate six additional units in the future as the CBP reached full development.

In the early 1960s, with the Pacific Northwest facing power shortages, the facility was identified for modification to add pumped storage capabilities. Pumped storage is a strategy for hydroelectric power management that involves pumping water up to a reregulation reservoir during periods of low power demand and storing it for release through a generator during peak power demand periods. It was determined that the remaining six units were to be reversible pump-generators; that is, the units would function as pumps when needed, and then water could be released from Banks Lake back down through these six units to generate power. The total generating capacity of the pump-generating plant is 314 MW. The pumps and pump-generators cannot be throttled back to pump small amounts. Generally, they are either on or off, pumping during light load hours at rates of between 1,700 cfs and 2,000 cfs. The 2.65 MAF of water used to irrigate the majority of the CBP is lifted through the plant using a combination of the 12 pumps and pump-generators.

Reclamation has contractual obligations to provide both on-demand delivery of irrigation water and to accommodate pumped storage at Banks Lake for balancing reserves and electrical load shaping. Balancing reserves refers to the capability to quickly balance generation with dynamic loads on the system in order to maintain the reliability of the power grid. This is accomplished at the Keys Pump-Generating Plant by adjusting short-term generation (supply) or pumping loads (demand) as needed. Load shaping is accomplished through the pumped storage capabilities of Banks Lake.

The Keys Pump-Generating Plant is generally operated to meet irrigation demand in the most cost-effective manner possible, while observing physical and regulatory operating constraints. This operational goal typically results in maximizing pumping during light-load hours or low-cost energy periods, and minimizing pumping, or even occasionally generating, during heavy-load hours or higher cost energy periods. The plant's current condition is marginal to meet irrigation and balancing/loadshaping for power as historically provided. In addition, the ability to operate the pump-generators in generation mode is compromised beginning at Banks Lake elevations below 1568 amsl and is lost entirely below elevation 1,560.5 as the siphon intakes become exposed above the lower water levels.

Banks Lake

Since its construction in the early 1950s, Banks Lake has been operated and maintained to store and deliver irrigation water to CBP lands. The lake has an active storage volume of 715,000 acre-feet between elevations 1570 feet amsl (full pool) and 1537 feet amsl.

Reclamation operates Banks Lake within established constraints on water surface elevation to meet contractual obligations, ensure public safety, and protect property. This facility was sized to provide water for the ultimate development of the project; however, since its construction, the facility has not been operated at its maximum capabilities.

Between the late 1950s and 1986, Banks Lake was annually drawn down by about 10 to 15 feet, typically in the spring. However, in the early 1980s, normal water surface elevations in Banks Lake were stabilized such that annual fluctuations were usually approximately 3 feet from full. In recent years, the Banks Lake surface elevation has fluctuated within a 5-foot range, from elevation 1,570 feet to elevation 1,565 feet.

Exceptions to this have included periodic drawdowns of up to 35 feet (to surface elevation of approximately 1,535 feet amsl) for facility maintenance or to address other water/reservoir management issues. In late 1994 and early 1995, the reservoir level was drawn down about 25 feet (to elevation 1,545 feet) to perform maintenance on constructed facilities and address an aquatic infestation of Eurasian milfoil. This past fall (2011) and winter (2012), the reservoir was drawn down again to elevation 1,537.2 feet amsl primarily for the maintenance at the Main Canal headworks at Dry Falls Dam.

Since 2000, adjustments have been made in Banks Lake operations to leave more water in the Columbia River during the summer for fish flow augmentation. Pumping to Banks Lake is reduced in August, resulting in a 5-foot drawdown by the end of the month. Refill occurs typically between September and November at rates subject to operational requirements and commitments at Grand Coulee Dam and Lake Roosevelt.

Under current conditions and the No Action Alternative, beyond this planned annual drawdown, withdrawals from Banks Lake for CBP irrigation and refill of the reservoir from Columbia River flows and Lake Roosevelt are generally balanced to result in little water-level fluctuation in Banks Lake.

4.2.3.2. CBP Irrigation Water Supply, Including Water Service Contracts in the Study Area

Currently, the CBP provides irrigation water supply to more than 671,000 acres in the Columbia River Basin. Other purposes of the CBP include power production, flood control, recreation, navigation, and fish management. CBP facilities include over 330 miles of main canals, approximately 2,000 miles of laterals, and over 3,500 miles of drains and wasteways.

All of Reclamation’s current water supply obligations related to the CBP would continue to be met in all Study alternatives. Specific to the Study Area, CBP water would continue to be provided to 16,864 acres under existing water service contracts through the East Columbia Basin Irrigation District (ECBID). The locations of these lands are shown on Figure 4- 10 as Lands Irrigated with Surface Water. About 11,700 of these acres are located north of I-90 and 5,164 acres are located south of I-90.

4.2.3.3. Columbia River Basin Water Management Program

Ecology was directed through the Management Act to pursue the development of water supplies to benefit both instream and out-of-stream uses. Ecology is currently in the process of developing the Management Program to facilitate implementation of the legislation. The Management Program includes administration of the Columbia River Basin Water Supply Development Account that the legislation created to fund storage, conservation, and other projects to provide new water supplies for the Columbia River Basin (Ecology 2007).

As part of this program, the State, Reclamation, ECBID, the SCBID, and the QCBID are implementing the MOU that the parties entered into December 2004. The purpose of the MOU is to establish collaboration to secure economic and environmental benefits from improved water management within the CBP and along the mainstem Columbia River.

Specific to the Study Area, the MOU includes three provisions (MOU Sections 14 to 16):

- Cooperate to support and pursue the diversion and delivery of an additional 30,000 acre-feet of water from Lake Roosevelt to the Study Area. Water use is limited to existing agricultural lands, with priority for lands currently irrigated under State groundwater permits.

- Cooperate to explore opportunities for water delivery to additional existing agricultural lands within the Odessa Subarea.

- Conduct an appraisal-level assessment of the potential to store additional water from the Columbia River mainstem in the Odessa Aquifer.

The State would continue to pursue the Management Program, including the MOU with Reclamation and the irrigation districts, under all of the Study alternatives. The first provision of the MOU is already being implemented as the Lake Roosevelt Incremental Storage Releases Program. Action on the second provision, however, may not proceed further under the No Action Alternative, since this Study is the direct response to this provision. The third provision is ongoing, with additional analysis of two storage sites being evaluated on the Confederated Tribes of the Colville Indian Reservation.

4.2.3.4. Coordinated Conservation Program

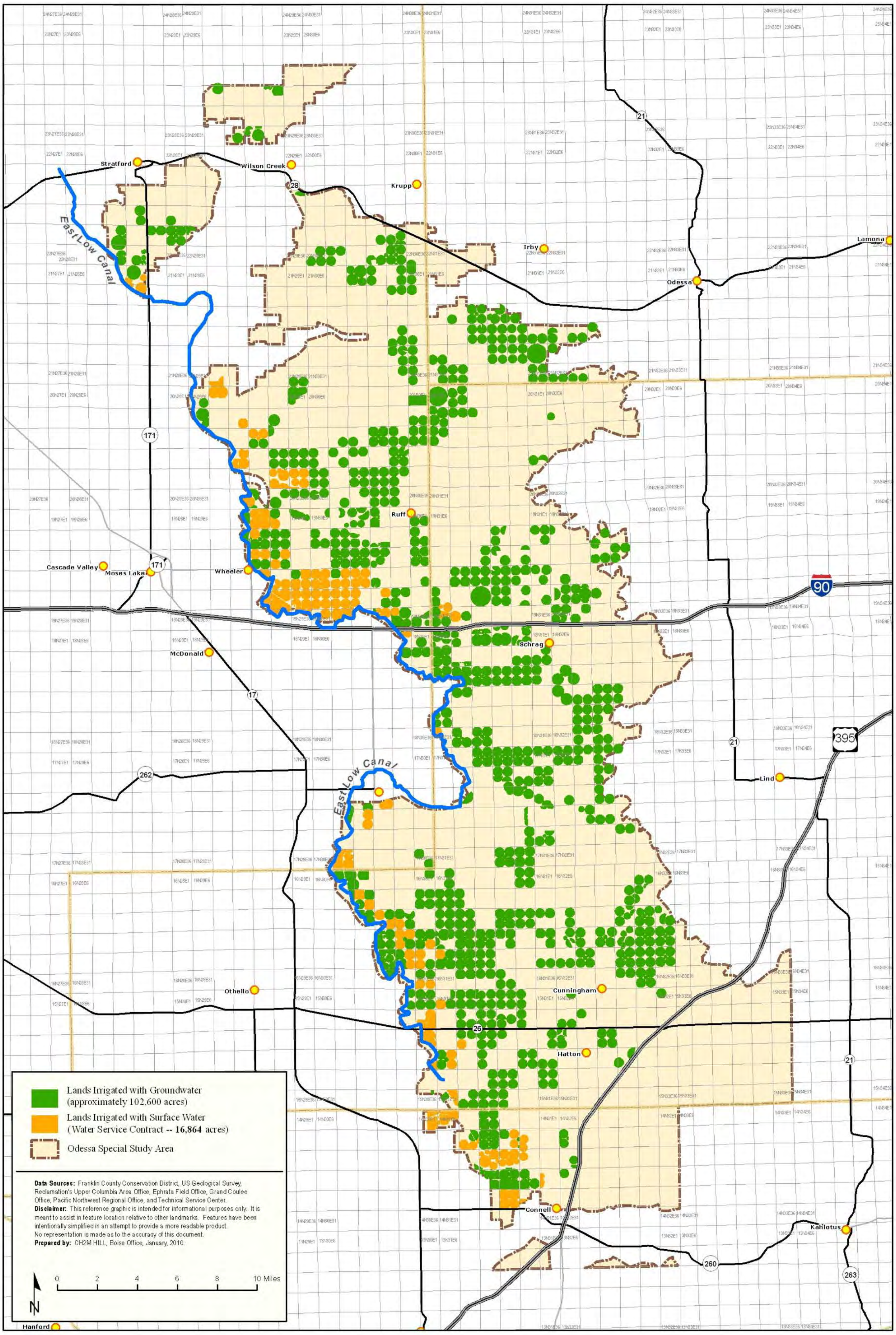
Under this program, Ecology is partnering with the ECBID, SCBID, and QCBID to pipe and line their delivery systems in the CBP. Since 2009, the Coordinated Conservation Program has resulted in approximately 10,800 acre-feet of water savings, which will provide replacement water for about 3,600 acres of groundwater irrigated land in the Odessa Subarea. This basinwide conservation program would continue under all action alternatives, and the water saved by these infrastructure improvements would be delivered to the Odessa Subarea.

4.3. Water Contract Actions

To protect the interests of the United States, general Reclamation law requires contracts for the delivery and storage of project and nonproject water; for the use of Federal facilities; and for the recovery of reimbursable project costs. Contracts are always required, unless a superseding Federal authority dictates otherwise, and must be executed pursuant to appropriate authority, whether found in general Reclamation law, project-specific legislation, or other congressional authorization. This is true whether the water is to be delivered for consumptive or nonconsumptive use.

Under all the action alternatives, contract(s) will be required for the repayment of reimbursable project costs based on the irrigator's ability to pay. Contractors' obligations to repay capital project costs under contracts made pursuant to subsection 9(d) of the 1939 Act are generally based on their ability to pay.

Reclamation's water-related contracts must protect the Federal investment and ensure that repayment of the reimbursable capital cost is made in accordance with Reclamation law. Subsections 9(c), (d), and (e) of the Reclamation Project Act of 1939 (1939 Act) require repayment of all reimbursable costs (Public Law 76-260; 43 U.S.C. § 485h[c], [d], and [e]). The methods used in recovering these costs vary.



Odessa Subarea Special Study
Columbia Basin Project, Washington

Currently Irrigated Agriculture in the Odessa Subarea Special Study Area (Study Area)

Figure 4- 10. Currently Irrigated Agriculture in the Odessa Subarea Special Study Area (Study Area)

4.3.1 Inclusion/Exclusion and Related Land Classification Actions

Some of the land in the Study Area was excluded from project development, either at the time the irrigation district formed or prior to entering into repayment contracts for the existing developed land on the CBP. The excluded land is currently not eligible to receive a Federal water supply. In order to be eligible for water from the Federal system, these land parcels would have to go through the inclusion process with the respective irrigation district and Reclamation prior to entering into any contract for the delivery of water. The inclusion process would require that some land be classified as irrigable to determine repayment and to receive Federal water under the six action alternatives.

4.4. Alternative 1: No Action Alternative

In this Study, no action means that the proposed Federal action would not take place and the resulting conditions from taking no action are compared to the effects of the action alternatives. Under the No Action Alternative, Reclamation and Ecology would not replace existing groundwater supplies with CBP surface water. Currently, farmers use groundwater to irrigate about 102,600 farmland acres in the Study Area, as shown in Figure 4- 10.

The No Action Alterative represents the foreseeable future if an action alternative is not implemented and groundwater levels continue to decline in the Study Area aquifers. Under the No Action Alternative, irrigated agriculture in the Study Area that currently relies on groundwater would continue using that source of water. With continued dependence on groundwater, aquifers would further decline in quantity and quality. As groundwater declines, well yield and irrigation capability will progressively diminish in the Study Area, resulting in a reduction of groundwater-irrigated acreage and crop yield.

4.4.1 Conditions under the No Action Alternative

4.4.1.1. Status of Groundwater Wells in the Odessa Subarea

Drilling groundwater wells within the Odessa Subarea, including the Study Area, began in the early 1960s, but drilling new wells essentially ended in the late 1980s. Groundwater levels in wells of the Odessa Subarea have steadily declined since substantive pumping began in the 1960s. Between 1984 and 2009, groundwater levels have declined an average of approximately 3.6 feet per year in the Odessa Study Area (Reclamation 2012 Groundwater). In many cases, wells have been drilled deeper to access water, or use of wells has been discontinued. Currently, most of the groundwater wells are 800 to 1,000 feet deep, but some are as deep as 2,100 feet (see Chapter 1, Figure 1−4).

During the period from September to December 2009, the GWMA interviewed well operators in the Odessa Subarea concerning the current status of well use and performance (GWMA 2010 Conditions). Using this information, GWMA characterized wells into five status levels, ranging from full delivery of permitted flow rates (Status Level 1) to failure and discontinued use (Status Level 5).

GWMA Status Levels: Describing Well Performance in the Odessa Subarea

- Status Level 1: Full Permit Delivery. The well operates within its original permitted delivery levels and specifications, and has never been deepened. The well performs within acceptable levels and irrigates high water use crops (such as potatoes) through a full season without unplanned interruption.
- Status Level 2: Full Permit Delivery, But Requiring Modifications. The well supports full permit delivery, but either has been substantially reconstructed or has had conservation measures implemented since construction. Reconstruction has deepened the well shaft, lowered pump intakes, or otherwise increased efficiency to irrigate high water use crops through a full season without unplanned interruption.
- Status Level 3: Partial Permit Delivery, But Still Supports Some High Water Crop Use. The well cannot support full permit delivery, but can sustain a high water use crop through part of a season. Although functioning, the well either fails to supply the original permit volume or cannot continue that volume for an entire season.
- Status Level 4: Low Permit Delivery and No Support of High Water Crop Use. The well has a low yield through the full season and cannot support high water use crops, even on reduced acreage. It can supply shorter season crops (such as wheat or peas), because these crops do not require irrigation after July 1.
- Status Level 5: Discontinued Use. The owner has discontinued use of a well, will not use it for any reason, and has chosen to not reconstruct or drill deeper.

The five status levels represent the life cycle of production wells in the Odessa Subarea. Wells were originally constructed for full permit delivery (Status Level 1). Over time as groundwater declines, well yield and irrigation capability progressively diminish. Typically, wells drop from Status Level 1 to Status Level 2, or Status Level 2 to Status Level 3, after the less expensive well changes have been implemented. Well changes include any or all of the following measures:

- Reducing irrigated acreage.
- Rotating to a shorter irrigation season crop.

- Lowering the level of in-well pump intakes (such as pump bowls) to offset groundwater declines through the irrigation season.
- Implementing water conservation measures to increase efficiency.

After these changes, a well could be drilled deeper, if feasible and affordable, to reach additional groundwater resources at a deeper level. GWMA considers wells entering Status Level 5 to have discontinued use permanently.

In January 2010, GWMA (2010 Survey) conducted an additional survey asking well operators in the Odessa Subarea to characterize the current status of their wells relative to the five status levels. This survey also asked well operators, if faced with well deepening as the only solution to water level decline, whether they intend to deepen their wells, or instead would reduce system use to shorter season or supplemental use only. Finally, the survey asked well operators to estimate what year current well use would be reduced to shorter season or supplemental use only.

GWMA estimates that approximately 5 percent of the wells in the Odessa Subarea currently operate within original permitted delivery levels and well specifications (Status Level 1), as shown on Table 4- 4. GWMA estimates that approximately 30 percent of the wells deliver full permit capacity after implementation of substantial well reconstruction or conservation measures (Status Level 2). Conversely, GWMA estimates that approximately 5 percent of wells have had their use discontinued (Status Level 5), with the remaining approximately 60 percent of wells operating at less-than-permitted levels and providing limited, if any, support to high water use crops (Status Levels 3 and 4).

GWMA's assessment of well decline is generally supported by observations of groundwater decline based on measured data obtained from known, reliable well records (see further discussion in Sections 3.3 and 4.3 – Groundwater Resources, in the Odessa Final EIS). In addition, a review of groundwater analysis was conducted and information from USGS 2010 report was used to verify assumption for well depths and rate of decline between 1984 and 2009 for the Final EIS (Reclamation 2012 Groundwater).

Table 4- 4. Estimated status of wells in the Odessa Subarea under current conditions and in the future

Well Status Levels	Percent of Wells By Status Level	
	Current [a]	Future: 10 Years (about 2020)[b]
Status Level 1: Full Permit Delivery	5	5
Status Level 2: Full Permit Delivery, But Requiring Modifications	30	10
Status Level 3: Partial Permit Delivery, But Still Supports Some High Water Crop Use	30	15

Table 4- 4. Estimated status of wells in the Odessa Subarea under current conditions and in the future

Well Status Levels	Percent of Wells By Status Level	
	Current [a]	Future: 10 Years (about 2020)[b]
Status Level 4: Low Permit Delivery and No Support of High Water Crop Use	30	15
Status Level 5: Discontinued Use	5	55

[a] Based on GWMA (2010 Survey) survey results. Assumed percent of wells equals percent of acres.

[b] Estimated by Reclamation's Economics and Resource Planning Group based on GWMA (2010 Survey) survey results as described further in Chapter 4, *Environmental Consequences*, Section 4.15 – *Irrigated Agriculture and Socioeconomics* in the Odessa Final EIS.

4.4.1.2. Future Risks Posed by Groundwater Conditions in the Odessa Subarea

As a result of the current conditions of groundwater decline in the Odessa Subarea, including the Study Area, the ability of farmers to irrigate their crops is at risk. Domestic, commercial, municipal, and industrial uses, as well as water quality, are potentially affected. Farmers irrigating with wells live with uncertainty about future well production. If no action is taken, GWMA (2010 Survey) estimates that wells would drop into lower status levels at a rate of 10 percent per year. Using current well status levels and the estimated rate of decline from GWMA (2010 Survey), along with other local information on agricultural trends and practices, Reclamation conducted an analysis of future conditions of well status and associated cropping patterns in the Study Area under a No Action Alternative. The methods and results of this analysis are described in Chapter 4, *Environmental Consequences*, Section 4.15 – *Irrigated Agriculture and Socioeconomics*, in the Odessa Final EIS.

The results of the GWMA analysis indicate that the proportion of the production wells in the Study Area that support high water crop use would decline from 35 percent to 15 percent by 2020 (Status Levels 1 and 2; Table 4- 4). Further, at the current rates of decline, 55 percent of the production wells in the Study Area would cease groundwater output and use of these wells would be permanently discontinued in 10 years. The remaining 30 percent of wells would operate at lower-than-permitted water delivery levels that would provide limited or no support for high water use crops (Status Levels 3 and 4; Table 4- 4).

Several factors would continue to cause disincentive for or the inability of most well owners and operators to deepen wells. As a result, these factors would lead to a continuing trend of wells dropping into lower-than-permitted water delivery levels (Status Levels 3 and 4) or discontinued use (Status Level 5) as estimated by GWMA. These factors include the following:

- **Unreliable Groundwater Quantity from Deeper Zones**. Some of the recently-deepened wells have failed to deliver sufficient quantities of water, while others are performing, but are declining in static water level each season. The deeper zones consist of older water that has resided in these zones for a very long time (thousands of years), indicating little or no active recharge. Therefore, the prospect of deepening to low or no-recharge zones discourages investment in deeper wells.
- **Impaired Water Quality in Deeper Zones**. Deep groundwater is older water with undesirable qualities, such as high pH, high salinity, high mineral content, and warm temperature. Sustained use of such water risks damaging irrigated crops and soils.
- **Uneconomical Pumping Limits Reached**. Most of the wells in the Odessa Subarea have lowered their in-well pump intakes as low as possible to achieve effective pumping. Pump intakes set below 900 feet are less effective because the pressure required to bring the water to the surface is beyond the performance capability of current economical pump equipment. Additionally, the electrical power required for 900-foot lifts is substantial (GWMA 2010 Conditions).
- **High Cost of Well Deepening**. At present, drilling deeper means going down 2,500 to 3,000 feet to reach additional groundwater resources at a deeper level. This is estimated to cost $700,000 to $1,000,000 per well (GWMA 2010 Conditions).

Drilling new groundwater wells is not a feasible solution to augment or replace existing irrigation water needs. New wells would be subject to the same future uncertainties as existing wells with declining groundwater levels in Study Area aquifers. In addition, the State is not issuing new water rights that would be required for new wells.[6]

4.4.1.3. Other Uses of Groundwater in the Study Area

Aquifers in the Odessa Subarea also supply commercial, domestic, M&I, and industrial users in and near the Study Area. For example, the cities of Moses Lake and Ritzville, the towns of Hatton and Wilson Creek, and numerous food processing and other agriculture-related businesses in Connell, Moses Lake, Othello, and Warden rely on this groundwater.

[6] New wells may be drilled and operated using the state's groundwater exemption provisions, but the exemption only applies for livestock watering, noncommercial lawn and gardens (up to 0.5 acre in size), and domestic uses up to 5,000 gallons per day.

Under the No Action Alternative, irrigation groundwater would not be replaced with surface water, aquifers would continue to decline, and all current commercial, domestic, M&I, and industrial users would be affected in and near the Study Area.

4.4.1.4. Other Water Management Programs and Requirements

Under the No Action Alternative, operations at Lake Roosevelt and Banks Lake would continue as they now occur. Lake Roosevelt would release water to meet authorized purposes, including water delivery for irrigation, municipal, and industrial uses, flood control, hydropower, recreation, and fish management. Water from Lake Roosevelt to the CBP would be lifted via the Keys Pump-Generating Plant to Banks Lake. Banks Lake would serve as a reregulation reservoir for the irrigation portion of the CBP, and water would be delivered to CBP lands through the Main Canal headworks at Dry Falls Dam.

Since 2000, adjustments have been made in Banks Lake operations to leave more water in the Columbia River during the summer for fish flow augmentation. Under the No Action Alternative, this adjustment would continue, whereby pumping from Lake Roosevelt to Banks Lake would be reduced in August by 5 feet to provide for summer fish flow augmentation in the Columbia River below Grand Coulee Dam.

Under the No Action Alternative, Reclamation's current water supply obligations related to the CBP would continue. Specific to the Study Area, CBP water would be provided to 16,864 acres under existing water service contracts through the ECBID. For existing water service contracts in the Odessa Subarea, contract holders pump directly out of the East Low Canal at 34 locations. This condition, characterized by individual, unscheduled starts and stops of pumps, decreases system efficiency and can adversely affect ECBID's ability to meet delivery commitments downstream. The No Action Alternative would not address this condition.

A specific provision of the Management Program being implemented by Ecology (as described in Section 3.5) is to pursue the development of water supply alternatives to groundwater for agricultural users in the Odessa Subarea, among other priorities (Section 90.90.020 of Chapter 90.90 RCW). Action on this specific provision, however, would not proceed further under the No Action Alternative, since this Study is the direct response to this particular provision. As a result, the No Action Alternative would fail to meet this specific provision of Chapter 90.90 RCW.

Under the No Action Alternative, two other specific activities of the Management Program would occur within the Study Area:

- The Coordinated Conservation Program (as described in Section 3.5.1) would continue to implement conservation efforts to create water savings in the

Study Area to reduce the use of groundwater for existing irrigation. Such actions and water savings would continue under the No Action Alternative.

- The Lake Roosevelt Incremental Storage Releases Program (as described in Section 3.5.1.4) would continue to implement incremental storage releases from Lake Roosevelt to supplement water supplies to benefit both instream and out-of-stream uses.

4.5. Partial Groundwater Irrigation Replacement Alternatives

The Partial-Replacement Alternatives, Alternatives 2A and 2B, would provide CBP surface water supply to approximately 57,000 acres of lands in the Study Area south of I-90 (Figure 4- 1 and Figure 4- 11). The total volume of water diverted from the Columbia River with partial groundwater replacement is estimated at 138,000 acre-feet. A small portion of currently groundwater-irrigated lands north of I-90, nearest the East Low Canal, may also be included in the Partial-Replacement Alternatives. As the surface water supply system is brought online and this water becomes available to eligible lands, the intent would be to cease operation of associated irrigation wells. Under current State regulations, the irrigation wells would not be decommissioned or abandoned. Instead, superseding state water rights would be issued and the wells would be placed in standby status, remaining operational for use in an emergency (such as an interruption of the Federal surface water delivery system). Any different scenario or mandatory decommissioning would require that the statute to be modified.

Alternatives 2A and 2B would involve the same water delivery system facilities and the same quantity of water. The delivery system would involve enlarging and extending the East Low Canal and constructing a distribution system. The alternatives vary only in the option used to store and supply CBP water.

4.5.1 Alternative 2A: Partial—Banks

The main aspects of Alternative 2A: Partial—Banks are illustrated on Figure 4- 11. As shown on the diagram, these aspects include providing water supply from Banks Lake (1), delivered through the East Low Canal (2) to currently groundwater-irrigated lands south of I-90. Major facility development associated with this alternative would be limited to enlargement and extension of the East Low Canal south of I-90 and installation of a distribution system to deliver the water from the canal to farmlands.

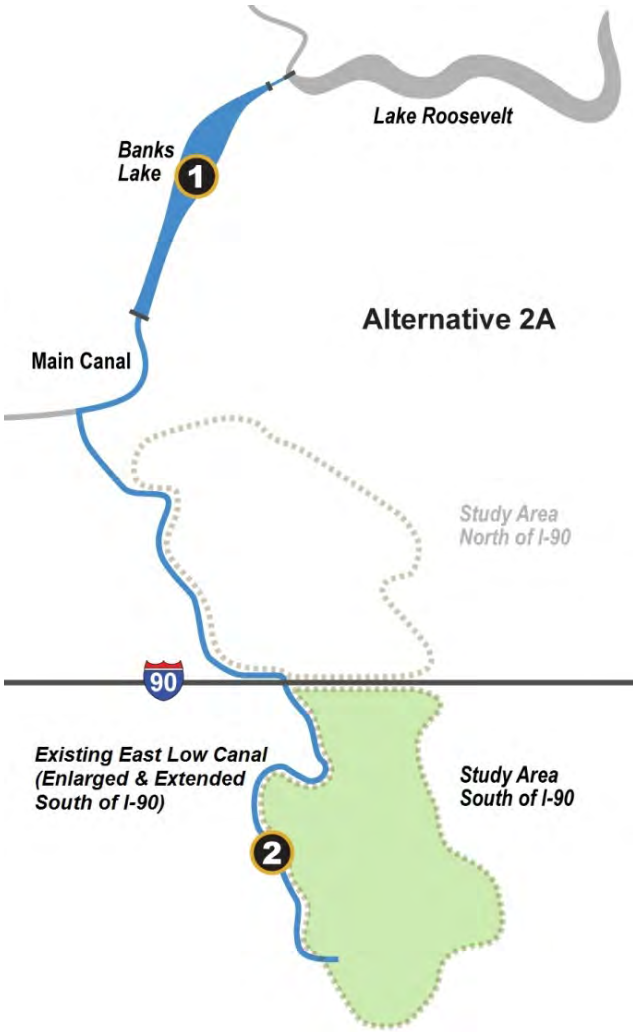


Figure 4- 11. Diagram of Alternative 2A: Partial – Banks

4.5.1.1. Water Supply

Water for the Partial-Replacement Alternatives would come from available Columbia River flows and additional drawdown of Banks Lake. Banks Lake water would be released into the Main Canal from Dry Falls Dam and diverted to the East Low Canal.

The additional drawdown of Banks Lake would be 2.3 feet (4.6 feet for Limited Spring Diversion Scenario) in an average year, beyond the 5-foot drawdown for summer fish flow augmentation in August that is part of the No Action Alternative. The total average-year maximum drawdown would be 7.3 feet (9.6 feet for Limited Spring Diversion Scenario) at the end of August (Figure 4- 2 and Figure 4- 3).

Banks Lake would be refilled as soon as practicable after the irrigation season, subject to any constraints imposed by Columbia River instream flow or operational requirements.

No construction or modification of facilities is required at Banks Lake under Alternative 2A: Partial—Banks.

4.5.1.2. Delivery System

Facility Descriptions

The water delivery system necessary for Alternative 2A: Partial—Banks and 2B: Partial — Banks + FDR is shown on Figure 4- 12. Facility development would include the following:

- Enlarging the capacity of the 43.3 miles of the East Low Canal south of I-90, including adding a second barrel to all five existing siphons.
- Extending the East Low Canal about 2.5 miles at its southern end.
- Constructing a pipeline distribution system fed by pumping plants along the canal and a gravity-feed turnout at mile 89. This system would require numerous meter and equipment stations along the pipeline routes, primarily at farm delivery points.

Other related requirements include the following:

- Potential reconstruction of some existing road bridges over the East Low Canal.
- Crossing of one local road by the East Low Canal extension.
- A new operations and maintenance (O&M) facility (Figure 4- 12).
- Additional easement width along the existing Weber wasteway.
- New electric transmission lines to each pumping plant and the O&M facility.

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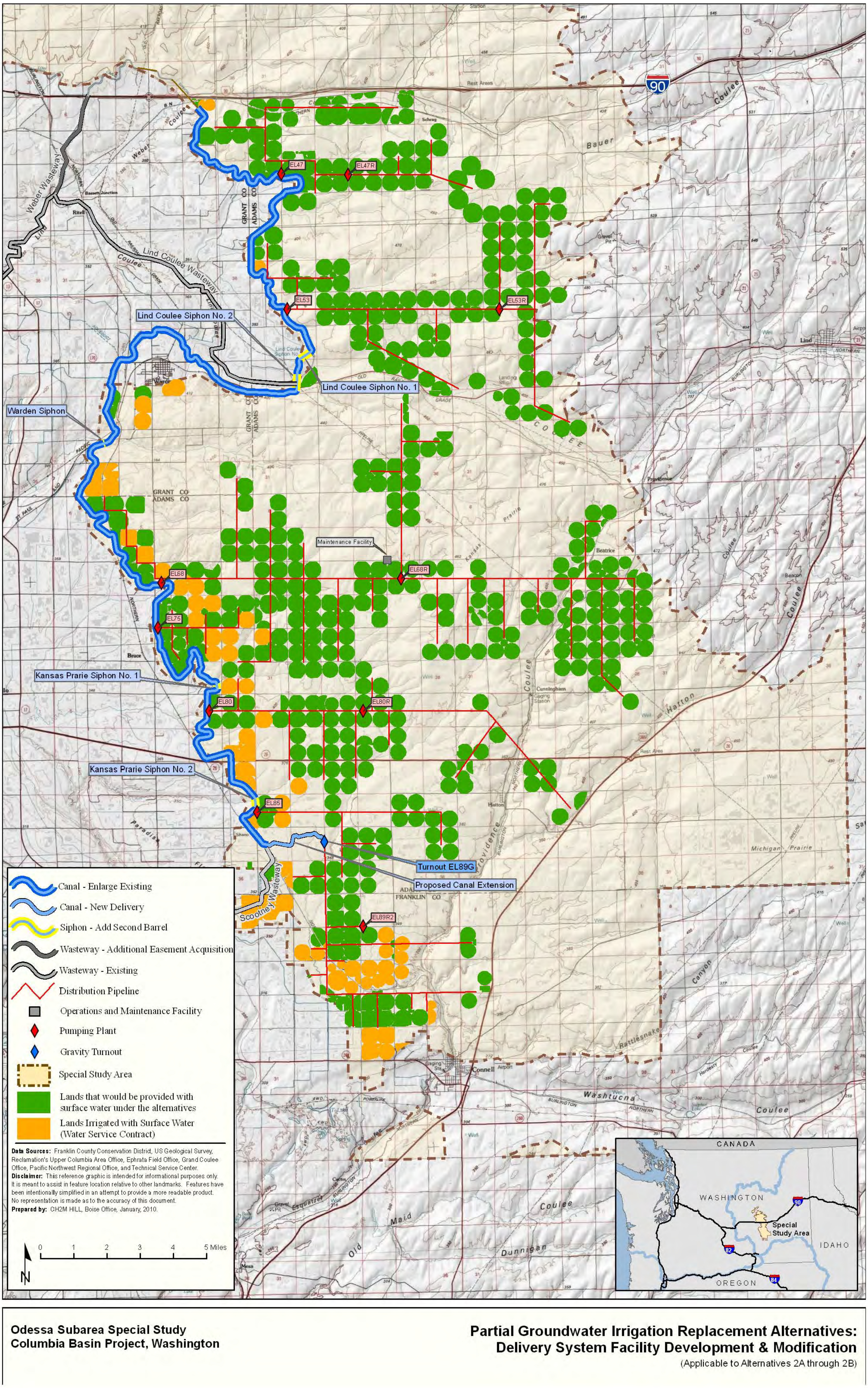


Figure 4- 12. Partial groundwater irrigation replacement alternatives – delivery system facility development and modification

Each of these facilities is described below in Table 4- 5 which provides a summary listing, including information on facility quantities and land requirements.

Table 4- 5. Partial-Replacement Alternatives – delivery system facility requirements.

Facility/Action	Quantity	Land Interest Acquisition Required	
		Type	Quantity
East Low Canal			
- Enlargement	43.3 miles	*NA--Within existing easement*	
- Extension	2.5 miles	Easement	200 feet wide
- Siphons--Add second barrel to all 5 existing	1.5 miles	*NA--Within existing easement*	
Weber Wasteway—Additional Easement Acquisition	3.0 miles	Easement	350 feet wide [a]
Pumping Plants			
Canal-side Plants (along East Low Canal)	6 Sites	Fee	3 acres each
(EL47, 53, 68, 75, 80 & 85)			
Relift Plants (EL47R, 53R, 68R, 80R, & 89R2)	5 sites	Fee	3 acres each
Gravity Turnout (EL89G)	1 site	Fee	2 acres
Distribution Pipeline < 24-inch pipe	83.2 miles	Easement	100 feet wide
Distribution Pipeline > 24-inch pipe	78.1	Easement	200 feet wide
Pipeline Meter/Equipment Sites	TBD [b]	*NA—2500 square feet within pipeline easement*	
Electric Transmission Lines [c]	84 miles	Easement	100 feet wide
Road Crossings			
- Existing bridges over East Low Canal —Reconstruct	NA[d]	*NA—Within road easement and canal easement*	
- Road Crossings By New Canal [e]	1 location		

[a] Existing Weber Wasteway easement width varies but averages 250 feet (125 feet on each side of the channel); Reclamation would acquire an additional 175 feet on each side, to bring total easement width to 600 feet.

[b] To Be Determined: Number and location not determined at this level of planning; all would be within pipeline easements.

[c] Electric power supply would be needed at each pumping plant and the operations and maintenance facility. Supplying this power would require construction of new transmission lines. For the Partial-replacement alternatives, it is expected that power would be brought to facilities from the Moses Lake area. Given this projected source, total distance of new transmission lines required is estimated to be 84 miles. The locations and routes for these new transmission lines would be determined during future design phases.

[d] Some existing road bridges across the East Low Canal may need to be lengthened/reconstructed to accommodate East Low Canal enlargement. Any such requirements would be defined during more detailed planning (see Transportation discussion in Section 4.16 – of the Odessa Final EIS).

[e] The East Low Canal extension would cross one existing road. Through traffic on this road would be closed.

NA: Not applicable

East Low Canal Enlargement

The existing earth-lined, 43.3-mile section of the East Low Canal south of I-90 to the Scootney Wasteway was constructed at 23 to 46 percent of design capacity; design capacity was determined based on potential full development of the CBP, as described in the 1989 Draft EIS for continued phased development of the CBP (Reclamation 1989). The five siphons along this reach of canal are also below design capacity, as they were constructed with one barrel (pipe), rather than the two barrels necessary to achieve full capacity.

Beyond these limitations, many aspects of East Low Canal development anticipated the potential for future expansion in their design and construction. Sufficient easement width was acquired to allow for canal expansion and the addition of the second siphon barrels. Siphon transitions, check structures, drainage inlets, cross-drainage facilities, and many of the roadway and other bridge crossings were built to accommodate full capacity.

Actions required along the East Low Canal south of I-90 for Alternative 2A: Partial—Banks and 2B: Partial—Banks + FDR would include the following:

- Widening the canal to increase its capacity to that needed for the proposed groundwater irrigation replacement. Figure 4- 13 presents a typical cross section of this widening work, which would be accomplished within the existing canal easement. All excavated material would be placed within the existing easement and existing O&M access along the canal would be maintained, similar to the approach used for initial canal construction. Concrete lining would also be added to short sections of the canal at 29 locations.

- Adding a second barrel to each of the five existing siphons (Lind Coulee 1 and 2, Warden, and Kansas Prairie 1 and 2), as illustrated in Figure 4- 14.

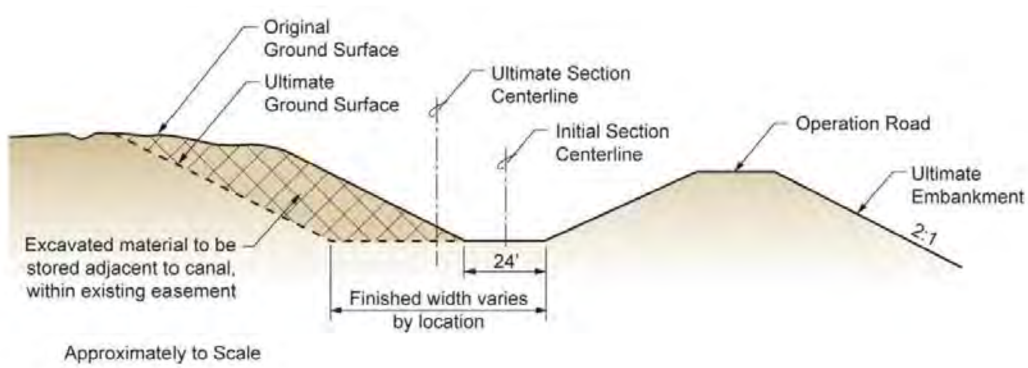


Figure 4- 13. East Low Canal enlargement – typical cross section

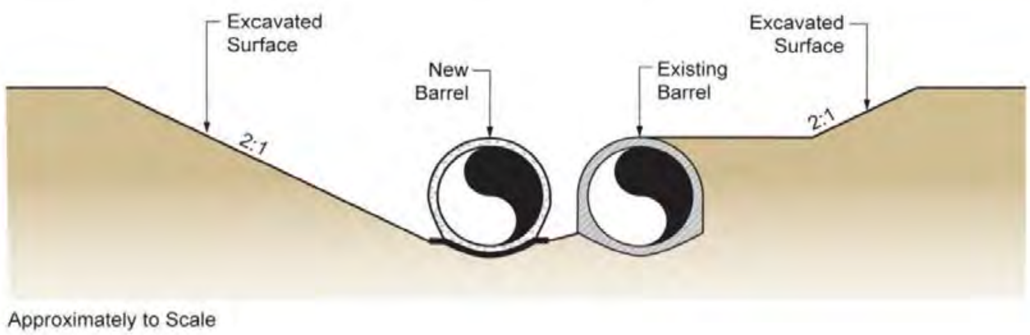


Figure 4- 14. Siphon second barrel addition – typical cross section

East Low Canal Extension

The East Low Canal would be extended approximately 2.5 miles beyond its current end. The general alignment of the extension is illustrated in Figure 4- 12, and a typical cross section of the new canal is shown in Figure 4- 15. Reclamation would acquire a 200-foot-wide easement to accommodate canal construction, operation, and maintenance. As with the existing East Low Canal, all excavated material would be placed within the canal easement and an access road would be developed and maintained along the full length of the new canal. This canal would be built only to the capacity needed for the proposed groundwater irrigation replacement. No new siphons, tunnels, or other major facilities would be required.

Figure 4- 15. East Low Canal extension – typical cross section

Distribution Pipeline System

CBP water from the East Low Canal would be provided by a pressurized pipeline distribution system to the groundwater-irrigated and water service contract lands south of I-90 that would be served in this alternative. The system would be pressurized by six canal-side pumping plants, five relift pumping plants, and one gravity-feed turnout to achieve 5 pounds per square inch (psi) at the highest delivery point. Metering stations would be located at numerous locations along the pipeline routes to record water deliveries. The following facilities would be included:

- **Distribution Pipelines**: The distribution system would require approximately 161.3 miles of buried pipeline. In general, as illustrated on Figure 4- 12, the system is designed to locate the pipelines along section and half-section lines and deliver water to typical quarter sections. Reclamation would acquire a 200-foot-wide easement for pipeline installation and would need to retain long-term access to and within the easement for any necessary repairs or replacements. These requirements would preclude any future structure development within the easement. However, except for the locations of relift pumping plants and equipment sites described in this section, agriculture or other nonstructural uses could generally continue once the pipeline is installed and operational.

- **Canal-Side Pumping Plants**: The six canal-side pumping plants that would feed the pipeline distribution system would be located on the east side of the East Low Canal, at canal miles 47, 53, 68, 75, 80, and 85. Each plant would require about 3 acres to accommodate the pumping plant equipment (no building/structure would be involved), a 6-foot to 35-foot-tall air chamber, and an electric power substation. The entire facility would be fenced for security using chain-link topped with barbed wire. A 50- to 205-foot-tall regulating tank would also be necessary with each of these pumping plants; this tank would be located along the pipeline up to 2 miles from the pumping plant site. Figure 4- 16 and Figure 4- 17 provide a conceptual site and elevation, respectively, of these pumping plants.

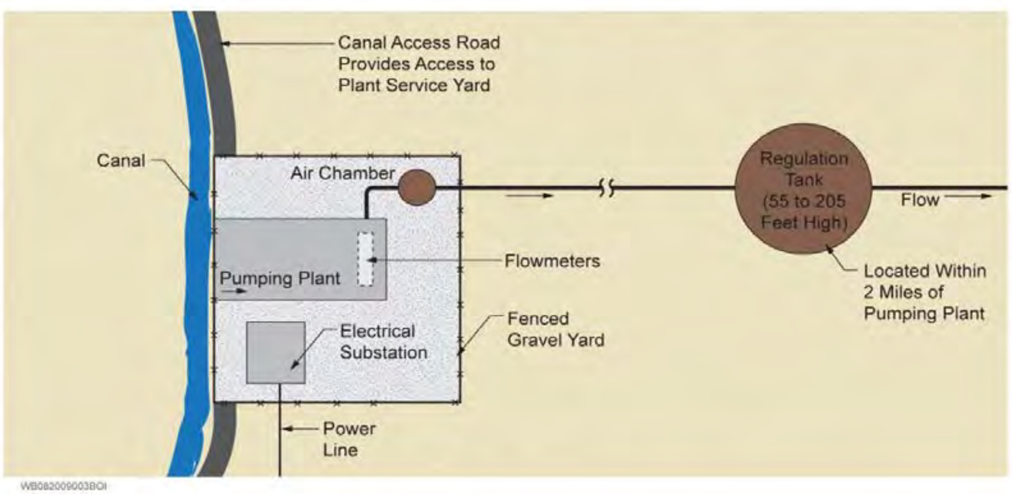


Figure 4- 16. Canal-side pumping plant conceptual site plan

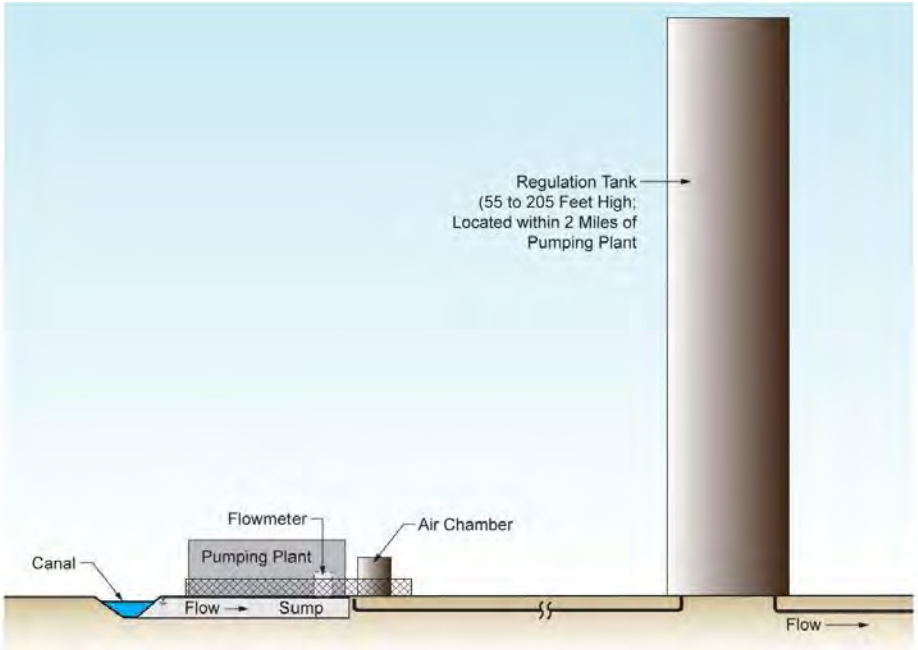


Figure 4- 17. Canal-side pumping plant conceptual elevation

- **Relift Pumping Plants**: Five relift pumping plants would be required to boost pipeline pressure in the central parts of the service area to reach the eastern-most lands. The approximate locations of these plants are shown on Figure 4- 12 and Figure 4- 18 provides a conceptual site plan. Each plant would require about 3 acres to accommodate the pumping plant equipment (as with the canal-side plants, no building would be involved), a 6- to 35-foot-tall air chamber, a 50- to 205-foot-tall regulating tank located along the pipeline up to 2 miles from the pumping plant site, and an electric power substation.

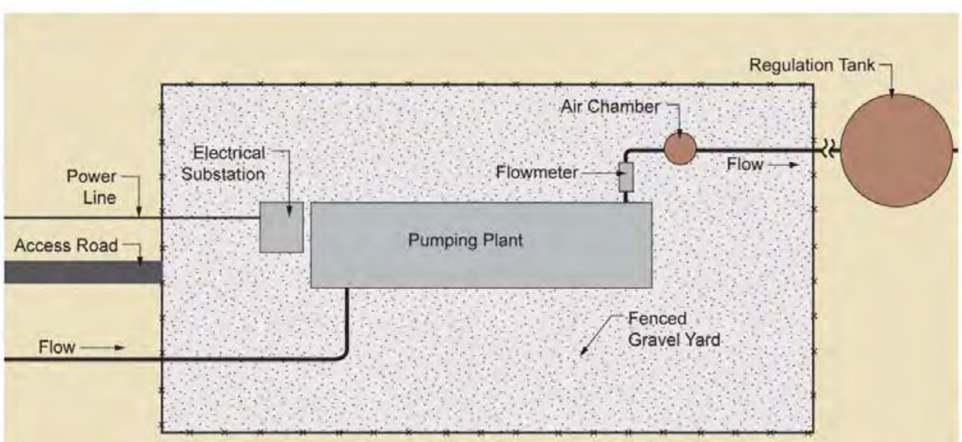


Figure 4- 18. Relift pumping plant conceptual site plan

- **Gravity Feed Turnout**: A turnout would be constructed at East Low Canal Mile 89 to deliver gravity-fed water to the pipelines serving lands at the southern end of the project area. This facility would require a 2-acre site.

- **Meter Equipment Sites**: Metering equipment would be installed at numerous locations in the water distribution pipeline system. Most of these metering sites would be located where landowners tap into the system. These sites would total approximately 2,500 square feet, all within the pipeline easement, and would be sited specifically not to interfere with existing irrigation equipment or other infrastructure. They would be placed near existing roads as much as possible.

Other Facility Requirements

- **Roadway Crossings of the East Low Canal**: Some of the existing road bridges over the East Low Canal may need to be modified to accommodate canal widening. A full review of the need for such work would be conducted during more detailed project design. In any case, it is expected that necessary modifications would remain within the existing canal and road easements.

  The East Low Canal extension would involve one new crossing of a county road. No bridge or realignment is proposed for this road. Through traffic would be rerouted to other nearby facilities (see Section 4.16 – *Transportation*, in the Final EIS).

- **O&M Facility**: An O&M facility would be built to provide support services. This facility would be approximately 7 acres in size and located at the northeast corner of South Johnson Road and West Herman Road, approximately 20 miles northeast of Othello, Washington. The main building would be 63 feet wide, 243 feet long, and 26 feet high, and would house office space, parts storage, a large maintenance shop, a welding shop, a garage area for large maintenance vehicles, and a covered outdoor storage area. Other features of the site would include two above-ground bullet-resistant double walled tanks for storage of diesel and gasoline fuel, a propane tank surrounded by concrete masonry walls, and an uncovered outdoor storage area. Much of the site would serve as a service yard for vehicle access and parking. Electrical service would need to be extended to the site. Water supply would be from a new well, and wastewater would be managed with a septic system. The entire facility would be fenced for security, using chain-link topped with barbed wire. A conceptual site plan of the facility is shown in Figure 4- 19.

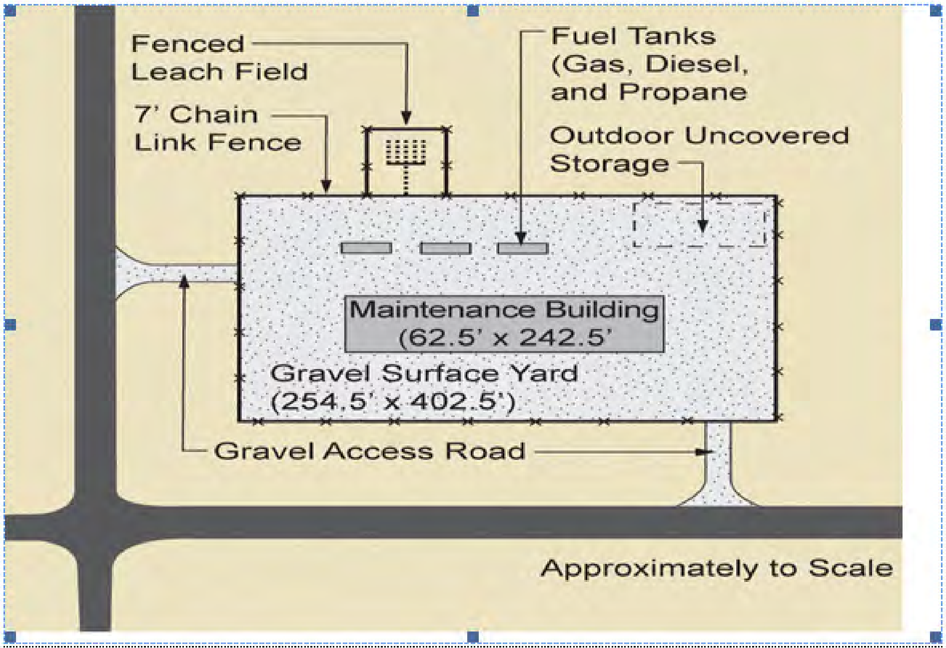


Figure 4- 19. O&M facility conceptual site plan

- **Additional Easement Width—Weber Wasteway**: The 3-mile-long constructed channel of the existing Weber Wasteway (shown on Figure 4- 12) has deteriorated over time. Rather than reconstruct the channel, Reclamation would propose to acquire additional easement width to accommodate continued operation using a natural unconstructed channel. Currently, the Reclamation easement along the wasteway averages 250 feet in width (125 feet from the channel centerline on each side); an additional (average) 175 feet easement would be acquired on each side of the channel, expanding total easement width to 600 feet. This acquisition would occur along the full 3 miles of the constructed channel alignment.

- **Electric Transmission Lines:** High voltage electric power (currently estimated at 34.5 kilovolt) would need to be provided at each of the canal-side and relift pumping stations, as well as at the O&M facility. New transmission lines would be needed to supply most, if not all of these facilities. The lines would be wood pole facilities, constructed in a 100-foot-wide easement. At the present stage of project planning, the locations and routes of these transmission lines have not been determined. However, it is expected that power would be brought from the Moses Lake area, with the requirement for new transmission lines estimated at 84 miles. During more detailed planning, these lines would be routed to reduce creation of new corridors in the landscape and to minimize impact on existing land uses by following existing power lines, roadways, railroads, or other existing linear infrastructure wherever possible.

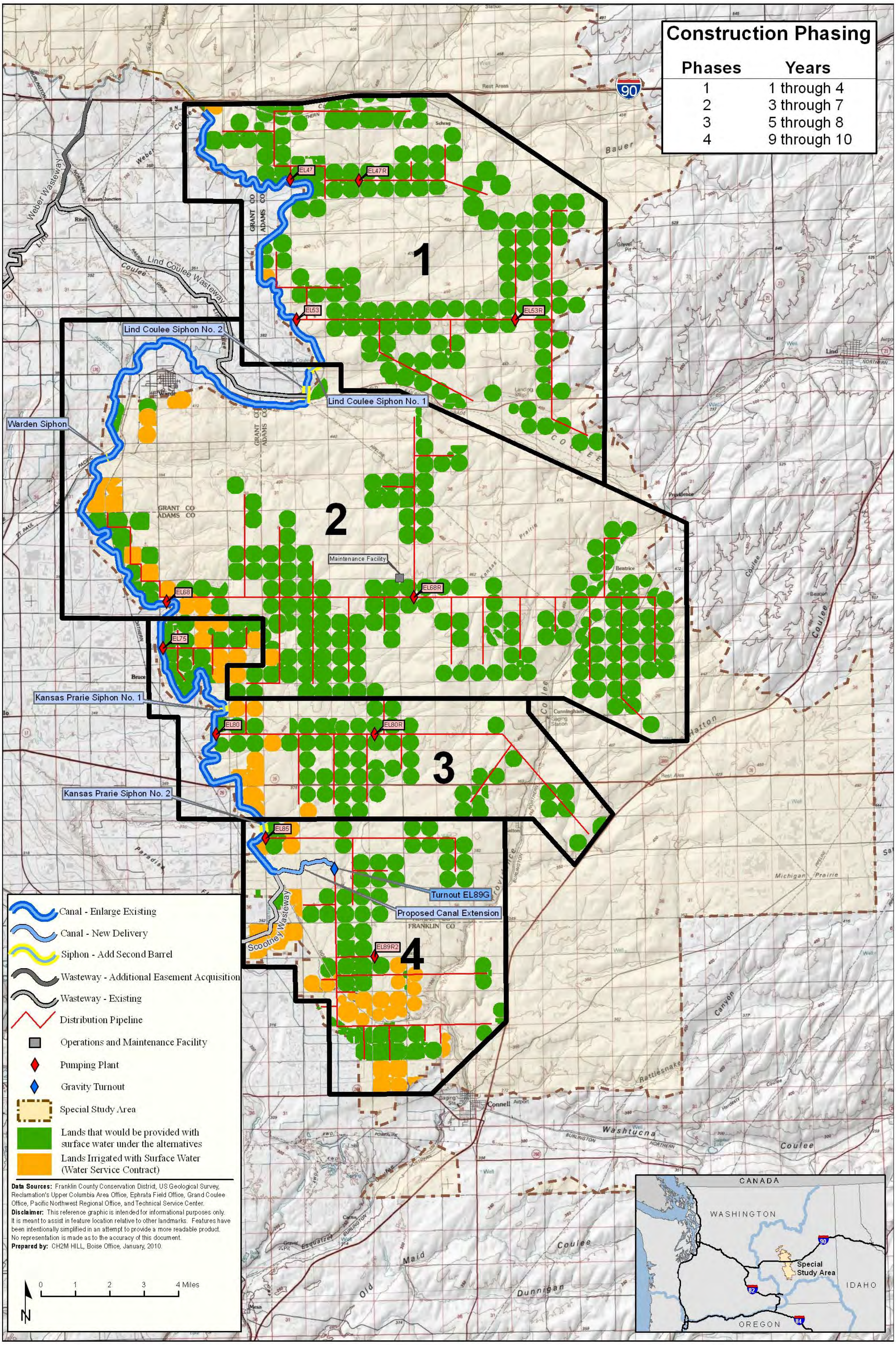
- **Access Roads**: Few, if any, permanent new access roads would be required outside of the existing and facility easements and acquisition areas associated with this alternative. Existing operations and maintenance roads along the East Low Canal would be retained and similar roads would be built along the East Low Canal extension; these roads would be used to access the canal-side pumping plants and the gravity turnout facility. For the relift pumping plants and the O&M facility, locations with existing road access would be selected to the extent feasible; however, short distances of new access road may be needed for some relift plants.

Access to distribution pipeline and power line alignments would be with existing roads or along the facility easements, as necessary. For pipeline and power line alignments, regular access would be necessary only during construction. There may be some need to use existing farm field roadways (trails) occasionally to access pipelines for appurtenant structure (air valve or blowoff) repair; any such use would be coordinated with the involved landowners.

Construction

Duration and Phasing

Development of the delivery system for Alternatives 2A and 2B would be divided into four phases, spanning a total of approximately 10 years, as shown on Figure 4- 20. Each construction phase would last 3 to 4 years, with work on two or more phases overlapping at times. Construction would be conducted in phases to spread the work as evenly as possible throughout the 10-year construction period and bring the delivery system online in stages, as early as possible.



Odessa Subarea Special Study
Columbia Basin Project, Washington

Partial Groundwater Irrigation Replacement Alternatives: Delivery System Construction Phasing

(Applicable to Alternatives 2A through 2B. *Note: Facilities and phasing are also part of the Full Replacement alternatives--see Section 2.4)*

Figure 4- 20. Partial groundwater irrigation replacement alternatives – delivery system construction phasing

Construction Workforce, Activities, Equipment, and Other Requirements

The total workforce requirement for construction of the delivery system for Alternative 2A and 2B is expected to be approximately 120 to 130 personnel at the peak level of activity, which would occur in the latter half of the construction period concurrent with work on multiple phases.

Construction activity, and thus deployment of the workforce, would occur at multiple locations simultaneously in each phase, and move progressively through the area identified for each phase. Worksites would include:

- Along the East Low Canal (widening or extension).
- Existing siphons (adding a second barrel).
- Pumping plant(s), including associated electric substations.
- Distribution pipeline alignments.
- Transmission line alignments.
- O&M facility.

Major construction in any given area is not expected to extend beyond a year and, in many cases, would be of substantially shorter duration. Work on the existing East Low Canal would be outside of the irrigation season to avoid disruption of existing water operations.

Access for facility construction would be primarily from existing public roads, Reclamation O&M roads along the East Low Canal, or temporary roads along distribution pipelines within the pipeline easements. Power lines would be installed along existing roads to the extent practical; where this is not feasible, temporary access roads would be needed along the power line easement.

Construction of the delivery system, especially canal widening and extension, would require use of heavy equipment including hydraulic excavators, large dozers, scrapers, cranes, and compaction equipment. Other equipment normally involved with major construction would also be employed, such as dump trucks, loaders, and delivery trucks (for concrete and other materials).

Staging areas would generally be located within canal, pipeline, and transmission line easements and at the sites of pumping plants and the operations and maintenance facility. To the extent possible, staging areas would be located at least 500 feet from a residence.

No disposal sites for excavated material are expected to be needed. All material excavated for canal enlargement and extension or for installation of pipelines and transmission lines would be stockpiled within the facility easements or backfilled, as appropriate.

Operation and Maintenance

Numerous activities are required to maintain irrigation system infrastructure and equipment, provide for efficient operation, and minimize unplanned outages in service. These activities include regular inspections, debris removal, cleaning, painting, resurfacing, and equipment maintenance, repair, and replacement. Collectively, these activities would not require a large workforce and only minimal use of heavy equipment. All such activities would be carried out by involved irrigation districts.

4.5.2 Alternative 2B: Partial—Banks + FDR

The primary elements of Alternative 2B: Partial—Banks + FDR are illustrated on Figure 4- 21. As shown on the diagram, these aspects include providing water supply from Lake Roosevelt (1) and Banks Lake (2) delivered through the East Low Canal (3) to currently groundwater-irrigated lands south of I-90. As with Alternative 2A: Partial—Banks, major facility development would be limited to enlargement and extension of the East Low Canal south of I-90 and installation of a distribution system to deliver the water from the canal to farmlands.

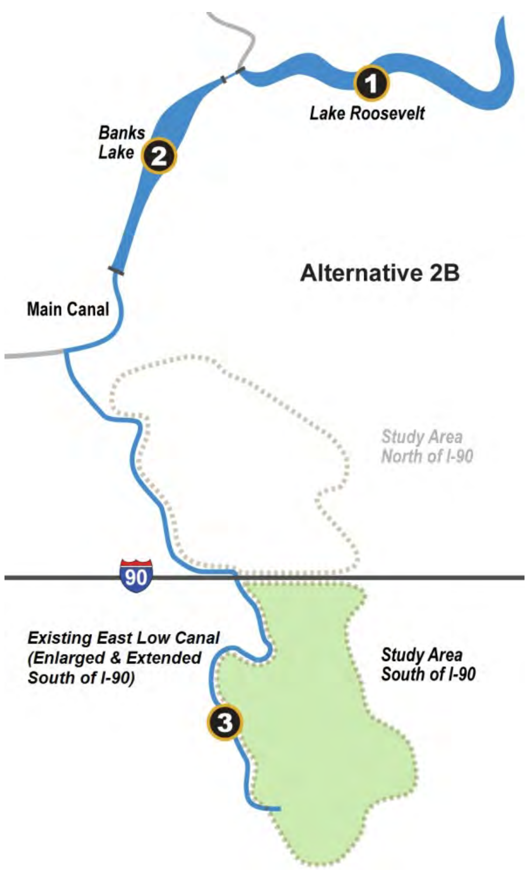


Figure 4- 21. Diagram of Alternative 2B: Partial –Banks + FDR.

4.5.2.1. Water Supply

Water for this alternative would come from available Columbia River flows and additional drawdown of both Lake Roosevelt and Banks Lake. Water from Banks Lake would be released into the Main Canal from Dry Falls Dam and diverted to the East Low Canal.

The additional drawdown of Banks Lake under this alternative would be 2.3 feet (3.0 feet for the Limited Spring Diversion Scenario) in an average water year, beyond the 5 feet of drawdown for summer fish flow augmentation that is part of the No Action Alternative. The total average-year maximum drawdown at Banks Lake would be 7.3 feet (3.0 feet for the Limited Spring Diversion Scenario) at the end of August (Figure 4- 2 and Figure 4-3).

The additional drawdown of Lake Roosevelt under this alternative would be 0 feet (0.5 feet for Limited Spring Diversion Scenario) in an average water year, beyond the No Action Alternative. The total average-year maximum drawdown at Lake Roosevelt would be 11.0 feet (11.5 feet for Limited Spring Diversion Scenario) at the end of August (Figure 4- 4 and Figure 4- 5). [7]

Reservoir refill would occur first for Lake Roosevelt, which is required to be at water surface elevation 1,283 feet amsl by the end of September. Banks Lake would then be refilled as soon as practicable subject to any constraints imposed by Columbia River instream flow or other operational requirements.

No construction or modification of facilities is required at either Lake Roosevelt or Banks Lake under Alternative 2B: Partial—Banks + FDR.

4.5.2.2. Delivery System

Delivery system facility requirements, construction, and O&M for this alternative would be the same as those described in Section 4.5.1.2.

4.6. Full Groundwater Irrigation Replacement Alternative

Full-replacement alternatives would provide CBP surface water supply to replace existing groundwater supply for most lands in the Study Area now irrigated with groundwater (approximately 102,600 acres), both north and south of I-90. The total volume of water diverted from the Columbia River would be approximately 273,000 acre-feet. As the surface water supply system is brought online and this water becomes available to eligible lands, the intent would be to cease operation of associated irrigation wells.

[7] For 50 percent of the average water years, FDR would draft 11 feet and 50 percent would draft 13 feet. Based on this requirement, roughly 50 percent of the time in average water years, FDR would draft 13 feet.

Under current State regulations, the irrigation wells would not be decommissioned or abandoned. Instead, superseding state water rights would be issued and the wells would be placed in standby status, remaining operational for use in an emergency (such as an interruption of the Federal surface water delivery system). Any different scenario or mandatory decommissioning would require that the statute to be modified.

Each of the two Full-Replacement Alternatives would involve the same water delivery system facilities and the same quantity of water. Delivery would require all facilities described for the Partial-Replacement Alternatives, plus development of the East High Canal System north of I-90 (Figure 4- 22). Each of the Full-Replacement Alternatives vary only in the option used to store and supply CBP water.

The two Full-Replacement Alternatives include the following:

- Alternative 3A: Full—Banks consisting of full replacement using the Banks Lake supply.
- Alternative 3B: Full—Banks + FDR consisting of full replacement using the Banks Lake and Lake Roosevelt supply.

The two Full-Replacement Alternatives are described in the following sections, including summaries of water supply aspects and more detailed information about required facility development.

4.6.1 Alternative 3A: Full—Banks

The primary elements of Alternative 3A: Full—Banks are illustrated on Figure 4- 22. As shown on the diagram, these include providing a water supply from Banks Lake (1) delivered through the existing East Low Canal (2) and a new East High Canal system (3) to groundwater-irrigated lands north and south of I-90. Major facility development would include:

- The same East Low Canal enlargement and pressurized pipeline system south of I-90 described for Partial-Replacement Alternatives, and
- The new East High Canal system, a reregulating reservoir, and an associated pressurized pipeline distribution network.

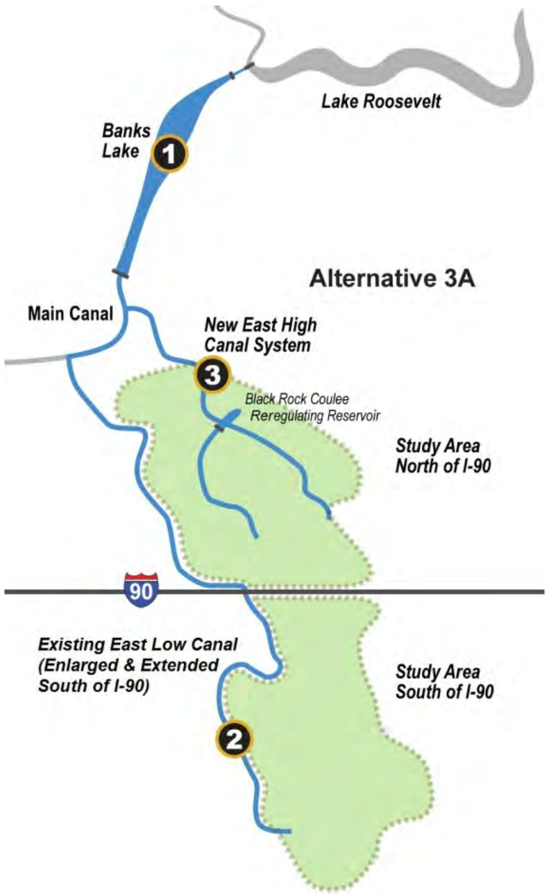


Figure 4- 22. Diagram of Alternative 3A: Full – Banks

4.6.1.1. Water Supply

Water for this alternative would come from available Columbia River flows and additional drawdown of Banks Lake. Water from Banks Lake would be released into the Main Canal from Dry Falls Dam and diverted to the East High and East Low canals.

The additional drawdown of Banks Lake would be 5.6 feet (9.8 feet for the Limited Spring Diversion Scenario) in an average year, beyond the 5 feet of drawdown for summer fish flow augmentation that 10.6 feet (14.8 feet for the Limited Spring Diversion Scenario) at the end of August (Figure 4- 2 and Figure 4- 3).

Banks Lake would be refilled as soon as practicable after the irrigation season subject to any constraints imposed by Columbia River instream flow or other operational requirements.

No construction or modification of facilities at Banks Lake would be required.

4.6.1.2. Delivery System

Facility Descriptions

The water delivery system for Alternative 3A: Full—Banks would require development of all facilities described for the Partial-Replacement Alternatives under Alternative 2A: Partial—Banks (Section 4.5.1) to serve acreage south of I-90. To serve acreage north of I-90, the following additional facilities would be developed (Figure 4- 23).

- 78.4 miles of new canal (including associated siphons and tunnels), comprised of the 44.8 mile East High Canal and the 26.8 mile Black Rock Branch Canal.
- Four new wasteway channels, 2.8 miles long, to manage canal flow.
- A reregulating reservoir in Black Rock Coulee (Black Rock Coulee Reregulating Reservoir), including a pumping plant to lift water from the reservoir to the Black Rock Branch Canal.
- A pipeline distribution system involving 187.3 miles of pipeline fed by 15 pumping plants and three gravity turnout facilities along the East High and Black Rock Branch Canals, and three relift pumping plants (two associated with the East High Canal and one associated with the Black Rock Branch Canal).

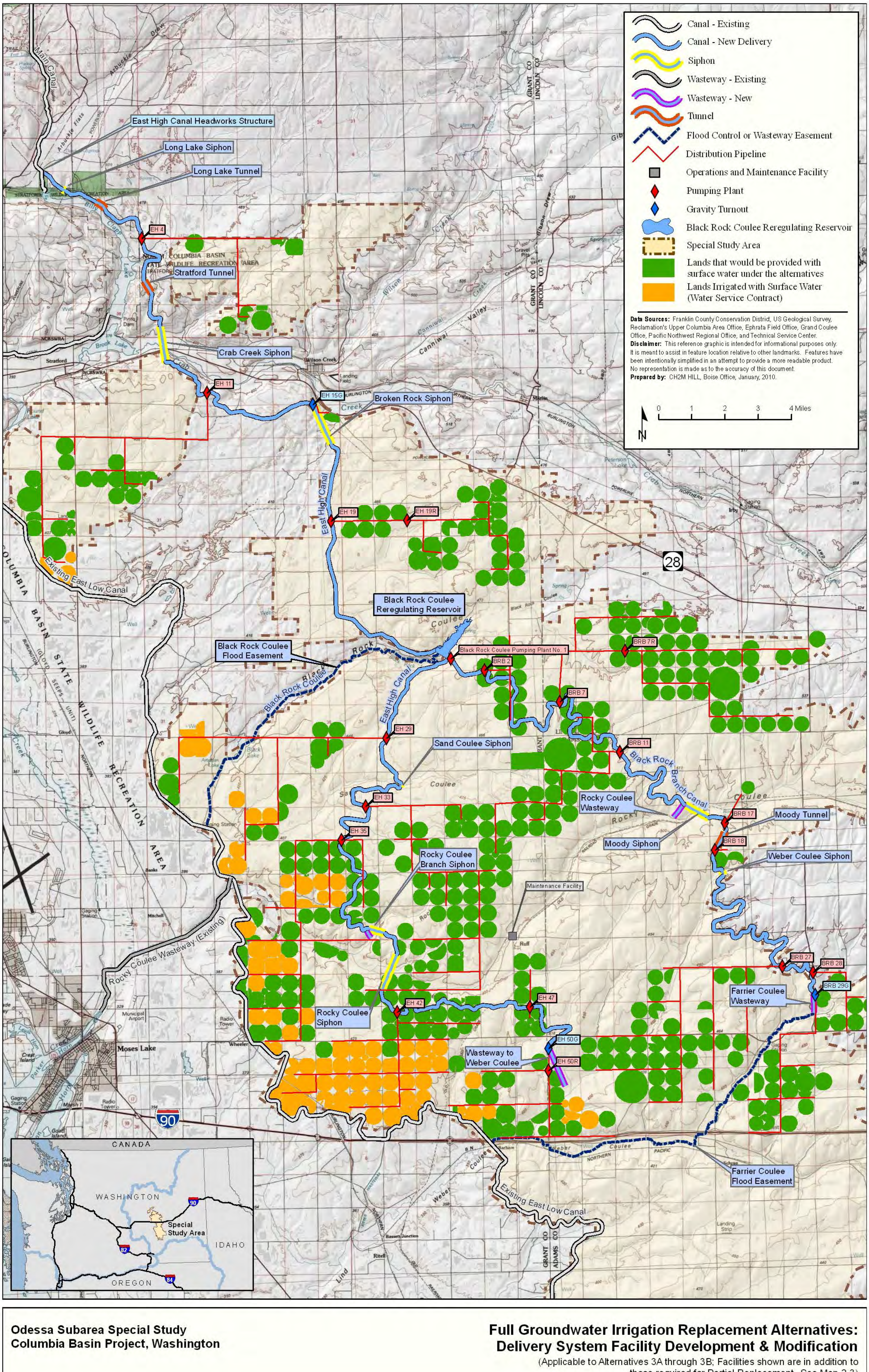


Figure 4- 23. Full groundwater irrigation replacement alternatives: delivery system facility development and modification.

Other related requirements include the following:

- Approximately 60 crossings of existing roadways and one crossing of an existing railroad by new canal.
- Limited instances and lengths of new, long-term access roads.
- Eleven wildlife crossings.
- Wildlife escape ramps at each canal check structure, at all siphon and tunnel portals, and along concrete lined canal reaches.
- A new O&M facility (Figure 4- 23).
- New electric transmission lines to each pumping plant and the O&M facility.

Canals

Under Alternative 3A: Full—Banks, 71.6 miles of new canal would be required to serve groundwater-irrigated lands north of I-90. This canal would be constructed in three main reaches: East High Canal north of the reregulating reservoir (21.4 miles), East High Canal south of the reregulating reservoir (23.4 miles), and Black Rock Branch Canal originating at the reregulating reservoir (26.8 miles). These distances do not include associated siphon and tunnel reaches along the canal alignments.

The East High Canal would be concrete lined. Most of the Black Rock Branch Canal would be earth lined because the native soils along the canal alignment can be compacted to serve as canal lining with minimal seepage. In the limited instances where this is not the case, concrete lining would be installed. This new canal would be constructed within a 200-foot easement, with all material excavated for the canal deposited within the easement. A typical cross section of the canal is shown in Figure 4- 24.

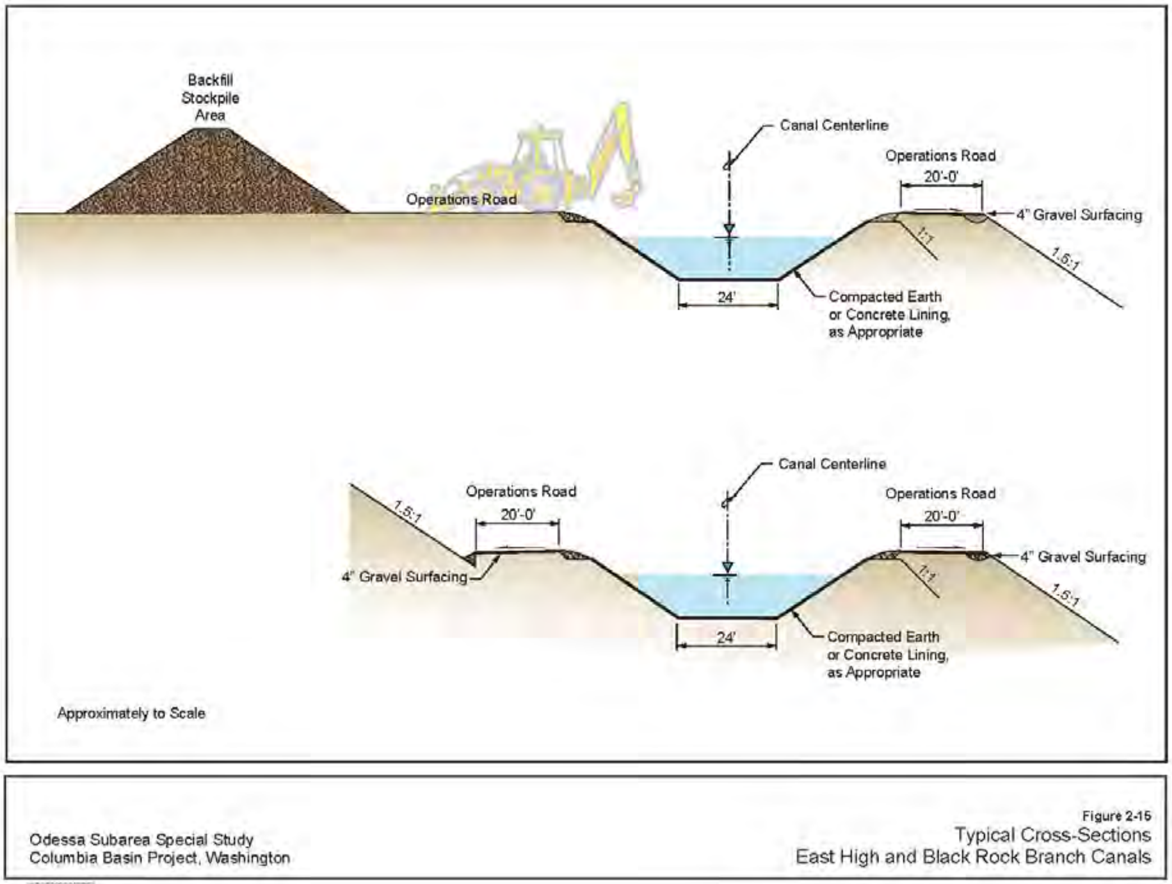


Figure 4- 24. Typical cross section East High and Black Rock Branch canals

The new canal would not be constructed to the full capacity that would be needed to serve full development of the CBP if a decision is made in the future to pursue full CBP development. Instead, for the purposes of the Full-Replacement Alternative, the canal would be built to approximately 15 percent of full capacity which is the size necessary to serve groundwater-irrigated lands in the Study Area.

As part of East High Canal and Black Rock Branch Canal development, a bifurcation along the Main Canal (the East High Canal Headworks Structure) would be needed, as well as eight siphon and three tunnel sections. The locations of these facilities along the canals are shown on Figure 4- 23. Table 4- 6 lists the facilities, including information on quantities and land requirements.

Table 4- 6. Full-Replacement Alternatives – delivery system facility requirements.

Facility/Action	South of I-90 (Figure 4- 23)	North of I-90 (Figure 4- 12)	Total	Land Interest Acquisition Required	
				Type	Quantity
Canals					
East Low Canal (primarily enlargement)					
- Enlargement	43.3 miles	-	43.3 miles	*NA—Within existing easement*	
- Extension	2.5 miles	-	2.5 miles	Easement	200 feet wide
- Siphons--Add second barrel to all 5 existing	1.5 miles	-	1.5 miles	*NA—Within existing easement*	
East High Canal System (new facilities)					
- Headworks Structure	-	1 site	1 site	*NA—Within canal easements*	
- New Canal	-	71.6 miles	71.6 miles	Easement	200 feet wide
East High Canal North Reach	-	21.4 miles			
East High Canal South Reach	-	23.4 miles			
Black Rock Branch Canal	-	26.8 miles			
- New Siphons (8)	-	5.5 miles	5.5 miles	Easement	200 feet wide
- New Tunnels (3)	-	1.3 miles	1.3 miles	Easement	200 feet wide
Wasteways-Constructed Channels					
Existing (Weber)—Additional Easement Acquisition	3.0 miles		3.0 miles	Easement	350 feet wide[a]
New		2.8 miles	2.8 miles	Easement	200 feet wide
- To Weber Coulee from East High Canal		1.3 miles			
- To Rocky Coulee from East High Canal		0.3 miles			
- To Rocky Coulee from Black Rock Branch Canal		0.5 miles			
- To Farrier Coulee from Black Rock Branch Canal		0.6 miles			
Drainage/Flowage Easements					
Black Rock Coulee		6.0 miles	6 miles	Easement	1,200 feet wide
Farrier Coulee		13.2 miles	13.2 miles	Easement	1,200 feet wide

Facility/Action	South of I-90 (Figure 4- 23)	North of I-90 (Figure 4- 12)	Total	Land Interest Acquisition Required	
				Type	Quantity
Reservoir					
Black Rock Coulee Reregulating Reservoir	-	1300 acres	1,300 acres	Fee	1,300 acres
Pumping Plants					
Black Rock Coulee Pumping Plant 1 (water from reregulating reservoir to Black Rock Branch Canal)		1 site	1 site	*NA—Within reregulating reservoir acquisition area*	
Canal-side Pumping Plants (distribution system)	6 sites	15 sites	21 sites	Fee	3 acres each
- East Low Canal (EL47, 53, 68, 75, 80 & 85)	6 sites	-	6 sites		
- East High Canal (EH4, 11,19, 29, 33, 35, 42, & 47)	-	8 sites	8 sites		
- Black Rock Branch Canal (BRB2, 7, 11, 17, 18, 27, 28)	-	7 sites	7 sites		
Relift Pumping Plants	5 sites	3 sites	8 sites	Fee	3 acres each
- East Low Canal (EL47R, 53R, 68R, 80R, & 89R2)	5 sites		5 sites		
- East High Canal (EH19R, 50R)		2 sites	2 sites		
- Black Rock Branch Canal (BRB7R)		1 site	1 site		
Gravity Turnout	1 site	3 sites	4 sites	Fee	2 acres
- East Low Canal (EL89G)	1 site		1 site		
- East High Canal (EH15G & EH50G)		2 sites	2 sites		
- Black Rock Branch Canal (BRB29G)		1 site	1 site		
Distribution Pipeline	161.3 miles	187.3 miles	348.6 miles	Easement	200 feet wide
Distribution Pipeline < 24-inch pipe	83.2 miles	10 miles	185.1 miles	Easement	100 feet wide
Distribution Pipeline > 24-inch pipe	78.1 miles	85.4 miles	163.5 miles	Easement	200 feet wide
East Low Canal	161.3 miles				
East High and Black Rock Branch Canals		187.3 miles			
Pipeline Meter/Equipment Sites	TBD [b]	TBD [b]	TBD [b]	*NA—2500 square feet within pipeline easement*	

Facility/Action	South of I-90 (Figure 4- 23)	North of I-90 (Figure 4- 12)	Total	Land Interest Acquisition Required	
				Type	**Quantity**
Electric Transmission Lines [c]	84 miles	127 miles	211 miles	Easement	100 feet wide
Road and Railroad Crossings					
Existing bridges over East Low Canal--Reconstruct	TBD [d]	TBD [d]	TBD [d]	*NA—Within road easement and canal easement*	
Road Crossings By New Canal [e]	1 location	~60 locations	~61 locations	*NA—Within road easement and canal easement*	
Railroad Crossings By New Canal [f]	-	1 location	1 location	*NA—Within road easement and canal easement*	
Wildlife Bridges	-	11 locations	11 locations	*NA—Within canal easements*	
New Access Roads	TBD [f]	TBD [f]	TBD [f]	Easement	TBD [f]

[a] Existing Weber Wasteway easement width varies but averages 250 feet (125 feet on each side of the channel); Reclamation would acquire an additional 175 feet on each side, to bring total easement width to 600 feet.

[b] To Be Determined: Number and location not determined at this level of planning; all would be within pipeline easements.

[c] Electric power supply would be needed at each pumping plant and the operations and maintenance facilities. Supplying this power would require construction of new transmission lines. As noted above for the Partial-replacement alternatives, it is expected that power would be brought to facilities south of I-90 from the Moses Lake area, requiring an estimated 84 miles of new transmission lines. For facilities north of I-90, power would be brought from Grand Coulee, with a requirement for new transmission lines estimated at 127 miles. The locations and routes for these new transmission lines would be determined during future design phases.

[d] To Be Determined: Some existing road bridges along the ELC may need to be lengthened/reconstructed to accommodate ELC expansion. Any such requirements would be defined during more detailed planning (See Transportation discussion in Section 4.16 ofthe Final EIS).

[e] New canal alignments cross existing roads at one location under the Partial-Replacement Alternatives and an estimated additional 60 locations under the Full-Replacement Alternatives. The Full-Replacement Alternatives would also involve one crossing of an existing railroad line. See Section 4.16 in the Odessa Final EIS for discussion of how these crossings would be addressed.

[f] To Be Determined: For Partial-Replacement Alternatives, all construction and long-term access would be from existing roads, O&M roads along canals, and/or temporary roads along pipeline and transmission line easements. For Full-Replacement Alternatives, need for new roads is undetermined at this level of planning; both construction and long term access would be predominantly from existing roads, O&M roads along canals, and temporary roads along pipeline and transmission line easements.

NA: Not Applicable

- **East High Canal Headworks Structure**: This bifurcation is where water from the CBP Main Canal would be diverted to the East High Canal for delivery to all lands to be served north of I-90. This structure would include a radial gate at the upstream end of the East High Canal. A conceptual site plan of the structure is provided in Figure 4- 25. This facility would be constructed entirely within the current easement of the existing Main Canal and the new 200-foot easement acquired for the East High Canal. All soil and rock material excavated for development of the bifurcation structure would be deposited within the easements.

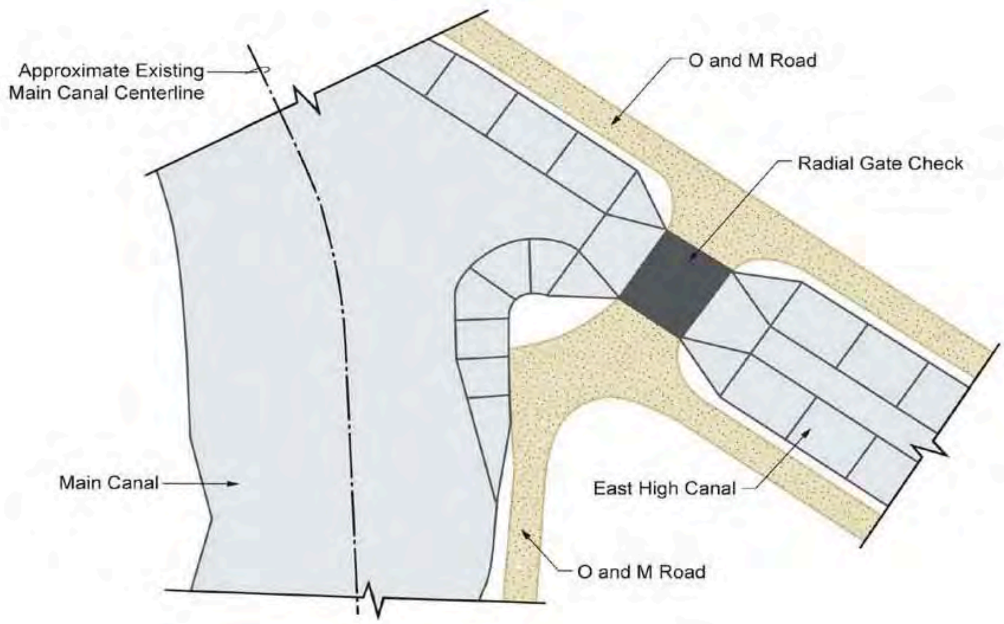


Figure 4- 25. East High Canal headworks structure – conceptual site plan

- **Siphons**: Three siphons would be constructed along the East High Canal north of the reregulating reservoir. Three would be required along the East High Canal south of the reservoir and two would be needed along the Black Rock Branch Canal. The locations of these facilities are shown on Figure 4- 23. All siphons would be constructed within a 200-foot easement with all material excavated for siphon installation deposited within this easement. Figure 4- 26 illustrates a typical siphon cross section.

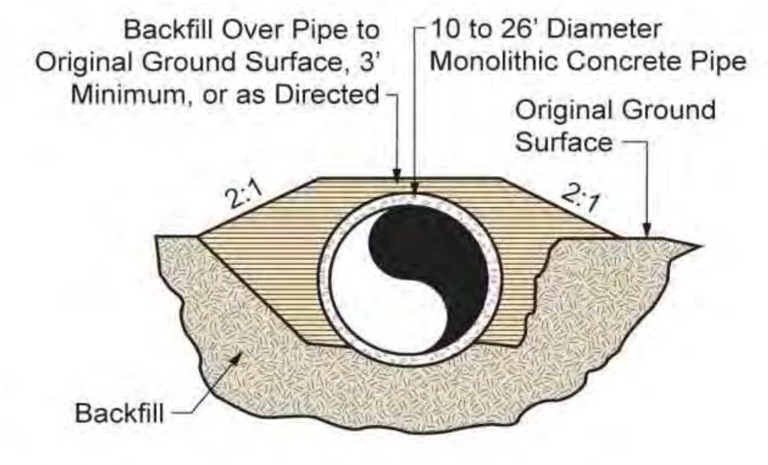


Figure 4- 26. Typical siphon cross section

- **Tunnels**: Two tunnel sections would be constructed as part of the East High Canal north of the reregulating reservoir and one would be located along the Black Rock Branch Canal. The locations of these tunnels are shown on Figure 4-23. The tunnel portals would be constructed within the 200-foot canal easement, and a 200-foot surface easement would be acquired along the tunnel alignments. Material excavated for tunnel development would be deposited within the canal easement at or near the tunnel portals.

Wasteways

Wasteways provide outlets from canals that are needed to manage water flow as demand changes, to receive return flows from irrigated lands and drains, and in case of pump equipment failure. Four wasteways would be constructed along the new canal; two along the southern portion of the East High Canal, and two along the Black Rock Branch Canal. The locations of these wasteways are illustrated on Figure 4- 23. The wasteways along the East High Canal would discharge to Rocky and Weber Coulees. Those along the Black Rock Branch Canal would discharge to Rocky and Farrier Coulees. The lengths of each of these are noted on Table 4- 6. Each of these wasteways would be constructed within a 200-foot-wide easement.

For the Farrier Coulee wasteway, Reclamation would also acquire a 1,200-foot-wide easement along approximately 13 miles of the natural coulee downstream of the constructed channel. This easement acquisition would be for the purposes of project operation and maintenance; additional uses of the easement land would be for fish and wildlife purposes.

Black Rock Coulee Reregulating Reservoir

A reregulating reservoir would be constructed in Black Rock Coulee to manage water delivery and distribute water to both the southern portion of the East High Canal and the Black Rock Branch Canal. The reservoir would have a storage capacity of 4,800 acre-feet, an active storage of 600 acre-feet, and a surface area of 225 acres at full pool. The reservoir dike would be a zoned earthfill embankment, approximately 50 feet high, 2,500 feet long, and 24 feet wide at its crest. Fill material for dike construction would be obtained from within the reservoir acquisition area. A conceptual site plan of the reservoir and related facilities is shown on Figure 4- 27.

In its role as a reregulating reservoir, this facility would not be significantly drawn down at any point during the year. Water levels would be relatively stable near full pool, fluctuating in a narrow range.

In addition to the dike and reservoir, the site would include a pumping plant to lift water from the reservoir into the Black Rock Branch Canal, as shown on Figure 4- 27.

Reclamation would also acquire a 1,200-foot-wide easement along the channel of Black Rock Coulee downstream of the reregulating reservoir dike. Similar to the easement along the Farrier Coulee channel downstream of the constructed wasteway, this easement acquisition would be for the purposes of project O&M. Additional uses of the land would be for fish and wildlife purposes.

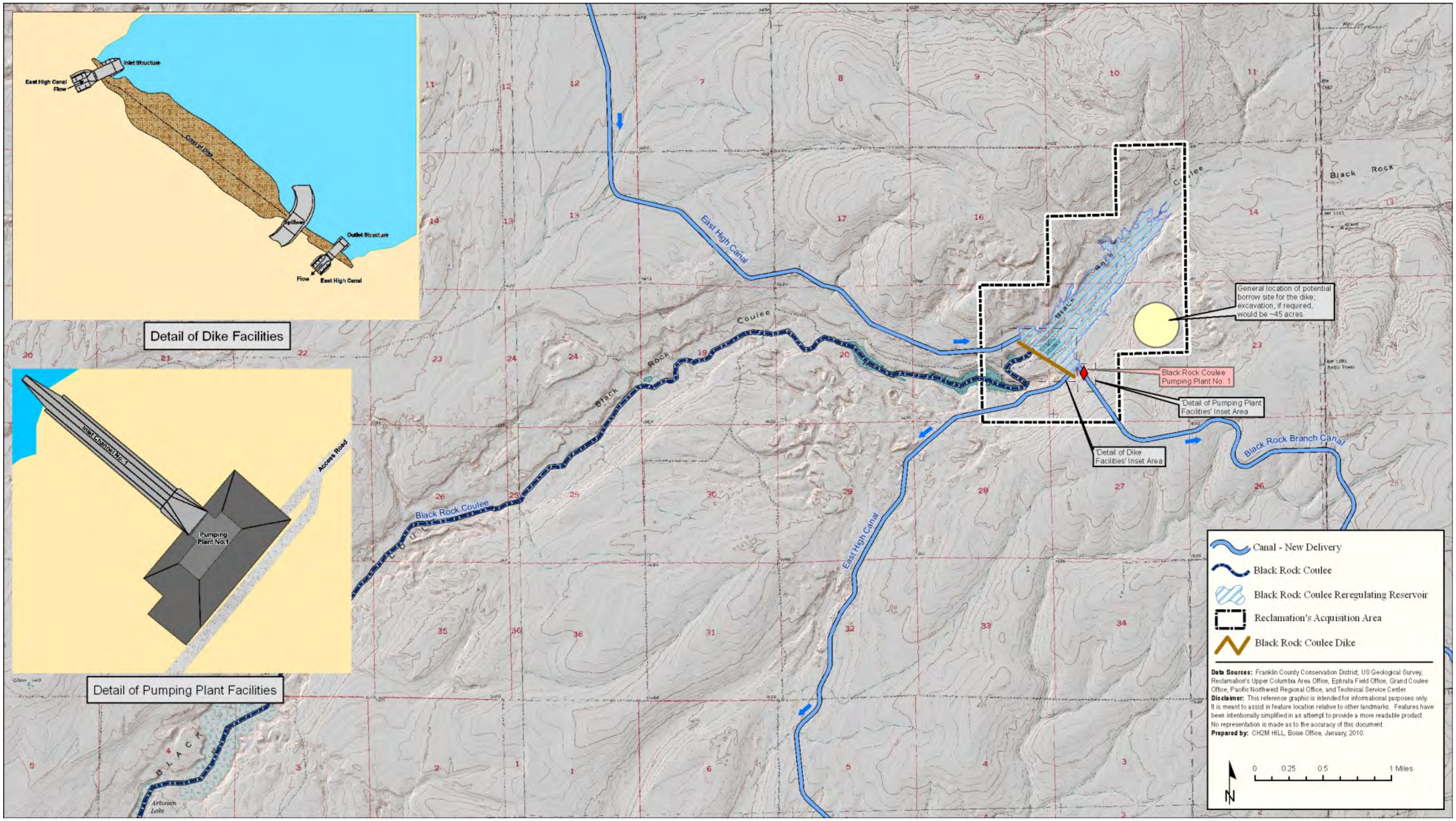


Figure 4- 27. Black Rock Coulee reregulating reservoir

Distribution Pipeline System

CBP water from the East High Canal and Black Rock Branch Canal would be provided by a pressurized pipeline distribution system to the groundwater-irrigated and water service contract lands north of I-90. The pipeline system would be fed by 15 canal-side pumping plants, three relift pumping plants, and three gravity turnouts, and would be pressurized to provide a minimum of 5 psi at the highest delivery points. At numerous locations along the pipeline routes, metering stations would be located to record water deliveries. Figure 4- 23 illustrates the preliminary layout the pipeline system and locations of the pumping plants and gravity turnouts. Additional information on these facilities is provided below and summarized on Table 4- 6.

- **Distribution Pipelines**: The distribution system from the East High Canal and Black Rock Branch Canal would consist of approximately 187.3 miles of buried pipeline. In general, as illustrated on Figure 4- 23, the system is designed to locate the pipelines along half-section lines and deliver water to quarter-sections. Reclamation would acquire a 200-foot-wide easement for pipeline installation, and to retain long-term access for any necessary repairs or replacements. These requirements would preclude any future structure development within the long-term easement; however, agriculture or other nonstructural uses could generally continue once the pipeline is installed and operational.

- **Canal-Side Pumping Plants**: As shown on Figure 4- 23, three canal-side pumping plants would be located along the East High Canal north of Black Rock Coulee Reregulating Reservoir (at canal miles 4, 11, and 19), five would be along the East High Canal south of the reservoir (at canal miles 29, 33, 35, 42, and 47), and seven would be along the Black Rock Branch Canal (at canal miles 2, 7, 11, 17, 18, 27, and 28). The site requirements and facilities at each of these stations would be the same as described for the plants south of I-90 in Section 4.5.1.2 and illustrated in Figure 4- 16 and Figure 4- 17.

- **Relift Pumping Plants**: Three relift pumping plants (two associated with the East High Canal and one associated with the Black Rock Branch Canal) would be required to boost pipeline pressure in the central parts of the service area to reach higher-elevation lands. The approximate locations of these plants are shown on Figure 4- 23. The site requirements and facilities at each of these stations would be the same as described for the plants south of I-90 in Section 4.5.1.2 and illustrated on Figure 4- 18.

- **Gravity Feed Turnout**: Two turnouts would be constructed at East High Canal Mile 15 and 50 and one turnout would be constructed at Black Rock Branch Canal Mile 29 to deliver gravity-fed water to the pipelines serving lands in these areas (see Figure 4- 23 for the locations of these turnouts). Each facility would require a 2-acre site.

- **Meter Equipment Sites**: Metering equipment would be installed at numerous locations in the water distribution pipeline system. Most of these metering sites would be associated with the locations where landowners tap into the system. These sites would be approximately 2,500 square feet, be within the pipeline easement, and be sited specifically to not interfere with existing irrigation equipment or other infrastructure.

Other Facility Requirements

- **Road and Railroad Crossings:** The new canal would cross existing roads at an estimated 60 locations. The exact treatment of these crossings would be defined in collaboration with involved jurisdictions during more detailed design work for the project. Bridges over the canal or pipelines under the road would be constructed at important through and all-weather roads and at the crossing of State Highway 28. At other locations, road realignments or closures with local re-routes may be implemented.

  The East High Canal also intersects one railroad line located along Crab Creek, west of the town of Wilson Creek. At this location, the canal alignment would be piped under the railroad.

  No additional easements are expected to be needed for bridges at road and railroad crossings. All construction would occur within the combination of existing road or railroad easement and the easement would be acquired by Reclamation for the new canal. In cases where road realignments would be needed, additional easements would need to be acquired.

- **Access Roads:** With minor exceptions, no new access roads outside of Reclamation easements and acquisition areas would be required for O&M or facility development. O&M roads would be built within the Reclamation easement along all new canals, siphons, and wasteways. To the extent that distribution pipelines and power lines cannot be aligned along existing roads, temporary access roads would be built within the Reclamation easements for construction of these facilities. A new road connection outside of Reclamation lands would be required for the Black Rock Coulee Reregulating Reservoir, where access from the reservoir eastward to County Road W NE is proposed. The alignment of this road has not been determined. Other possible access road locations are not known.

- **Wildlife Crossings and Escape Ramps:** As part of East High Canal development, 11 wildlife crossings would be installed over the East High Canal: nine along the reach north of Black Rock Coulee Reregulating Reservoir and two along the reach south of Black Rock Coulee Reregulating Reservoir. The canal would present a barrier to wildlife movement in the area, and the crossings are intended to mitigate the extent of those effects. The conceptual design of these crossings is illustrated on Figure 4- 28.

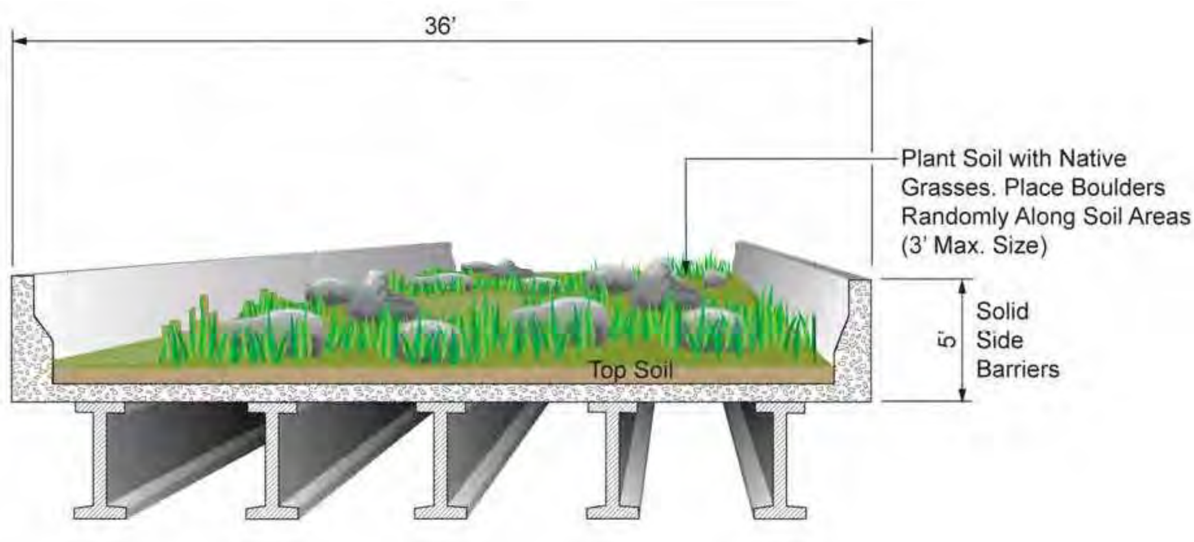


Figure 4- 28. Wildlife crossing bridge typical cross section

Animal escape ramps would be located upstream of each structure (such as checks, siphons, and tunnel portals) in the canal alignment and along concrete-lined reaches. Figure 4- 29 illustrates these ramps, which would be concrete lined and placed perpendicular to the canal centerline. Overall design and placement of the ramps would be coordinated with the WDFW.

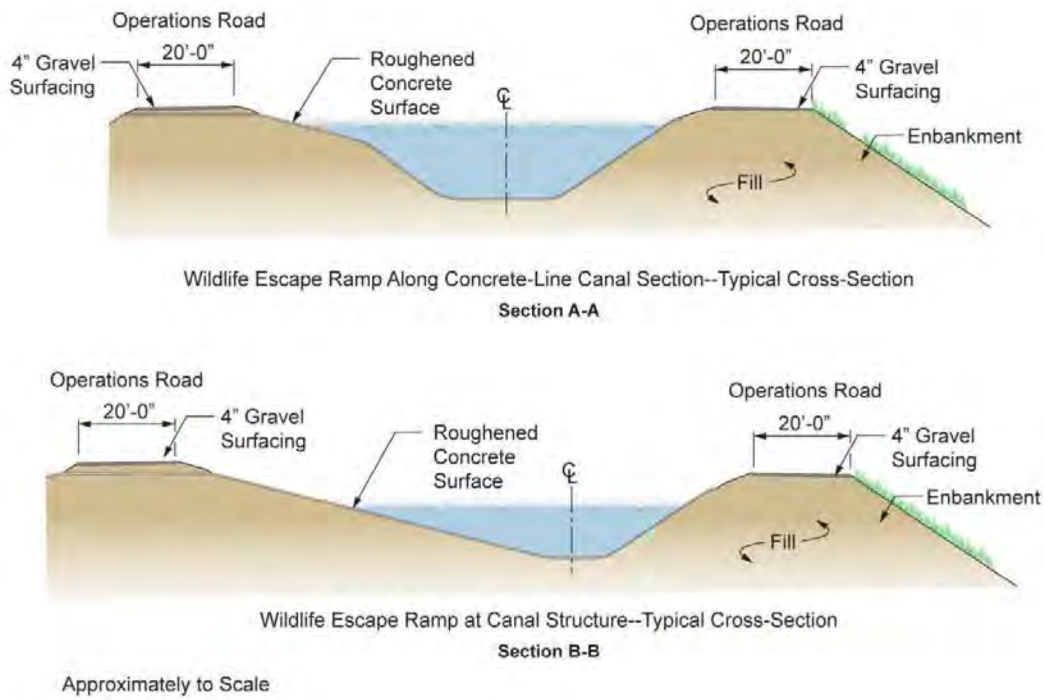


Figure 4- 29. Wildlife escape ramps typical cross section

- **Operations and Maintenance Facility**: A second O&M facility (in addition to the one described in Section 4.5.1) would be built at the northeast corner of the intersection of County Road 6 NE and County Road W NE, approximately 0.25 mile north of Ruff, Washington. This facility would be the same as that described for location south of I-90 in Section 4.5.1.2 and illustrated in Figure 4-19.

- **Electric Transmission Lines**: High voltage electric power supply would be needed at each pumping plant and the O&M facilities. Supplying this power would require construction of new transmission lines. As noted above for the Partial-Replacement Alternatives, it is expected that power would be brought to facilities south of I-90 from the Moses Lake area, requiring an estimated 84 miles of new transmission lines. For facilities north of I-90, power would be brought from Grand Coulee, requiring an estimated 127 miles of new transmission lines. The locations and routes for these new transmission lines have not been determined. During more detailed planning, the goal would be to route these lines to reduce creation of new corridors in the landscape and to minimize impact on existing land uses by following existing power lines, roadways, railroads, or other existing linear infrastructure wherever possible.

Construction

Duration and Phasing

Development of the delivery system for the Full-Replacement Alternatives would be divided into nine phases, as shown on Figure 4- 20 and Figure 4- 30 (showing phasing of facilities south and north of I-90, respectively). The total construction period is projected to be approximately 10 years, with phases being built simultaneously north and south of I-90. Construction within each phase would last 3 to 4 years.

Construction would be conducted in phases to both spread the work as evenly as possible throughout the 10-year construction period and bring the delivery system online in stages, as early as possible.

Construction Workforce, Activities, Equipment, and Other Requirements

The total workforce requirement for construction of the delivery system for the Full-Replacement Alternatives is expected to be 410 to 420 personnel on facilities north of I-90 and 120 to 130 personnel on facilities south of I-90. This would total 530 to 550 personnel at the peak level of activity during the latter half of the construction period, when work on several phases is occurring simultaneously.

Construction activity, and thus deployment of the workforce, would occur at multiple locations simultaneously in each phase and move progressively through the area identified for each phase. Primary work locations for facilities south of I-90 were listed in discussion of the Partial-Replacement Alternatives (Section 4.5.1.2); primary work locations for facilities north of I-90 would include:

- East High Canal Headworks structure (Phase 5 only)
- Black Rock Coulee Reregulating Reservoir (Phase 5 only)
- New canal alignments (East High or Black Rock Branch)
- New siphons, tunnels, and wasteways
- Pumping plant(s), including associated electric substations
- Distribution pipeline alignments
- Transmission line alignments
- O&M facility.

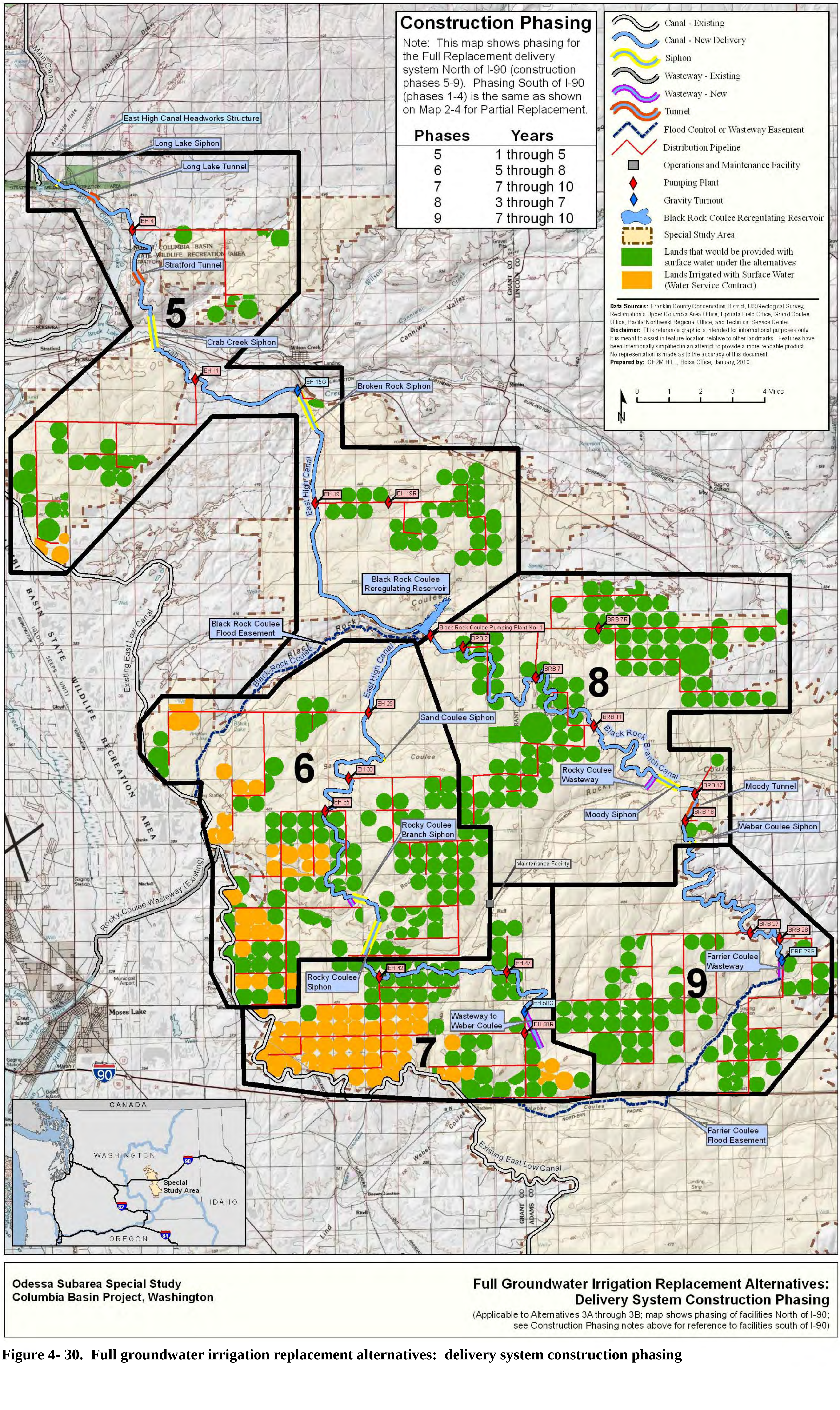


Figure 4- 30. Full groundwater irrigation replacement alternatives: delivery system construction phasing

With the exception of Black Rock Coulee Reregulating Reservoir, major construction in any given area is not expected to extend beyond a year, and in many cases would be of substantially shorter duration. Wherever possible, work would be planned and scheduled to avoid or minimize disruption of existing irrigation operations or other land uses.

Access for facility construction within Reclamation easements and acquisition areas would be primarily from existing public roads. In the case of canal alignments, long-term operations and maintenance roads would remain after construction is complete. Permanent access would also be required along power line and pipeline easements, although developed roads would generally not be necessary after construction is completed.

Construction of the delivery system, especially the canals and reregulating reservoir dike, would require use of heavy equipment including hydraulic excavators, large dozers, scrapers, cranes, and compaction equipment. Other equipment normally involved with major construction would also be employed, such as dump trucks, loaders, and delivery trucks (for concrete and other materials). Blasting may be necessary during construction of the tunnels north of I-90, along some reaches of the new canals, and at the site of the reregulating reservoir dike.

Staging areas would generally be located within canal, pipeline, and transmission line easements and within facility acquisition areas including the reregulating reservoir, pumping plants, and O&M facilities. To the extent possible, staging areas would be located at least 500 feet from a residence.

No offsite disposal sites for excavated material, borrow sites, or construction material processing facilities are expected to be needed. All material excavated for canal development and installation of pipelines and transmission lines would be stockpiled within the facility easements or backfilled, as appropriate. All material necessary for the reregulating reservoir dike is expected to be available from within the reservoir acquisition area, primarily from within the inundation zone. All construction materials would be acquired through available existing local and regional sources.

Operation and Maintenance

O&M activities for Alternative 3A: Full—Banks would be generally the same as described for O&M of the partial replacement facilities in Section 4.5.1.2.

4.6.2 Alternative 3B: Full—Banks + FDR

The main aspects of Alternative 3B: Full—Banks + FDR are illustrated on Figure 4- 31. As shown on the diagram, these include providing water supply from Lake Roosevelt (1) and Banks Lake (2) delivered through the East Low Canal (3) and East High Canal system (4) to currently groundwater-irrigated lands north and south of I-90. Major facility development would include enlargement of the East Low Canal south of I-90 and construction of a new East High Canal system north of I-90. Water would be delivered to farmlands from both canals by a pressurized pipeline system.

Figure 4- 31. Alternative 3B: Full – Banks + FDR

4.6.2.1. Water Supply

Water for this alternative would come from available Columbia River flows and additional drawdown of both Lake Roosevelt and Banks Lake. Water from Banks Lake would be released into the Main Canal from Dry Falls Dam and diverted to the East High and East Low Canals.

The additional drawdown of Banks Lake under this alternative would be 3 feet (the same as the Limited Spring Diversion Scenario) in an average year, beyond the 5 feet of drawdown for summer fish flow augmentation that is part of the No Action Alternative. The total average-year maximum drawdown at Banks Lake would be 8 feet (the same as the Limited Spring Diversion Scenario) at the end of August (Figure 4- 2 and Figure 4-3).

The additional drawdown in an average year at Lake Roosevelt would be 0.9 feet (2.2 feet for the Limited Spring Diversion Scenario) at the end of August beyond the No Action Alternative. Currently, 92 MAF water supply forecast is the dividing line between 10 and 12 feet end of August draft at Lake Roosevelt under the No Action Alternative. The total maximum drawdown at Lake Roosevelt for the representative average water year (1995) is 11.9 feet (13.2 feet for the Limited Spring Diversion Scenario) at the end of August (Figure 4- 4 and Figure 4- 5). Other average years that have volumes less than 92 MAF would be drawn down 2 feet lower.

Reservoir refill would occur first at Lake Roosevelt, which is required to be at water surface elevation 1283 feet amsl by the end of September; refill to No Action Alternative levels would be completed by the end of October. Banks Lake would be refilled by the end of March.

No construction or modification of facilities is required at either Lake Roosevelt or Banks Lake under Alternative 3B: Full—Banks + FDR.

4.6.2.2. Delivery System

Delivery system facility requirements, construction, and O&M for Alternative 3B: Full—Banks + FDR would be the same as those described in Section 4.6.1 – Alternative 3A: Full—Banks.

4.7. Modified Partial Groundwater Irrigation Replacement Alternatives

In response to public comments and concerns regarding the partial and full groundwater replacement alternatives presented in the Odessa Draft EIS and, in consultation with the ECBID, Reclamation and Ecology developed the modified partial groundwater irrigation replacement alternatives. The Modified Partial-Replacement Alternatives are similar to the Alternative C option described in the *Appraisal-Level Investigation Summary of Findings, Odessa Subarea Special Study* (Reclamation, 2008 Appraisal) and in Section 3.3.3.2.2 in this report. Alternative C was considered but eliminated in the Draft EIS because it precluded deliveries to some lands within the SCBID and was not an economically viable option as configured. The Modified Partial-Replacement Alternatives incorporate modifications to Alternative C, which makes them “reasonable” alternatives for the proposed action in Study and the Final EIS.

Further review of the PASS Analysis and Appraisal Study indicated that the Modified Partial-Replacement Alternatives would not preclude full development and would, in fact, provide service to some of the SCBID lands. Thus, Reclamation and Ecology developed Alternatives 4A and 4B for this Study and the Final EIS to address expressed concerns. These alternatives were configured in such a way as to economically serve lands both north and south of I-90 while increasing the number of acres that would no longer pump from the Odessa aquifer (Reclamation 2012 Economics).

Alternatives 4A: Modified Partial—Banks and 4B: Modified Partial — Banks + FDR would provide a CBP surface water supply to approximately 70,000 acres of lands in the Study Area north and south of I-90 (Figure 4- 1and Figure 4- 32. The total volume of water diverted from the Columbia River with the modified partial groundwater replacement alternatives is estimated at 164,000 acre-feet. As the surface water supply system is brought online and this water becomes available to eligible lands, the intent would be to cease operation of associated irrigation wells. Under current State regulations, the irrigation wells would not be decommissioned or abandoned. Instead, superseding state water rights would be issued and the wells would be placed in standby status, remaining operational for use in an emergency (such as an interruption of the Federal surface water delivery system). Any different scenario or mandatory decommissioning would require that the statute to be modified.

As part of these alternatives, the 16,864 acres of existing water service contracts that pump out of the East Low Canal at 34 locations would not be incorporated into the delivery system. This action would have no effect on current system operations or ECBID's ability to meet scheduled deliveries.

Alternatives 4A: Modified Partial—Banks and 4B: Modified Partial — Banks + FDR would involve the same water delivery system facilities and the same quantity of water. The delivery system would involve enlarging the East Low Canal and constructing a distribution system. The alternatives vary in the option used to store and supply CBP water.

A component of the modified partial alternatives would include an "infill" option to allow some groundwater irrigators in areas distant from the East Low Canal to move their operations to previously disturbed lands closer to the canal. It is anticipated that as much as 15 percent of the lands served under these alternatives would involve relocation of current operations. Relocation would be limited to an acre-per-acre exchange; that is, one acre of currently groundwater-irrigated land would be retired for each acre of relocated irrigated land served with replacement water.

Figure 4- 32. Alternative 4A: Modified Partial – Banks (Preferred)

4.7.1.1. Water Supply

Water for this alternative comes from available Columbia River flows and additional drawdown of Banks Lake. Banks Lake water would be released into the Main Canal from Dry Falls Dam and diverted to the East Low Canal.

The additional drawdown of Banks Lake would be 3.1 feet (6.0 feet for the Limited Spring Diversion Scenario) in an average year, beyond the 5 feet of drawdown for summer fish flow augmentation that is part of the No Action Alternative. The total average-year maximum drawdown would be 8.1 feet (11.0 feet for the Limited Spring Diversion Scenario) at the end of August (Figure 4- 2 and Figure 4- 3).

Banks Lake would be refilled by the end of October, subject to any unusual constraints imposed by operational requirements.

The Limited Spring Diversion Scenario is the preferred diversion scenario.

No construction or modification of facilities is required at Banks Lake under Alternative 4A: Modified Partial—Banks.

4.7.1.2. Delivery System

Facility Descriptions

The water delivery system necessary for Alternatives 4A: Modified Partial—Banks (Preferred) and 4B: Modified Partial — Banks + FDR is shown on Figure 4- 33. Facility development would the same south of I-90 as described for Alternative 2A: Partial—Banks and 2B: Partial — Banks + FDR in Section 4.5.1.2 except for:

- No extension of East Low Canal.
- No gravity feed turnout at mile 89.

North of I-90 facility development would include:

- Constructing a pipeline distribution system fed by pumping plants along the canal. This system would require numerous meter and equipment stations along the pipeline routes, primarily at farm delivery points.
- New electric transmission lines to each pumping plant and the O&M facility.

Each of these facilities is described below. Table 4- 7 provides a summary listing, including information on facility quantities and land requirements.

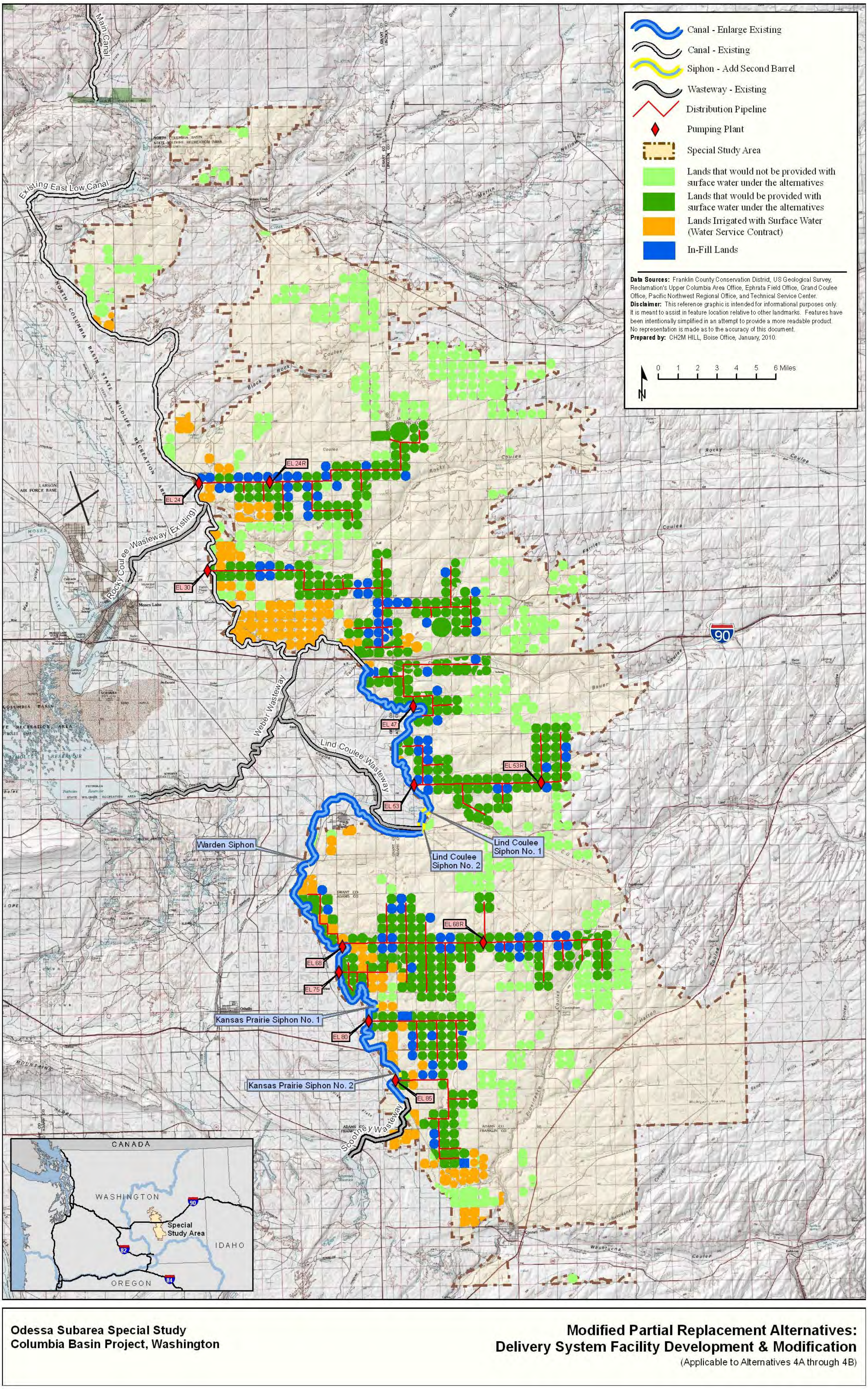


Figure 4- 33. Modified Partial-Replacement Alternatives: delivery system facility development and modifications

Table 4- 7. Modified Partial-Replacement Alternatives – delivery system facility requirements

Facility/Action	Quantity	Land Interest Acquisition Required	
		Type	Quantity
East Low Canal			
- Enlargement	43.3 miles	*NA--Within existing easement*	
- Siphons--Add second barrel to all 5 existing	1.5 miles	*NA--Within existing easement*	
Weber Wasteway—Additional Easement Acquisition	3.0 miles	Easement	350 feet wide [a]
Pumping Plants			
Canal-side Plants (along East Low Canal)	8 Sites	Fee	3 acres each
(EL47, 53, 68, 75, 80 & 85)			
Relift Plants (EL47R, 53R, 68R, 80R, & 89R2)	3 sites	Fee	3 acres each
Distribution Pipeline < 24 inches	72 miles	Easement	100 feet wide
Distribution Pipeline > 24 inches	78 miles	Easement	200 feet wide
Pipeline Meter/Equipment Sites	TBD [b]	*NA—2,500 square feet within pipeline easement*	
Electric Transmission Lines [c]	150 miles	Easement	100 feet wide
Road Crossings			
- Existing bridges over East Low Canal — Reconstruct	NA[d]	*NA—Within road easement and canal easement*	

[a] Existing Weber Wasteway easement width varies but averages 250 feet (125 feet on each side of the channel); Reclamation would acquire an additional 175 feet on each side, to bring total easement width to 600 feet.

[b] To Be Determined: Number and location not determined at this level of planning; all would be within pipeline easements.

[c] Electric power supply would be needed at each pumping plant and the operations and maintenance facility. Supplying this power would require construction of new transmission lines. For the Modified Partial-replacement alternatives, it is expected that power would be brought to facilities from the Moses Lake area. Given this projected source, total distance of new transmission lines required is estimated to be 150 miles. The locations and routes for these new transmission lines would be determined during future design phases.

[d] Some existing road bridges across the East Low Canal may need to be lengthened/reconstructed to accommodate East Low Canal enlargement. Any such requirements would be defined during more detailed planning (see Transportation discussion in Section 4.16 of the Odessa Final EIS).

NA: Not applicable

East Low Canal Enlargement

The enlargement of the East Low Canal would be the same as described for Alternatives 2A and 2B.

Distribution Pipeline System

CBP water from the East Low Canal would be provided by a pressurized pipeline distribution system to the groundwater-irrigated and water service contract lands north and south of I-90 that would be served in this alternative. The system would be pressurized by eight canal-side pumping plants and three relift pumping plants. Metering stations would be located at numerous locations along the pipeline routes to record water deliveries. The following facilities would be included:

- **Distribution Pipelines**: The Preferred Alternative distribution system would require approximately 150 miles of buried pipeline. In general, the system is designed to locate the pipelines along section and half-section lines and deliver water to typical quarter sections. Depending on the size of the pipeline, Reclamation would acquire a 100- to 200-foot-wide easement for pipeline installation and would need to retain long-term access to and within the easement for any necessary repairs or replacements. These requirements would preclude any future structure development within the easement. However, except for the locations of relift pumping plants and equipment sites described below, agriculture or other nonstructural uses could generally continue once the pipeline is installed and operational.

- **Canal-Side Pumping Plants**: The eight canal-side pumping plants that would feed the pipeline distribution system would be located on the east side of the East Low Canal at canal miles 24, 30, 47, 53, 68, 75, 80, and 85. Each plant would require about 3 acres to accommodate the pumping plant and equipment, an air chamber, and an electric power substation. Each plant would be fenced for security using chain-link topped with barbed wire. A regulating tank would also be necessary with each of these pumping plants; this tank would be located along the pipeline up to 2 miles from the pumping plant site. Figure 4- 16 and Figure 4-17 provide a conceptual site and elevation, respectively, of these pumping plants.

- **Relift Pumping Plants**: Three relift pumping plants required for the pipeline distribution system would be required to boost pipeline pressure in the central parts of the service area to reach the eastern-most lands. One plant would be north of I-90 on the pipeline system that would be fed from the pump station at canal mile 24. Two additional plants would be south of I-90, one serving the pipeline from the pumping plant at canal mile 53 and another associated with the pipeline receiving water from the pumping plant at canal mile 68. The approximate locations of these plants are shown on Figure 4- 33 and Figure 4- 18 provides a conceptual site plan. Each plant would require about 3 acres to accommodate the pumping plant structure and equipment (no metal building would be constructed), an air chamber, and an electric power substation.

- **Meter Equipment Sites**: Metering equipment would be installed at numerous locations in the water distribution pipeline system. Most of these metering sites would be located where landowners tap into the system. These sites would total approximately 2,500 square feet, all within the pipeline easement, and would be sited specifically not to interfere with existing irrigation equipment or other infrastructure. They would be placed near existing roads as much as possible.

Other Facility Requirements

The facility requirements would be the same as described in Section 4.5.1.2 (Figure 4-19), except there would be no extension of East Low Canal.

Construction

Construction would be the same as Alternative 2A and 2B, except there would be a total workforce requirement of 145 to 160 personnel at the peak level of activity and there would be pumping plants and relift plants as well as distribution systems north of I-90. There would be no extension of East Low Canal (Figure 4- 34).

Operation and Maintenance

O&M activities for Alternative 4A: Modified Partial—Banks would be generally the same as described for O&M of Alternatives 2A and 2B as described in Section 4.5. – *Partial Groundwater Irrigation Replacement Alternatives*.

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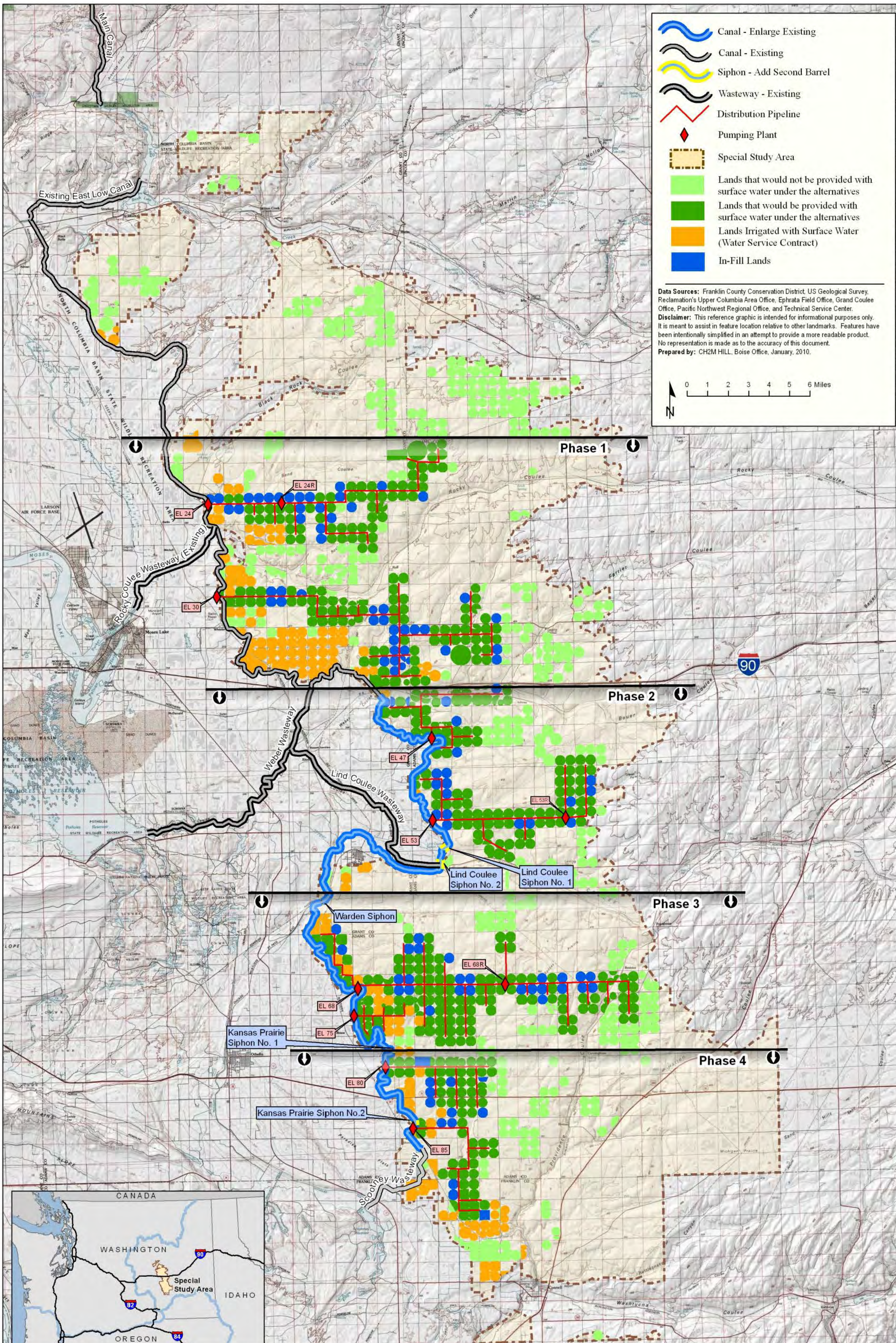

Odessa Subarea Special Study
Columbia Basin Project, Washington

Modified Partial Replacement Alternatives: Delivery System Construction Phasing
(Applicable to Alternatives 4A through 4B)

Figure 4- 34. Modified Partial-Replacement Alternatives: delivery system construction phasing

4.7.2 Alternative 4B: Modified Partial—Banks + FDR

The delivery system for Alternatives 4B is the same as Alternative 4A with the main elements illustrated on Figure 4- 35. As shown on the diagram, Alternative 4B differs from 4A in that the water supply source would utilize both Banks Lake and Lake Roosevelt.

Figure 4- 35. Alternative 4B: Modified Partial – Banks + FDR

4.7.2.1. Water Supply

Water for this alternative comes from available Columbia River flows and additional drawdown of Banks Lake and Lake Roosevelt. Banks Lake water would be released into the Main Canal from Dry Falls Dam and diverted to the East Low Canal.

The additional drawdown of Banks Lake would be 3.0 feet (the same as the Limited Spring Diversion Scenario) in an average year, beyond the 5 feet of drawdown for summer fish flow augmentation that is part of the No Action Alternative. The total average-year maximum drawdown would be 8.0 feet (the same as the Limited Spring Diversion Scenario) at the end of August (Figure 4- 2 and Figure 4- 3).

The additional drawdown of Lake Roosevelt under this alternative would be 0 feet (1.0 feet for Limited Spring Diversion Scenario) in an average water year, beyond the No Action Alternative. The total maximum drawdown at Lake Roosevelt for an average water year is 11.0 feet (12.0 feet for the Limited Spring Diversion Scenario) at the end of August. Other average years that have volumes less than 92 MAF would be drawn down 2 feet lower (Figure 4- 4 and Figure 4- 5).

Reservoir refill would occur first at Lake Roosevelt, which is required to be at water surface elevation 1,283 feet amsl by the end of September; refill to No Action Alternative levels would be completed by the end of October. Banks Lake would be refilled by the end of March.

No construction or modification of facilities is required at either Lake Roosevelt or Banks Lake under Alternative 4B.

4.7.2.2. Delivery System

Delivery system facility requirements, construction, and O&M for this alternative would be the same as those described for Alternative 4A.

4.8. Consequences of No Action

The consequences of the No Action Alternative over the next 10 years[8] (approximately 2020) (see Chapter 4.3.2.2 *Groundwater Resources*) would include:

- Only 15 percent of the production wells in the Study Area would continue to support irrigation for valuable high-water crops, such as potatoes.
- About 55 percent of the production wells in the Study Area would cease groundwater output and use of these wells would be permanently discontinued.
- The remaining 30 percent of the production wells in the Study Area would no longer support high water use crops, even on reduced acreage.

The consequences of the No Action Alternative to various environmental and socioeconomic resources are discussed further in Chapter 4 – *Environmental Consequences*.

Under the No Action Alternative, the following would occur related to other water management programs:

[8] Based on information provided by GWMA, as well as others, Reclamation interpreted the rate at which wells would go out of production to be approximately 26 years (Reclamation 2012 Groundwater).

- Operations at Lake Roosevelt and Banks Lake would continue as they do currently, providing water supply to meet authorized CBP purposes, including water delivery for irrigation, fish management, municipal and industrial uses, and recreation.

- Actions by the Management Program to pursue the development of water supply alternatives to groundwater for agricultural users in the Odessa Subarea would not proceed further under the No Action Alternative since this Study is the direct response to this specific provision of Chapter 90.90 RCW – *Columbia River Water Management Act*.

- The No Action Alternative would not address existing East Low Canal system constraints that affect ECBID's ability to meet delivery commitments to existing water service contract holders in the Study Area (as described in Section 4.4.1.4).

- The Coordinated Conservation Program (as described in Section 3.5.1.2) would continue to implement conservation efforts to create water savings in the Study Area to reduce the use of groundwater for existing irrigation.

- The Lake Roosevelt Incremental Storage Releases Program (as described in Section 3.5.1.4) would continue to implement additional incremental storage releases from Lake Roosevelt to supplement water supplies for instream flows, existing agricultural lands in the Study Area, and municipal and industrial needs.

4.9. Summary of Impacts

Chapter 4 in the Odessa Final EIS provides a detailed analysis of the impacts (direct, indirect, and cumulative) and associated mitigation measures of the alternatives. This summary of impacts provides a brief explanation of the resources analyzed and their context.

Both the adverse impacts and beneficial effects of the alternatives are directly related to how much land is provided with CBP surface water to replace failing groundwater supplies. For the No Action Alternative, the same beneficial effects and adverse impacts generally apply across the entire Study Area because none of the lands would receive a replacement water supply. Similarly, the Full-Replacement Alternatives typically deliver the same types of impacts and effects across the entire Study Area because CBP water would be delivered throughout the Study Area. For the Partial-Replacement Alternatives, effects and impacts tend to be the same as expected for the No Action Alternative on lands north of I-90 because these lands would not receive a replacement water supply. Effects and impacts on lands south of I-90 tend to be similar to those expected for the Full-Replacement Alternative in that portion of the Study Area. For the Modified Partial-

Replacement Alternatives, beneficial effects and adverse impacts would be similar to those for the Full-Replacement Alternatives for lands north and south of I-90 but on a lesser scale for lands north of I-90, as there are fewer lands involved and less facility construction.

Resources that would have potential benefits and minimal to adverse impacts include, but are not limited to, wildlife and wildlife habitat; fisheries and aquatic habitat; land and shoreline use, recreation; visual resources; and cultural resources.

Resource areas that would have no notable beneficial effects or adverse impacts include, but are not limited to, surface water quantity; water rights; geology; soils; threatened and endangered species; air quality; public services and utilities; public health; Indian Trust Assets; Indian sacred sites; and environmental justice.

4.9.1 Surface Water Quantity

Potential changes in surface water quantity were evaluated for the Columbia River, Lake Roosevelt, and Banks Lake, and other surface water features. The No Action Alternative would have no impact on Lake Roosevelt, Banks Lake, or the Columbia River downstream of Grand Coulee Dam because no additional water would be withdrawn. Under all the action alternatives, changes to the Columbia River flows would be minor. Under those alternatives that withdraw water from Lake Roosevelt, minor additional drawdowns would occur late in the irrigation season. Reductions in water surface elevation at Banks Lake would generally be smaller and of shorter duration under the partial- and Modified Partial-Replacement Alternatives than under the Full-Replacement Alternatives. There are no significant impacts or effects associated with surface water resources.

4.9.2 Groundwater Resources

The shallow and deep aquifer systems beneath the Study Area are the area’s primary source of municipal, industrial, domestic, and irrigation water. The deep aquifers are being depleted within and beyond the Study Area as a result of large-scale pumping. Consequently, groundwater users must pump from greater and greater depths as wells dry up and require deepening. This may impact all groundwater users, potentially those in nearby towns.

The No Action Alternative would have long-term significant impacts. These impacts would include continued decline of water levels in the Study Area which would result in some existing wells going dry, possible pump replacement, and increased pumping head and costs. At some point, using groundwater to grow high-water-demand crops would become uneconomical. Under all the action alternatives, the decline in groundwater levels in the Study Area south of I-90 would slow, which would be an important beneficial effect for all users. In the full-replacement and Modified Partial-Replacement Alternatives, groundwater-level declines north of I-90 are also anticipated to slow.

4.9.3 Surface Water Quality

Surface water quality issues associated with the Study alternatives consist of potential changes to temperature, dissolved oxygen, total dissolved gas, pH, nutrients, and heavy metals at Lake Roosevelt, Banks Lake, the Columbia River downstream of Grand Coulee Dam, and in the Study Area irrigation network.

The No Action Alternative would have no impact on water quality in Lake Roosevelt, Banks Lake, or the Columbia River. The Study Area irrigation network would experience a minor beneficial effect because of decreased delivery of pesticides and fertilizers to the canal and drain system. Potential additional drawdowns at Lake Roosevelt under Alternatives 2B, 3B, and 4B would have minimal effects on water quality. The additional late summer drawdowns would not further mobilize contaminants in the lake or raise water temperatures.

Banks Lake water quality, particularly temperature and dissolved oxygen, would be minimally impacted under all of the action alternatives. Water quality in the Columbia River downstream of Grand Coulee Dam, particularly temperature and total dissolved gas, would experience only a minimal impact from any of the action alternatives. Either no impacts or minimal beneficial effects to water quality in the irrigation network would be expected.

4.9.4 Water Rights

Water rights considered included those within the Study Area, plus downstream rights associated with the Columbia River. The analysis focused primarily on Lake Roosevelt because minimal impacts would occur to downstream water rights. With the need to meet minimum flow requirements and ESA target flows built into the alternatives, no impacts to water rights are anticipated for any of the alternatives.

4.9.5 Geology

The geologic setting of the Study Area has a major influence on the topography, groundwater occurrence, erosion potential, and availability of resources in constructing the proposed facilities. The No Action Alternative would have no impact on geologic resources because no new facilities would be constructed. Some geologic resources would be committed to build the facilities proposed under the action alternatives, with the greatest amount of material required for the Full-Replacement Alternatives for construction of the Black Rock Coulee Reregulating Reservoir dam. Construction of the dam would require earthen materials; borrow materials are anticipated to come from within the reservoir inundation areas. Impacts associated with the depletion of geologic resources are anticipated to be minimal for all of the partial, full, and Modified Partial-Replacement Alternatives. There are no significant impacts or effects associated with geology.

4.9.6 Soils

Soil productivity can be reduced when ground-disturbing activities increase erosion or soil compaction. Impacts would result from new facilities that would take current land out of production, or construction activities that increase erosion and compaction. A long-term reduction in soil productivity would occur under the No Action Alternative as irrigated farmland shifts to dryland farming.

Short-term impacts to soils from construction activities would occur under all of the action alternatives. The extent of these impacts would be greater under the Full-Replacement Alternatives because of the larger construction footprint.

Erosion control requirements, best management practices (BMPs), and mitigation measures would minimize offsite movement of sediment until new vegetation becomes established on temporarily disturbed lands. These lands would be put back into production following construction. Long-term impacts to soils would occur under all alternatives.

State-important unique farmland would be permanently taken out of production under all of the action alternatives, which is significant in terms of the Farmland Protection Policy Act. The extent of this impact would vary; however, no significant impacts would occur with implementation of legal requirements, BMPs, and mitigation measures.

4.9.7 Vegetation and Wetlands

The action alternatives would impact both native upland vegetation and wetlands. No impacts are expected at Lake Roosevelt under any of the alternatives.

Shrub-steppe losses would be greatest under the Full-Replacement Alternatives, as these involve construction of new facilities in or through areas of shrub-steppe. The Black Rock Coulee Reregulating Reservoir and long stretches of the East High Canal and Black Rock Branch Canal would be located in shrub-steppe. There would be significant impacts to Washington-listed rare or sensitive plant species under the Full-Replacement Alternatives. The partial-replacement and Modified Partial-Replacement Alternatives would impact much less shrub-steppe, as fewer facilities would be constructed in areas supporting shrub-steppe vegetation. Under all action alternatives, there would be long time periods for restoration of disturbed shrub-steppe habitat. This would occur over much larger areas under the Full-Replacement Alternatives.

Impacts to wetlands surrounding Banks Lake would primarily involve shifts in the plant community composition as the less drought-tolerant wetland species replace those that are more tolerant of drawdowns. The impacts would be adverse under Alternative 3A, but minimal under the other alternatives. Fringe wetlands along the banks of the East Low Canal south of I-90 would be lost under all the alternatives but would reestablish once the construction is finished. Wetlands in the footprint of the Black Rock Coulee Reregulating Reservoir would be lost under the Full-Replacement Alternatives.

4.9.8 Wildlife and Wildlife Habitat

Both native and nonnative wildlife habitats would be impacted by the action alternatives. The extent of shrub-steppe habitat in eastern Washington has declined dramatically, largely because of conversion to agriculture. Any further losses of high-quality shrub-steppe habitat would be significant.

The wildlife analysis is based on changes in the amount of available habitat identified in the vegetation studies, WDFW studies at the sites of major proposed facilities, and the effect of habitat fragmentation and movement barriers on wildlife. A shift from irrigated agriculture to dryland farming under the No Action Alternative would cause minimal impacts to wildlife that use irrigated croplands. Under all of the action alternatives, long-term adverse impacts to wildlife would occur as a result of lost shrub-steppe habitat. Additionally, long-term significant impacts would occur to special status species and migratory birds under all of the action alternatives. As a result of drawdowns at Banks Lake, western grebes would be adversely affected as a result of loss of nesting habitat and lowered nest success. The extent of these impacts would be greater under the full- and modified-Partial-Replacement Alternatives. The East High Canal and Black Rock Branch Canal would result in significant impacts to wildlife under all of the Full-Replacement Alternatives. The canals would create barriers to animal movements and fragment native shrub-steppe habitat, thereby isolating some segments of animal populations.

4.9.9 Fisheries

Potential impacts of the action alternatives on fisheries and aquatic resources were assessed in Lake Roosevelt, Banks Lake, and the Columbia River downstream of Grand Coulee Dam.

Under the No Action Alternative, no short- or long-term impacts on fisheries and aquatic resources would occur. Under Alternatives 2B, 3B, and 4B, changes in the reservoir pool at Lake Roosevelt would not differ greatly from current conditions, impacts are expected to be minimal, if any, on the fishery in that reservoir.

For the Columbia River, the greatest reduction in flows would occur in September and October when adult fall Chinook salmon and steelhead trout are migrating up the lower and mid-Columbia River. However, no impacts to these adult migrating fish are anticipated. Similarly, spawning success of fall Chinook in the free-flowing Hanford Reach of the Columbia River and chum salmon that spawn below Bonneville Dam would not be impacted. During the salmonid smolt downstream migration season from mid-April through August, no diversions would be made in the July through September period and diversions in April through June would only occur would the ESA flow objectives for the Columbia River are exceeded. These changes would result in no to minimal impacts on migrating smolts.

Projected summer water surface elevations in Banks Lake would be lower and would last for longer periods under the action alternatives compared to the No Action Alternative. Impacts may include the potential for reduced habitat availability for various life stages of fish, shifts in zooplankton production, and increased fish and zooplankton entrainment. Under all the action alternatives, impacts to fisheries and aquatic resources would, for the most part, be minimal to none.

4.9.10 Threatened and Endangered Species

No short-term impacts to threatened and endangered species would occur under the No Action Alternative or any of the action alternatives.

There would be no long-term impacts to terrestrial threatened and endangered species under any of the action alternatives, as none are known to occur in the Study Area. Potential long-term impacts to aquatic threatened and endangered species would be related to changes in Columbia River streamflows. Minimal to no impacts would occur to some downstream smolt migrants under the action alternatives, as spring diversions only occur when ESA flow objectives on the Columbia River are exceeded. No impacts would occur for upstream adult migrants or spawning under any of the action alternatives.

4.9.11 Air Quality

Non-road engine exhaust emissions have been identified by the U.S. Environmental Protection Agency as a significant contributor to air pollution throughout the country. Short- and long-term minimal impacts from construction vehicle exhaust, release of fugitive dust, and greenhouse gasses would occur under all of the action alternatives, but would be greater under the Full-Replacement Alternatives. There are no significant impacts or effects associated with air quality.

4.9.12 Land Use and Shoreline Resources

Concerns related to land use and shoreline resources focus on changes in land ownership, changes in existing land uses, and consistency with relevant plans, programs, and policies. No significant impacts to water bodies under the State Shoreline Management Act would occur with any of the alternatives.

4.9.12.1. Land Ownership

The No Action Alternative would not involve major changes in land ownership in the Study Area; there is a potential for consolidation of farms. The action alternatives would require significant acquisition of land interests by Reclamation for water delivery systems. Land interests that would need to be acquired include easements for linear facilities such as canals, wasteways, pipelines, and transmission lines, and fee title to sites for pumping plants, operation and maintenance facilities, and reservoirs. Acquisition requirements would be greatest for the Full-Replacement Alternatives, less for the Partial-Replacement Alternatives, and even less for the Modified Partial-Replacement Alternatives.

4.9.12.2. Land and Shoreline Use

The No Action Alternative would result in a significant change in land use as irrigated agriculture transitions to dryland farming. This same change would occur on groundwater-irrigated lands north of I-90 under the Partial-Replacement Alternatives. Beyond these broad changes, land use impacts would center on development of the facilities needed for the action alternatives. The categories of existing land use that would be significantly impacted include residences, center pivot irrigation systems, and irrigated agriculture in general. Other impacted land uses would include dryland agriculture and open space and habitat lands.

Irrigated agricultural lands would be preserved under all of the action alternatives, which would be a beneficial effect. Beneficial effects would be substantially higher under the Full-Replacement Alternatives.

4.9.12.3. Relevant Plans, Programs and Policies

All involved counties designate land in the Study Area as agriculture and emphasize the importance of irrigated agriculture. Also, many of the State lands in the Study Area are leased for irrigated agriculture as a revenue source for State Trust beneficiaries. The No Action Alternative would be broadly inconsistent with this plan and program framework throughout the Study Area. The Partial-Replacement Alternatives reflect the same inconsistency north of I-90. Only the full- and Modified Partial-Replacement Alternatives support this framework throughout the Study Area and result in a beneficial effect.

4.9.13 Recreation Resources

No significant impact would occur to recreational resources at Lake Roosevelt or in the Study Area with any of the alternatives. Impacts at Banks Lake would be due to the additional drawdowns of the reservoir pool beyond the No Action Alternative necessary to provide irrigation water supply to the Study Area. These drawdowns would cause some boat ramps and most developed swimming sites to become unusable for a period time each year under all alternatives. Developed and dispersed day use and camping sites would be adversely impacted in two ways:

- The loss of adjacent boat launches and swimming site capacity
- The additional distance to water caused by the lower pool elevation.

These impacts would center on the end of August each year when drawdowns reach their maximum depth. Generally, impacts at Banks Lake would be greater under Alternatives 3A and 4A than under Alternative 2A. Alternatives that use storage from Lake Roosevelt have relatively fewer impacts on recreation at Banks Lake than those that rely solely on Banks Lake storage. Alternatives 3A and 4A would have the most widespread impacts, with use limitations averaging 2 months. Impacts related to loss of boat ramp and swimming area availability could be mitigated by developing replacement facilities or redeveloping existing facilities. Impacts related to increased distance to the water's edge could not be mitigated.

4.9.14 Transportation

Transportation concerns focus on impacts to roads, highways, and railroads in the Study Area caused when proposed facilities intersect these routes. No such concerns exist for the No Action Alternative, and no air or navigable waterway transportation systems would be affected by any of the alternatives.

For all action alternatives, Reclamation and Ecology are committed to preparing a Transportation Management Plan in collaboration with affected counties and other agencies. The planning process would create a blueprint for avoiding short-term, construction-related impacts, and for assessing the best solution for resolving long-term impacts where facilities obstruct current routes. Development of the delivery system for the Partial-Replacement Alternatives would not involve significant potential for short- or long-term transportation impacts.

The full replacement delivery system north of I-90 would involve more than 60 new crossings of existing roadways, including one state highway and one crossing of an active rail line by surface water conveyance facilities like canals. Through the transportation planning process, requirements for maintaining adequate transportation service would be defined and programmed, including bridges over the new conveyances or placing the facilities underground.

4.9.15 Energy

Energy issues associated with the Study alternatives include the potential to alter regional and local energy balances. Additional withdrawals from the Columbia River would lead to lost hydroelectric generation potential and a possible reduction in regional energy supply and availability. Additional pumping requirements to deliver water through new or modified canal systems would increase the burden on local energy providers responsible for supplying energy resources and could affect regional energy demand.

Under the No Action Alternative, irrigators would require more energy to pump groundwater from greater depths, but local energy providers would experience minimal impacts because they would have sufficient capacity to supply all customers.

Regional net energy availability would be minimally impacted by all of the action alternatives. In the short term, even under critical water conditions, impacts to the regional net energy availability would be minimal. As a result of late summer drawdowns of Banks Lake, the Keys Pump-Generating Plant would not be operable for some period of time under all action alternatives until reservoir elevations recover. This impact would be adverse and significant for Alternatives 3A and 4A.

The Tribes of the Colville Reservation Grand Coulee Dam Settlement Act

Lost hydropower generation has an indirect impact on the Confederated Tribes of the Colville Reservation. The Confederated Tribes of the Colville Reservation Grand Coulee Dam Settlement Act (Settlement Agreement) stipulates that BPA pay the Confederated Tribes of the Colville Reservation an annual monetary compensation for the reservation lands used to build Grand Coulee Dam and reservoir. The amount of compensation is based partially upon the preceding fiscal year’s generation in megawatt-hours at the Grand Coulee Dam.

Water withdrawal from Lake Roosevelt to supply activities covered in the Final EIS would reduce water flow past Grand Coulee Dam. A reduction in water flow results in a reduction of generation. Thus, a reduction in generation has the potential to reduce the monetary compensation per calculation formulas outlined by the Settlement Agreement. Based on preliminary flow information data, it appears that the amount of generation at Grand Coulee Dam would be reduced as a result of activities covered in thethe Odessa Final EIS. The exact amount of the reductions would be based on a variety of factors. During April and May 2012, BPA coordinated with representatives for the Confederated Tribes of the Colville Reservation on this issue and provided information which should assist them in estimating the potential impacts to the monetary compensation.

4.9.16 Public Services and Utilities

Public services in the Study Area include law enforcement, fire protection, and emergency medical services. Utilities providers include electricity, natural gas, water supply, telecommunications, and wastewater management.

There would be no significant adverse impact on any public service or utilities in the Study Area with any of the alternatives. However, the No Action Alternative and, to a lesser extent, the Partial-Replacement Alternatives, do have the potential to cause a downsizing impact on public service capacity in the area because of the drop in the regional economy as land use changes.

4.9.17 Noise

Localized, short-term noise impacts would occur during construction of facilities associated with the action alternatives. Construction noise is exempt from state noise regulations. Nonetheless, BMPs would be employed to control and minimize construction noise to the extent practical, and no significant adverse short-term noise impacts are anticipated. In the long term, ambient noise levels would increase near the pumping plants and operation and maintenance facilities associated with the action alternatives. These impacts would not be significant, and there are no significant impacts or effects associated with noise.

4.9.18 Public Health

Public health considerations related to the Special Study alternatives include potential exposure to hazardous materials and mosquito-borne illnesses. No impacts are expected under the No Action Alternative.

With the action alternatives, development of delivery system facilities and additional drawdown at reservoirs would create the potential for exposure to hazardous materials such as fuels and chemicals or contaminated sediments, and for short- and long-term increases in mosquito habitat. However, existing regulations and BMPs would ensure that any such impacts are either avoided or minimized. There are no significant impacts or effects associated with public health.

4.9.19 Visual Resources

Changes in visual character or quality would occur in the Study Area with all alternatives, including the No Action Alternative. Additional drawdowns at Banks Lake under the action alternatives also have the potential to result in adverse visual resource impacts.

In the Study Area, the No Action Alternative and the portion of the Partial-Replacement Alternatives north of I-90 would result in significant, broad-scale impacts caused by the transition from irrigated agriculture to dryland. Where lands would receive replacement water supply for irrigation under the action alternatives, broad-scale visual character would not be changed.

However, development of water delivery system facilities would result in significant localized visual impacts associated with introduction of major new infrastructure. Some of the new facilities, such as canals, would be compatible with the irrigated agriculture environment. However, facilities such as regulating tanks up to 200 feet high would likely be seen as an adverse impact on visual quality.

Additional drawdowns at Banks Lake under the action alternatives would generally result in adverse impacts on visual quality. Impacts on visual quality would be related to the extent of additional drawdown, with deeper drawdowns, creating a much larger "bathtub ring" effect where open, unvegetated shoreline is exposed around the reservoir.

4.9.20 Cultural and Historic Resources

Cultural resources encompass a wide range of historic and prehistoric resources defined by State and Federal regulations.

The No Action Alternatives would not impact such resources. At the current level of project planning, assessment of potential for impact under the action alternative uses a predictive model to estimate the likelihood of significant resources being encountered for the sake of comparison among the alternatives. No surveys of potential facility sites have been conducted because of the scale and complexity of the alternatives. All action alternatives involve development and operation of delivery system facilities in areas with high potential to contain significant cultural resources. These alternatives would also involve additional drawdowns at Banks Lake each year, exposing more shoreline with potential to contain significant resources. Generally, the Partial-Replacement Alternatives would have considerably less potential for adverse impact than the Full-Replacement Alternatives because fewer facilities would be built and these facilities would be located in less sensitive areas, and because additional drawdowns at Banks Lake are generally less. Full field surveys to identify cultural and historic resources would be completed and all necessary consultation with the State Historic Preservation Officer and involved Tribes would be carried out if a decision is made to proceed with one of the action alternatives. Through this effort, impact avoidance and mitigation measures would be defined.

4.9.21 Indian Trust Assets

Government-to-Government consultation has been initiated with involved Tribes related to Indian Trust Assets. To date, no Indian Trust Assets have been identified in or near the project area. If a decision is made to proceed with development of one of the action alternatives, Reclamation would continue consultation, consistent with existing regulations and policies.

Project activities would be conducted to protect these resources, promote Tribal access to resource sites, and avoid adverse effects whenever possible. There are no significant impacts or effects associated with Indian Trust Assets

4.9.22 Sacred Sites

Government-to-Government consultation has been initiated with involved Tribes related to Sacred Sites. To date, no Sacred Sites have been identified in or near the project area. If a decision is made to proceed with development of one of the action alternatives, Reclamation would continue consultation consistent with existing regulations and policies. Project activities would be conducted to protect these resources, promote Tribal access to resource sites, and avoid adverse effects whenever possible. There are no significant impacts or effects associated with Sacred Sites.

4.9.23 Environmental Justice

The environmental justice analysis area is generally comprised of Adams, Franklin, Grant, and Lincoln Counties. The area is primarily rural, supporting agricultural land uses with few towns. Minority and low-income populations reside in the area, but no disproportionate economic, land use, construction-related, or other impacts to these populations would occur with any of the alternatives. There are no significant impacts or effects associated with environmental justice.

4.10. Comparative Evaluation of Alternatives

Table 4- 8 displays the results of the Study alternatives for all resource topics identified and analyzed in the Odessa Final EIS. For each resource topic, one or more impact indicators are listed in the left-hand column. These indicators identify how changes to the environment are measured. The criteria used to judge whether those changes are significant is provided in the Final EIS.

A short description of the benefit or adverse impact for each of these impact indicators is listed under the alternatives and describes the relative magnitude of the effects of the alternatives. For all of the resource topics, the expected impacts shown are those that would remain after all regulatory requirements and best management practices are met. The impact analysis shown on Table 4- 8 reflects the application of mitigation measures.

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Table 4- 8. Overview of the benefits and impacts from the alternatives on all resource topics and areas assessed

Resource Indicator, Topic, or Measurement	No Action	Partial Groundwater Irrigation Replacement Alternatives		Full Groundwater Irrigation Replacement Alternatives		Modified Partial Groundwater Irrigation Replacement Alternatives	
		2A: Partial—Banks	2B: Partial—Banks + FDR	3A: Full—Banks	3B: Full—Banks + FDR	4A: Modified Partial—Banks	4B: Modified Partial—Banks + FDR
Surface Water Quantity							
Instream flow requirements	No impact	Minimal Impact with both diversion scenarios.	Minimal Impact with both diversion scenarios.	Minimal Impact with both diversion scenarios.	Minimal Impact with both diversion scenarios.	Minimal Impact with both diversion scenarios.	Minimal Impact with both diversion scenarios.
Reduction of surface water elevations in Lake Roosevelt	No impact	No impact with both diversion scenarios	Minimal additional drawdown in late August and September with both diversion scenarios. Minimal hydrologic impact.	No impact with both diversion scenarios	Minimal additional drawdown in late August and September with both diversion scenarios. Minimal hydrologic impact.	No impact with both diversion scenarios	Minimal additional drawdown in August and September with both diversion scenarios. Minimal hydrologic impact.
Reduction of surface water elevations in Banks Lake	No impact	Drawdown starting April through late September with both diversion scenarios. Minimal hydrologic impact.	Drawdown starting April through late September with both diversion scenarios. Minimal hydrologic impact.	Drawdown starting April through late September with both diversion scenarios. Minimal hydrologic impact.	Drawdown starting April through late September with both diversion scenarios. Minimal hydrologic impact.	Drawdown starting April through late September with both diversion scenarios. Minimal hydrologic impact.	Drawdown starting April through late September with both diversion scenarios. Minimal hydrologic impact.
Changes to flows, geomorphology, or connectivity from inundation under a planned reservoir or spillway flow from a reservoir	No impact	No impact with both diversion scenarios	No impact with both diversion scenarios	Inundation by Black Rock Coulee Reregulating Reservoir. Minimal impact with both diversion scenarios.	Inundation by Black Rock Coulee Reregulating Reservoir. Minimal impact with both diversion scenarios.	Minimal impact with both diversion scenarios.	Minimal impact with both diversion scenarios.
Changes to areas that receive water from the wasteways	No impact	Minimal impact with both diversion scenarios.	Minimal impact with both diversion scenarios.	Minimal impact in Black Rock Coulee with both diversion scenarios	Minimal impact in Black Rock Coulee with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios
Groundwater Resources							
Groundwater level declines	Continued decline in levels and high level of discontinued use in next 10-20 years. Adverse impact.	Conservation of about 138,000 ac-ft/year of groundwater; level declines continue, but at slower rate with both diversion scenarios. Beneficial impact.	Conservation of about 138,000 ac-ft/year of groundwater; level declines continue, but at slower rate with both diversion scenarios. Beneficial impact.	Conservation of about 273,000 ac-ft/year of groundwater; level declines continue and may rise slightly with both diversion scenarios. Beneficial impact.	Conservation of about 273,000 ac-ft/year of groundwater; level declines continue and may rise slightly with both diversion scenarios. Beneficial impact.	Conservation of about 164,000 ac-ft/year of groundwater; level declines continue, but at slower rate with both diversion scenarios. Beneficial impact.	Conservation of about 164,000 ac-ft/year of groundwater; level declines continue, but at slower rate with both diversion scenarios. Beneficial impact.
Recharge or seepage in Black Rock Coulee	No impact	No impact with both diversion scenarios	No impact with both diversion scenarios	Local recharge to shallow groundwater from reservoir with both diversion scenarios	Local recharge to shallow groundwater from reservoir with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios
Municipal and industrial users	Continued decline in levels. Adverse impact.	Reduced rate of declining groundwater levels. Beneficial effect south of I-90. Continued decline in levels north of I-90 with both diversion scenarios. Adverse impact.	Reduced rate of declining groundwater levels. Beneficial effect south of I-90. Continued decline in levels north of I-90 with both diversion scenarios. Adverse impact.	Reduced rate of declining groundwater levels as shallow aquifer seeps into deep aquifer with both diversion scenarios. Beneficial impact.	Reduced rate of declining groundwater levels as shallow aquifer seeps into deep aquifer with both diversion scenarios. Beneficial effect.	Reduced rate of declining groundwater levels with both diversion scenarios. Beneficial effect.	Reduced rate of declining groundwater levels with both diversion scenarios. Beneficial effect.

Table 4- 8. Overview of the benefits and impacts from the alternatives on all resource topics and areas assessed

Resource Indicator, Topic, or Measurement	No Action	Partial Groundwater Irrigation Replacement Alternatives		Full Groundwater Irrigation Replacement Alternatives		Modified Partial Groundwater Irrigation Replacement Alternatives	
		2A: Partial—Banks	2B: Partial—Banks + FDR	3A: Full—Banks	3B: Full—Banks + FDR	4A: Modified Partial—Banks	4B: Modified Partial—Banks + FDR
Water Quality							
Temperature (FDR)	No impact	No impact with both diversion scenarios	Minimal impact with both diversion scenarios	No impact with both diversion scenarios	Minimal impact with both diversion scenarios	No impact with both diversion scenarios	Minimal impact with both diversion scenarios
Dissolved oxygen (FDR)	No impact	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios
Heavy metals (FDR)	No impact	No impact with both diversion scenarios	Minimal impact with both diversion scenarios	No impact with both diversion scenarios	Minimal impact with both diversion scenarios	No impact with both diversion scenarios	Minimal impact with both diversion scenarios
Temperature (Banks)	No impact	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact, but greater than 2A with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact, but greater than 2A with both diversion scenarios	Minimal impact with both diversion scenarios
Dissolved oxygen (Banks)	No impact	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact, but greater than 2A with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact, but greater than 2A with both diversion scenarios	Minimal impact with both diversion scenarios
Turbidity (Banks)	No impact	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios
Temperature (Columbia)	No impact	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios
Total dissolved gas (Columbia)	No impact	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios
Temperature (CBP)	No impact	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios
pH (CBP)	No impact	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios
Salinity (CBP)	No impact	Minor beneficial effect with both diversion scenarios	Minor beneficial effect with both diversion scenarios	Minor beneficial effect with both diversion scenarios	Minor beneficial effect with both diversion scenarios	Minor beneficial effect with both diversion scenarios	Minor beneficial effect with both diversion scenarios
Nutrients (CBP)	Potential minor beneficial effect	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios
Water Rights							
Loss or curtailment of groundwater rights	No impact	Minor impacts with both diversion scenarios	Minor impacts with both diversion scenarios	Minor impacts with both diversion scenarios	Minor impacts with both diversion scenarios	Minor impacts with both diversion scenarios	Minor impacts with both diversion scenarios
Columbia River and Lake Roosevelt Tribal water rights	No impact	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios
Geology							
Commitment of geologic resources	No impact	No impact to minimal impact with both diversion scenarios	No impact to minimal impact with both diversion scenarios	No impact to minimal impact with both diversion scenarios	No impact to minimal impact with both diversion scenarios	No impact to minimal impact with both diversion scenarios	No impact to minimal impact with both diversion scenarios
Geologic hazards	No impact	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios

Table 4- 8. Overview of the benefits and impacts from the alternatives on all resource topics and areas assessed

Resource Indicator, Topic, or Measurement	No Action	Partial Groundwater Irrigation Replacement Alternatives		Full Groundwater Irrigation Replacement Alternatives		Modified Partial Groundwater Irrigation Replacement Alternatives	
		2A: Partial—Banks	2B: Partial—Banks + FDR	3A: Full—Banks	3B: Full—Banks + FDR	4A: Modified Partial—Banks	4B: Modified Partial—Banks + FDR
Unique geologic features	No impact	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios
Soils							
Farmland Protection Policy Act	No impact	No impacts with both diversion scenarios with implementation of legal requirements, BMPs, and mitigation measures	No impacts with both diversion scenarios with implementation of legal requirements, BMPs, and mitigation measures	No impacts with both diversion scenarios with implementation of legal requirements, BMPs, and mitigation measures	No impacts with both diversion scenarios with implementation of legal requirements, BMPs, and mitigation measures	No impacts with both diversion scenarios with implementation of legal requirements, BMPs, and mitigation measures	No impacts with both diversion scenarios with implementation of legal requirements, BMPs, and mitigation measures
Vegetation and Wetlands							
Impact on native plant communities	No impact	Adverse impact on native plant communities with both diversion scenarios	Adverse impact on native plant communities with both diversion scenarios	Significant impact with both diversion scenarios, including Black Rock Coulee Reregulating Reservoir	Significant impact with both diversion scenarios, including Black Rock Coulee Reregulating Reservoir	Adverse impact on native plant communities with both diversion scenarios	Adverse impact on native plant communities with both diversion scenarios
Fragmentation of native plant communities	No impact	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Adverse impact with both diversion scenarios with construction of new canals	Adverse impact with both diversion scenarios with construction of new canals	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios
Impact on special status plants	No impact	Potential impacts with both diversion scenarios; not yet quantified	Potential impacts with both diversion scenarios; not yet quantified	Potential impacts with both diversion scenarios; not yet quantified, but approximately an order of magnitude greater than 2A	Potential impacts with both diversion scenarios; not yet quantified, but approximately an order of magnitude greater than 2A	Potential impacts with both diversion scenarios; not yet quantified	Potential impacts with both diversion scenarios; not yet quantified
Habitat restoration	No impact	Long time periods for restoration of disturbed habitat with both diversion scenarios	Significant requirement for restoration of disturbed habitat with both diversion scenarios	Long time periods for restoration of disturbed habitat over larger areas than 2A with both diversion scenarios	Significant requirement for restoration of disturbed habitat over larger areas than 2A with both diversion scenarios	Long time periods for restoration of disturbed habitat with both diversion scenarios	Significant requirement for restoration of disturbed habitat with both diversion scenarios
Long-term loss of wetland area	No impact	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Adverse impact at Banks Lake with both diversion scenarios	Adverse impact at Banks Lake with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios
Long-term loss or degradation of wetland function	No impact	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal to adverse impact at Banks Lake depending on water year with both diversion scenarios	Minimal to adverse impact at Banks Lake depending on water year with both diversion scenarios	Minimal impact at Banks Lake depending on water year with both diversion scenarios	Minimal impact at Banks Lake depending on water year with both diversion scenarios

Table 4- 8. Overview of the benefits and impacts from the alternatives on all resource topics and areas assessed

Resource Indicator, Topic, or Measurement	No Action	Partial Groundwater Irrigation Replacement Alternatives		Full Groundwater Irrigation Replacement Alternatives		Modified Partial Groundwater Irrigation Replacement Alternatives	
		2A: Partial—Banks	2B: Partial—Banks + FDR	3A: Full—Banks	3B: Full—Banks + FDR	4A: Modified Partial—Banks	4B: Modified Partial—Banks + FDR
Wildlife and Wildlife Habitat							
Impact on intact shrub-steppe habitat	Minimal impact on wildlife that use farm lands because wheat fields would be fallowed every other year	Adverse impact with both diversion scenarios with removal of shrub-steppe habitat	Adverse impact with both diversion scenarios with removal of shrub-steppe habitat	Significant impact with both diversion scenarios over substantially larger area than with Alternative 2A	Significant impact over substantially larger area than with Alternative 2A	Adverse impact over slightly larger area than with Alternative 2A	Adverse impact over slightly larger area than with Alternative 2A
Barriers to unrestricted movement by wildlife	No impact	No impact to minimal impact with both diversion scenarios	No impact to minimal impact with both diversion scenarios	Significant impact with both diversion scenarios from extended canal system	Significant impact with both diversion scenarios from extended canal system	No impact to minimal impact with both diversion scenarios	No impact to minimal impact with both diversion scenarios
Impact on special status species, including migratory birds	No impact	Significant impact on multiple species with both diversion scenarios. Impacts to grebes would be more pronounced with the limited spring diversion scenario.	Significant impact on multiple species with both diversion scenarios. Impacts to grebes would be more pronounced with the limited spring diversion scenario.	Significant impact on multiple species with both diversion scenarios, involving substantially larger area and a number of species than with Alternative 2A	Significant impact on multiple species with both diversion scenarios, involving substantially larger area and a number of species than with Alternative 2A	Significant impact on multiple species with both diversion scenarios, involving slightly larger area and a number of species than with Alternative 2A	Significant impact on multiple species with both diversion scenarios, involving slightly larger area and a number of species than with Alternative 2A
Habitat fragmentation and population viability	No impact	No impact with both diversion scenarios	No impact with both diversion scenarios	Significant impact from extended canal system	Significant impact from extended canal system	No impact with both diversion scenarios	No impact with both diversion scenarios
Fisheries and Aquatic Resources							
Columbia River: Downstream migration of salmonid smolts (mid-April to August)	No impact	No to minimal impact Spring Diversion Scenario No impact Limited Spring Diversion Scenario	No to minimal impact Spring Diversion Scenario No impact Limited Spring Diversion Scenario	No to minimal impact Spring Diversion Scenario No impact Limited Spring Diversion Scenario	No to minimal impact Spring Diversion Scenario No impact Limited Spring Diversion Scenario	No to minimal impact Spring Diversion Scenario No impact Limited Spring Diversion Scenario	No to minimal impact Spring Diversion Scenario No impact Limited Spring Diversion Scenario
Columbia River: Upstream migration of adult salmon and steelhead (September to October for Fall Chinook, Steelhead)	No impact	No to minimal impact under both diversion scenarios	No to minimal impact under both diversion scenarios	No to minimal impact under both diversion scenarios	No to minimal impact under both diversion scenarios	No to minimal impact under both diversion scenarios	No to minimal impact under both diversion scenarios
Columbia River: Chum salmon spawning below Bonneville Dam (November to mid-April)	No impact	No impact under both diversion scenarios	No impact under both diversion scenarios	No impact under both diversion scenarios	No impact under both diversion scenarios	No impact under both diversion scenarios	No impact under both diversion scenarios
FDR: Zooplankton production	No impact	No impact to minimal impact under both diversion scenarios	No impact to minimal impact under both diversion scenarios	No impact to minimal impact under both diversion scenarios	No impact to minimal impact under both diversion scenarios	No impact to minimal impact under both diversion scenarios	No impact to minimal impact under both diversion scenarios
FDR: Rainbow trout net pen program	No impact	No impact to minimal impact under both diversion scenarios	No impact to minimal impact under both diversion scenarios	No impact to minimal impact under both diversion scenarios	No impact to minimal impact under both diversion scenarios	No impact to minimal impact under both diversion scenarios	Minimal impact under both diversion scenarios
FDR: Kokanee salmon spawner access to San Poil River	No impact	No impact to minimal impact under both diversion scenarios	No impact to minimal impact under both diversion scenarios	No impact to minimal impact under both diversion scenarios	Minimal impact under both diversion scenarios	No impact to minimal impact under both diversion scenarios	Minimal impact under both diversion scenarios

Table 4- 8. Overview of the benefits and impacts from the alternatives on all resource topics and areas assessed

Resource Indicator, Topic, or Measurement	No Action	Partial Groundwater Irrigation Replacement Alternatives		Full Groundwater Irrigation Replacement Alternatives		Modified Partial Groundwater Irrigation Replacement Alternatives	
		2A: Partial—Banks	2B: Partial—Banks + FDR	3A: Full—Banks	3B: Full—Banks + FDR	4A: Modified Partial—Banks	4B: Modified Partial—Banks + FDR
Banks Lake: Fish and zooplankton entrainment	No impact	Minimal impact under both diversion scenarios	Minimal impact under both diversion scenarios	Minimal to adverse impact under both diversion scenarios	Minimal impact under both diversion scenarios	Minimal to adverse impact under both diversion scenarios	Minimal impact under both diversion scenarios
Surface areas of littoral habitat temporarily exposed during drawdowns	No impact	Minimal impact under both diversion scenarios	Minimal impact under both diversion scenarios	Significant impact from greater drawdown under both diversion scenarios.	Minimal impact under both diversion scenarios	Minimal to adverse impact under both diversion scenarios	Minimal impact under both diversion scenarios
Banks Lake: Overall condition of the fishery	No impact	Minimal under both diversion scenarios	Minimal impact under both diversion scenarios	Minimal to adverse impact under both diversion scenarios	Minimal impact under both diversion scenarios	Minimal to adverse impact under both diversion scenarios	Minimal impact under both diversion scenarios
Threatened and Endangered Species							
Pygmy rabbits	No impact	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios
Downstream migration of salmonid smolts	No impact	Minimal impact Spring Diversion Scenario No impact Limited Spring Diversion Scenario	Minimal impact Spring Diversion Scenario No impact Limited Spring Diversion Scenario	Minimal impact Spring Diversion Scenario No impact Limited Spring Diversion Scenario	Minimal impact Spring Diversion Scenario No impact Limited Spring Diversion Scenario	Minimal impact Spring Diversion Scenario No impact Limited Spring Diversion Scenario	Minimal impact Spring Diversion Scenario No impact Limited Spring Diversion Scenario
Upstream migration of adult salmon, steelhead, and bull trout	No impact	Minimal impact under both diversion scenarios	Minimal impact under both diversion scenarios	Minimal impact under both diversion scenarios	Minimal impact under both diversion scenarios	Minimal impact under both diversion scenarios	Minimal impact under both diversion scenarios
Chum salmon spawning below Bonneville Dam	No impact	No impact under both diversion scenarios	No impact under both diversion scenarios	No impact under both diversion scenarios	No impact under both diversion scenarios	No impact under both diversion scenarios	No impact under both diversion scenarios
Air Quality							
Primary air quality standards	No impact	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios
Secondary air quality standards	No impact	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios
Attainment area classification	No impact	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios
Land Use and Shoreline Resources							
Changes in land ownership and land status	Potential for consolidation of farms	About 5,150 acres acquired (easements and fee title) with both diversion scenarios. Adverse impact	About 5,150 acres acquired (easements and fee title) with both diversion scenarios. Adverse impact	About 17,360 acres acquired (easements and fee title) with both diversion scenarios. Adverse impact	About 17,360 acres acquired (easements and fee title) with both diversion scenarios. Adverse impact	About 4,740 acres acquired (easements and fee title) with both diversion scenarios. Adverse impact	About 4,740 acres acquired (easements and fee title) with both diversion scenarios. Adverse impact
Changes in land or shoreline uses: Protection of irrigated agriculture	Adverse impact with significant change from irrigated to dryland agriculture.	57,000 acres of irrigated agriculture preserved with both diversion scenarios. Beneficial effect.	57,000 acres of irrigated agriculture preserved with both diversion scenarios. Beneficial effect.	102,600 acres of irrigated agriculture preserved with both diversion scenarios. Beneficial effect.	102,600 acres of irrigated agriculture preserved with both diversion scenarios. Beneficial effect.	70,000 acres of irrigated agriculture preserved with both diversion scenarios. Beneficial effect.	70,000 acres of irrigated agriculture preserved with both diversion scenarios. Beneficial effect.

Table 4- 8. Overview of the benefits and impacts from the alternatives on all resource topics and areas assessed

Resource Indicator, Topic, or Measurement	No Action	Partial Groundwater Irrigation Replacement Alternatives		Full Groundwater Irrigation Replacement Alternatives		Modified Partial Groundwater Irrigation Replacement Alternatives	
		2A: Partial—Banks	2B: Partial—Banks + FDR	3A: Full—Banks	3B: Full—Banks + FDR	4A: Modified Partial—Banks	4B: Modified Partial—Banks + FDR
Consistency with relevant plans, policies and programs	Adverse impact from inconsistent plans across 102,614 acres.	Supports county comprehensive plans across 57,000 acres with both diversion scenarios. Beneficial effect.	Supports county comprehensive plans across 57,000 acres with both diversion scenarios. Beneficial effect.	Supports county comprehensive plans across 102,600 acres with both diversion scenarios. Beneficial effect.	Supports county comprehensive plans across 102,600 acres with both diversion scenarios. Beneficial effect.	Supports county comprehensive plans across 70,000 acres with both diversion scenarios. Beneficial effect.	Supports county comprehensive plans across 70,000 acres with both diversion scenarios. Beneficial effect.
Recreation							
FDR: Loss of boating capacity	No impact	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	In dry years, 6 of 22 launches unavailable for 1-3 weeks. Slight increase in impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	No impact with both diversion scenarios	Minimal impact with both diversion scenarios
FDR: Exposure of boating hazards	No impact	No impact with both diversion scenarios	Minimal impact with both diversion scenarios	No impact with both diversion scenarios	Minimal impact with both diversion scenarios	No impact with both diversion scenarios	Minimal impact with both diversion scenarios
FDR: Loss of fishing opportunities	No impact	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios
FDR: Loss of usability at developed swimming areas	No impact	No impact with both diversion scenarios	Increased distance to water's edge with both diversion scenarios. Minimal impact.	No impact with both diversion scenarios	Increased distance to water's edge with both diversion scenarios. Adverse impact.	No impact with both diversion scenarios	Increased distance to water's edge with both diversion scenarios. Minimal impact.
FDR: Decrease in usability or aesthetic quality at developed camping or day use facilities	No impact	No impact with both diversion scenarios	Increased distance to water's edge with both diversion scenarios. Minimal impact.	No impact with both diversion scenarios	Increased distance to water's edge with both diversion scenarios. Adverse impact.	No impact with both diversion scenarios	Increased distance to water's edge with both diversion scenarios. Minimal impact.
FDR: Dispersed recreation	No impact	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	Minimal impact with both diversion scenarios
FDR: Loss of opportunity for hunting, wildlife viewing, hiking, etc. on lands surrounding the reservoirs	No impact	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios
Banks: Loss in boat launch capacity and related impacts on fishing access, camping, and day use	No impact	In dry years, two of five high-capacity launches unavailable for 3-4 weeks with both diversion scenarios. Adverse impact.	With both diversion scenarios, minimal impact at high-capacity ramps, but low-capacity ramps would be out of service for up to 5 weeks	All but one boat ramp unavailable for 6 weeks with both scenarios. Adverse impact.	With both diversion scenarios, minimal impact at high-capacity ramps, but low-capacity ramps would be out of service for up to 5 weeks	In dry years, high capacity ramps unavailable for 1-4 weeks. Potential increased impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	With both diversion scenarios, minimal impact at high-capacity ramps, but low-capacity ramps would be out of service for up to 5 weeks

Table 4- 8. Overview of the benefits and impacts from the alternatives on all resource topics and areas assessed

Resource Indicator, Topic, or Measurement	No Action	Partial Groundwater Irrigation Replacement Alternatives		Full Groundwater Irrigation Replacement Alternatives		Modified Partial Groundwater Irrigation Replacement Alternatives	
		2A: Partial—Banks	2B: Partial—Banks + FDR	3A: Full—Banks	3B: Full—Banks + FDR	4A: Modified Partial—Banks	4B: Modified Partial—Banks + FDR
Banks: Exposure of boating hazards	Minimal impact	Drawdown exposure of hazards would last for about 3-6 weeks. Potential for increased hazard exposure with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	Drawdown exposure of hazards would last for about 6-7 weeks. Potential for increased impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	Drawdown exposure of hazards would last for about 10-13 weeks. Potential for increased hazard exposure with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	Drawdown exposure of hazards would last for about 10-13 weeks. Potential for increased impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	Drawdown exposure of hazards would last for about 4-7 weeks. Potential for increased impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	Drawdown exposure of hazards would last for about 6-7 weeks. Potential for increased impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.
Banks: Loss of fishing opportunities (because of impact on fishery; impact on fishing access reflected in boating capacity indicator)	No impact	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal Impact with both diversion scenarios.	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios
Banks: Loss of usability at developed swimming areas	No impact	Three of four swimming areas unusable for about 6 weeks. Slight increase in impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	Three of four swimming areas unusable for about 5-6 weeks. Potential increased impact with limited spring diversion scenario than with spring diversion scenario Adverse impact.	All four swimming areas would be unusable for up to 12 weeks. Potential increased impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	Three of four swimming areas unusable for about 5-6 weeks. Potential increased impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	Three of four swimming areas unusable for about 6 weeks. Potential increased impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	Three of four swimming areas unusable for about 5-6 weeks. Potential increased impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.
Banks: Decrease in usability or aesthetic quality at developed camping or day use facilities	Minimal impact	Distance to water's edge would be about 20-260 feet for dry years with both diversion scenarios. Adverse impact.	Distance to water's edge would be about 20-260 feet for dry years with both diversion scenarios. Adverse impact.	Distance to water's edge would be about 50-850 feet in dry years. Potential increased impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	Distance to water's edge would be about 20-260 feet for dry years with both diversion scenarios. Adverse impact.	Distance to water's edge would be about 50-450 feet in dry years. Potential increased hazard exposure with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	Distance to water's edge would be about 20-260 feet for dry years with both diversion scenarios. Adverse impact.
Banks: Decrease in usability of aesthetic quality at dispersed recreation sites	Minimal impact	Distance to water's edge would be about 20-445 feet for dry years with both diversion scenarios. Adverse impact.	Distance to water's edge would be about 20-420 feet for dry years with both diversion scenarios. Adverse impact.	Distance to water's edge would be over 50-890 feet for dry years. Potential increased impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	Distance to water's edge would be about 20-420 feet for dry years. Adverse impact.	Distance to water's edge would be about 25-470 feet for dry years. Adverse impact.	Distance to water's edge would be about 20-420 feet for dry years. Adverse impact.
Banks: Loss of opportunity for hunting, wildlife viewing, hiking, etc. on lands surrounding the reservoirs	No impact	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios

Table 4- 8. Overview of the benefits and impacts from the alternatives on all resource topics and areas assessed

Resource Indicator, Topic, or Measurement	No Action	Partial Groundwater Irrigation Replacement Alternatives		Full Groundwater Irrigation Replacement Alternatives		Modified Partial Groundwater Irrigation Replacement Alternatives	
		2A: Partial—Banks	2B: Partial—Banks + FDR	3A: Full—Banks	3B: Full—Banks + FDR	4A: Modified Partial—Banks	4B: Modified Partial—Banks + FDR
Loss of hunting and/or wildlife viewing opportunities in Odessa Special Study Area	No impact	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios
Irrigated Agriculture							
Gross Farm Income 2025 Study Area Compared to Four-County Analysis Area	Adverse long-term impact: gross farm income drops from about $119.1 million to $54.5 million	Beneficial long-term effect: gross farm income increases from about $119.1 million to $156.8 million	Beneficial long-term effect: gross farm income increases from about $119.1 million to $156.8 million	Beneficial long-term effect: gross farm income increases from about $119.1 million to $243.5 million	Beneficial long-term effect: gross farm income increases from about $119.1 million to $243.5 million	Beneficial long-term effect: gross farm income increases from about $119.1 million to $182.6 million	Beneficial long-term effect: gross farm income increases from about $119.1 million to $182.6 million
Socioeconomics							
Change in regional employment (number of jobs) within the four-county analysis area	Minimal long–term impact: less than 1 percent decrease in jobs	Short–term beneficial effects: less than one percent increase in jobs. Net long–term beneficial effects: less than 1 percent increase in jobs. Ag: less than 2 percent increase in jobs.	Short–term beneficial effects: less than 1 percent increase in jobs. Net long–term beneficial effects: Ag: less than 2 percent increase in jobs.	Short–term beneficial effects: less than 4 percent increase in jobs. Net long–term beneficial effects: less than 1 percent increase in jobs. Ag: less than 2 percent increase in jobs.	Short–term beneficial effects: less than 4 percent increase in jobs. Net long–term beneficial effects. Ag: less than 2 percent increase in jobs.	Short–term beneficial effects: less than 1 percent increase in jobs. Net long–term beneficial effects: O&M: less than 1 percent increase in jobs. Ag: less than 2 percent in jobs.	Short–term beneficial effects: less than 1 percent increase in jobs. Net long–term beneficial effects: O&M: less than 1 percent increase in jobs. Ag: less than 2 percent increase in jobs.
Change in regional labor income within the four-county analysis area	Minimal long–term impact: less than 0.5 percent decrease in labor income	Short–term beneficial effects: less than 2 percent increase in labor income. Net long–term beneficial effects. Ag: less than 2 percent increase in jobs.	Short–term beneficial effects: less than 2 percent increase in labor income. Net long–term beneficial effects: less than 1 percent increase in labor income. Ag: less than 2 percent increase in jobs.	Short–term beneficial effects: less than 6 percent increase in labor income. Net long–term beneficial effects: less than 1 percent increase in labor income. Ag: less than 3 percent increase in jobs.	Short–term beneficial effects: less than 6 percent increase in labor income. Net long–term beneficial effects. Ag: less than 3 percent increase in jobs.	Short–term beneficial effects: less than 1 percent increase in jobs. Net long–term beneficial effects: O&M: less than 1 percent increase in jobs. Ag: less than 2 percent in jobs.	Short–term beneficial effects: less than 1 percent increase in jobs. Net long–term beneficial effects: O&M: less than 1 percent increase in jobs. Ag: less than 2 percent increase in jobs.
Change in regional sales within the four-county analysis area	Minimal long–term impact: less than 0.5 percent decrease in sales	Short–term beneficial effects: less than 1 percent increase in sales. Net long–term beneficial effects. Ag: less than 2 percent increase in jobs.	Short–term beneficial effects: less than 1 percent increase in sales. Net long–term beneficial effects. Ag: less than 2 percent increase in jobs.	Short–term beneficial effects: less than 4 percent increase in sales. Net long–term beneficial effects: less than 1 percent increase in sales. Ag: less than 4 percent increase in jobs.	Short–term beneficial effects: less than 4 percent increase in sales. Net long–term beneficial effects. Ag: less than 4 percent increase in jobs.	Short–term beneficial effects: less than 1 percent increase in jobs. Net long–term beneficial effects: O&M: less than one percent increase in jobs. Ag: less than 3 percent increase in jobs.	Short–term beneficial effects: less than 1 percent increase in jobs. Net long–term beneficial effects: O&M: less than 1 percent increase in jobs. Ag: less than 3 percent increase in jobs.

Table 4- 8. Overview of the benefits and impacts from the alternatives on all resource topics and areas assessed

Resource Indicator, Topic, or Measurement	No Action	Partial Groundwater Irrigation Replacement Alternatives		Full Groundwater Irrigation Replacement Alternatives		Modified Partial Groundwater Irrigation Replacement Alternatives	
		2A: Partial—Banks	2B: Partial—Banks + FDR	3A: Full—Banks	3B: Full—Banks + FDR	4A: Modified Partial—Banks	4B: Modified Partial—Banks + FDR
Transportation							
Short- or long-term increases in traffic (general average daily and peak hour) on regional or local roads	No impact	Minimal Impact with both diversion scenarios	Minimal Impact with both diversion scenarios	Minimal Impact with both diversion scenarios	Minimal Impact with both diversion scenarios	Minimal Impact with both diversion scenarios	Minimal Impact with both diversion scenarios
Increases in large and/or heavy-load vehicle traffic on regional or local roads	No impact	Minimal Impact with both diversion scenarios	Minimal Impact with both diversion scenarios	Minimal Impact with both diversion scenarios	Minimal Impact with both diversion scenarios	Minimal Impact with both diversion scenarios	Minimal Impact with both diversion scenarios
Existing roads and railroads: crossings by new surface facilities or inundation by new reservoirs	No impact	Minimal impact given committed Transportation Management Plan (TMP)	Minimal impact given committed TMP	Minimal impact given committed TMP	Minimal impact given committed TMP	Minimal impact given committed TMP	Minimal impact given committed TMP
Energy							
Change in net energy available in region	No impact	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios
Keys PGP reserves, reliability and diurnal load shifting	No impact	Adverse to significant impact with both diversion scenarios	Adverse impact with both diversion scenarios	Significant impact with both diversion scenarios	Adverse impact with both diversion scenarios	Significant impact with both diversion scenarios	Adverse impact with both diversion scenarios
Public Services and Utilities							
Exceedance of service or utility capacity (long-term)	No impact	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios
Disruption of services or utilities for existing residents and landowners (short-term, construction-phase)	No impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact
Impact on emergency response times (short-term, construction-phase)	No impact	Minimal Impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact
Noise							
Short-term (construction) increases in noise levels	No impact	Localized adverse impact	Localized adverse impact	Localized adverse impact	Localized adverse impact	Localized adverse impact	Localized adverse impact
Long-term increases in noise levels	No impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact	Minimal impact
Public Health (Hazardous Materials)							
Hazardous sites	No impact	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios
Mosquito habitat	No impact	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios	Minimal impact with both diversion scenarios

Table 4- 8. Overview of the benefits and impacts from the alternatives on all resource topics and areas assessed

Resource Indicator, Topic, or Measurement	No Action	Partial Groundwater Irrigation Replacement Alternatives		Full Groundwater Irrigation Replacement Alternatives		Modified Partial Groundwater Irrigation Replacement Alternatives	
		2A: Partial—Banks	2B: Partial—Banks + FDR	3A: Full—Banks	3B: Full—Banks + FDR	4A: Modified Partial—Banks	4B: Modified Partial—Banks + FDR
Visual Resources							
Landscape-level change: conversion from irrigated agriculture to dryland or fallow over approximately 30-year period	About 100,000 acres would convert to dryland or fallow. Adverse impact.	About 48,000 acres would convert to dryland or fallow. Adverse impact.	About 48,000 acres would convert to dryland or fallow. Adverse impact.	General landscape appearance does not change.	General landscape appearance does not change.	About 35,000 acres would convert to dryland or fallow. Adverse impact.	About 35,000 acres would convert to dryland or fallow. Adverse impact.
Introduction of new developed facilities	No impact	Pumping plants and regulating tanks south of I-90 only. Adverse impact.	Pumping plants and regulating tanks south of I-90 only. Adverse impact.	Canal, laterals, pumping plants, and regulating tanks north and south of I-90. Adverse impact.	Canal, laterals, pumping plants, and regulating tanks north and south of I-90. Adverse impact.	Pumping plants and regulating tanks north and south of I-90. Adverse impact.	Pumping plants and regulating tanks north and south of I-90. Adverse impact.
Changes in reservoir drawdown patterns at Banks Lake and Lake Roosevelt	Minimal Impact	Adverse impact at Banks Lake generally related to depth of additional drawdown. Adverse impact with both diversion scenarios.	Adverse impact at Banks Lake generally related to depth of additional drawdown. Adverse impact with both diversion scenarios.	Adverse impact at Banks Lake generally related to depth of additional drawdown. Impacts would be slightly more pronounced with the limited spring diversion scenario.	Adverse impact at Banks Lake generally related to depth of additional drawdown. Impacts would be slightly more pronounced with the limited spring diversion scenario.	Adverse impact at Banks Lake generally related to depth of additional drawdown. Adverse impact with both diversion scenarios.	Adverse impact at Banks Lake generally related to depth of additional drawdown. Adverse impact with both diversion scenarios.
Cultural and Historic Resources *Potential for construction to encounter and impact significant cultural resources*							
Miles of new linear facilities with high potential	No impact	166 miles. Adverse impact.	166 miles. Adverse impact.	245 miles. Adverse impact.	245 miles. Adverse impact.	162 miles. Adverse impact.	162 miles. Adverse impact.
Acres of facility site acquisition with high potential	No impact	38 acres. Adverse impact.	38 acres. Adverse impact.	100 acres. Adverse impact.	100 acres. Adverse impact.	27 acres. Adverse impact.	27 acres. Adverse impact.
Additional acreage exposed by drawdowns at Banks Lake	No impact	About 560 acres exposed with spring diversion scenario and about 1,080 acres with limited spring diversion scenario. Adverse impact.	About 560 acres exposed with spring diversion scenario and about 700 acres with limited spring diversion scenario. Adverse impact.	About 1,400 acres exposed with spring diversion scenario and about 2,430 acres with limited spring diversion scenario. Adverse impact.	About 700 acres exposed with spring diversion scenario and about 700 acres with limited spring diversion scenario. Adverse impact.	About 790 acres exposed with spring diversion scenario and about 1,480 acres with limited spring diversion scenario. Adverse impact.	About 700 acres exposed with spring diversion scenario and about 700 acres with limited spring diversion scenario. Adverse impact.
Indian Sacred Sites							
Potential for facility development to impact known sacred sites	No impact	Potential impacts; not yet quantified	Potential impacts; not yet quantified	Potential impacts; not yet quantified	Potential impacts; not yet quantified	Potential impacts; not yet quantified	Potential impacts; not yet quantified
Indian Trust Assets							
Potential for facility development to impact known ITAs	No impact	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios

Table 4- 8. Overview of the benefits and impacts from the alternatives on all resource topics and areas assessed

Resource Indicator, Topic, or Measurement	No Action	Partial Groundwater Irrigation Replacement Alternatives		Full Groundwater Irrigation Replacement Alternatives		Modified Partial Groundwater Irrigation Replacement Alternatives	
		2A: Partial—Banks	2B: Partial—Banks + FDR	3A: Full—Banks	3B: Full—Banks + FDR	4A: Modified Partial—Banks	4B: Modified Partial—Banks + FDR
Environmental Justice							
Disproportionate impact to minority or low-Income populations	No impact	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios	No impact with both diversion scenarios

Chapter 5: Four-Account Analysis

The alternatives were compared using the four accounts of the Principles and Guidelines defined in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (March 10, 1983) (P&Gs), to facilitate evaluation and to display effects of the alternatives:

National Economic Development (NED): The Federal objective is to contribute to national economic development consistent with protecting the Nation's environment. The NED account measures the beneficial and adverse monetary effects of each alternative in terms of changes in the value of the national output of goods and services.

Regional Economic Development (RED): This account evaluates the beneficial and adverse impacts of each alternative on the economy of the affected region, with particular emphasis on income and employment measures. The affected region reflects the geographic area where significant impacts are expected to occur. Impacts can be measured in both monetary and nonmonetary terms.

Environmental Quality (EQ): This account displays the effects on ecological, cultural, and aesthetic attributes of significant natural and cultural resources which cannot be adequately measured in monetary terms within the NED and RED accounts.

Other Social Effects (OSE): This account displays plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts.

The NED and RED accounts evaluate economic effects of proposed alternative plans. According to the P&Gs, a primary distinction between an NED benefit-cost analysis (BCA) and a RED regional economic impact analysis is geographic. The RED analysis focuses on economic impacts to the local region, whereas the NED analysis focuses on economic benefits to the entire Nation. The RED evaluation recognizes the NED benefits accruing to the local region plus the transfers of income into the region. However, since the RED analysis focuses purely on the local region, it does not take into account potential offsetting effects occurring outside the region, as does the NED analysis. As a Federal agency, Reclamation must analyze the NED effects so as not to favor one area of the country over another. Reclamation also analyzes the RED effects to the local economy to provide specific information on the primary impact area. However, economic justification is determined for each alternative based solely on the results of the NED BCA. In addition to the geographic differences between the economic analyses, the RED analysis includes not only the initial or direct impact on the primary affected industries (as does the NED analysis), but also the secondary or indirect effects on those industries providing inputs to the directly affected industries (referred to as the multiplier effect). This multiplier effect is not included in the NED analysis.

For each of the four accounts, analyses were conducted on the alternatives considered in this Study. In addition to the No Action Alternative, six proposed "action" alternatives to replace groundwater with surface water within the Odessa Study Area were evaluated. The Partial-Replacement Alternatives (2A and 2B) would provide nearly 57,100 acres with CBP surface water, the Full-Replacement Alternatives (3A and 3B) would provide CBP water to approximately 102,600 acres, and the Modified Partial-Replacement Alternatives (4A and 4B) would provide CBP water to approximately 70,000 acres. The main difference between the range of partial-, full-, and Modified Partial-Replacement Alternatives is the source of the water supply. Alternatives 2A, 3A, and 4A assume the water supply would come from Banks Lake; Alternatives 2B, 3B, and 4B assume the water supply would come from Banks Lake and Lake Roosevelt.

5.1. National Economic Development Benefit-Cost Analysis and Financial Analysis

The purpose of an NED BCA is to compare the benefits of a proposed project to its costs. The total costs of the project are subtracted from the total benefits to measure net benefits. If the net benefits are positive, implying that benefits exceed costs, the project would be considered economically justified. In studies where multiple alternatives are being considered, the alternative with the greatest positive net benefit would be preferred from strictly an economics perspective. Another way of displaying this benefit-cost comparison involves dividing total project benefits by total project costs—resulting in the benefit-cost ratio (BCR). A BCR greater than 1:1 is equivalent to a positive net benefit.

Reclamation cost engineers assumed that construction associated with each alternative would be broken down into several construction phases – four construction phases for Alternatives 2A/2B and 4A/4B and nine construction phases for Alternatives 3A/3B. The canal construction period was assumed to occur from 2015 to 2025 with the construction schedule for each phase as follows: Phase 1—2015-2019; Phase 2—2017-2022; Phase 3—2019-2023; Phase 4—2021-2025; Phase 5—2015-2020; Phase 6—2019-2023; Phase 7—2021-2025; Phase 8—2017-2022; and Phase 9—2021-2025. If this construction period or schedule changes, either in terms of total length or sequence and timing of the phases, the cost and benefit estimates would change and would need to be updated (e.g., the construction schedule used for this BCA does not assume the alternatives would be developed and phased using public-private partnerships). All subsequent canal construction phases would be dependent upon the first phase which was assumed to end in year 2019. Therefore, by applying the standard 100-year Reclamation study period, the period of analysis ends for all phases in year 2118.

Before comparisons can be made between costs and benefits, they must be converted to the same dollar year and point in time. Since all the costs and benefits are measured in current dollars, no dollar year adjustment was necessary. However, the costs and benefits would occur at different times. As is typical in Reclamation studies, the decision was made to measure all the costs and benefits as of the end of the construction period. Since canal construction is divided into a series of phases, the end of the canal construction period is defined as the end of the last canal construction phase (year 2025).

Costs and benefits incurred after year 2025 are discounted (reduced) back to the end of the construction period using the Federal 2011-2012 water project planning rate of 4.0 percent. Benefits associated with all phases prior to the last construction phase would begin at the end of each phase (not the end of the last canal construction phase), and would end in year 2118. Thus, some of those benefits would accrue prior to the end of the canal construction period. This implies that those pre-2025 benefits would need to be compounded (increased) to the end of the canal construction period. These same discounting and compounding concepts are also applied to the costs incurred during the construction period and period of analysis so as to measure all costs and benefits as of the end of the canal construction period (year 2025). Due to the conversion of costs to year 2025, the costs presented in this NED BCA section will differ from the unadjusted costs by alternative presented in Chapter 4.

5.1.1 Methodology and Assumptions

This section briefly describes the methodology and assumptions associated with each benefit and cost component. For more detail on the NED methodology, see the Economics Technical Report, Odessa Subarea Special Study, Columbia Basin Project, Washington (Reclamation 2012 Economics).

5.1.1.1. Benefit Analyses

The primary beneficiary of the proposed project to replace groundwater with surface water is irrigated agriculture. However, benefits were also estimated for municipal and industrial users. Municipal and industrial benefits were considered “other direct benefits” since they are “incidental to the purposes for which the water resources plan is being formulated” (U.S. Water Resources Council, 1983).

5.1.1.2. Agricultural Benefits

Benefit values for irrigated agriculture were estimated following the criteria for measuring National Economic Development (NED) benefits defined in the P&Gs. The P&Gs are the Federal guidelines by which Reclamation determines NED benefits of Federal actions or project implementation. A P&G analysis of NED agricultural benefits is based on a “with- and without-project” comparison.

The without-project condition is similar to the no action alternative described in an environmental impact statement prepared under National Environmental Policy Act

(NEPA) requirements. The without-project condition was defined for the Odessa Subarea Special Study so that differences in the amounts of economic output generated could be quantitatively compared to the economic output of the formulated action alternatives (the with-project conditions). Generally speaking, the without-project condition assumed that groundwater pumping in the Study Area would continue as long as possible over a 100-year period. As well performance degraded over time and wells were eventually taken offline, those lands in the Odessa Subarea being irrigated with groundwater would revert to dryland farming. The with-project condition assumed that 3 acre-feet of irrigation water would be delivered to each of the groundwater-irrigated acres within the area, thus allowing irrigated agriculture to continue in the future.

Agricultural irrigation benefit values are estimated using a farm budget application developed by Reclamation. The farm budget methodology is used to estimate how valuable an irrigation water supply is to the crops produced within a project. This is accomplished by estimating the residual net farm income of representative crops expected to be found in the project area under with- and without-project conditions. Enterprise crop budgets are used to characterize the production, management, and marketing strategies commonly used in producing the mix of crops expected to be produced in the project area. Each enterprise budget is sized to provide approximately full-time employment to the operator through the growing season. Additionally, each budget provides a fair return to land, labor, and capital, as specified by the P&Gs. Furthermore, the P&Gs specify the debt load to be carried by the farm and identify the prices and interest rates to be used in the analysis. Residual net farm income refers to the amount of farm income remaining after subtracting production costs and an allowance for management and labor from the gross farm income expected from the sale of crops. Agricultural benefits are calculated by estimating the residual net farm income for the with- and without-project farms. After estimating the residual net farm income for both conditions, the difference between the two residual net farm incomes is calculated; this difference is the agricultural benefit.

The agricultural benefits analysis for the Odessa Subarea Special Study is based on:

1. Changes in the crop mix expected to occur under the with- and without-project conditions,

2. On-farm savings (or decreased production costs) resulting from implementing the project, and

3. The subsequent differences in residual net farm income under the with- and without-project conditions.

Six enterprise budgets were used for the without-project conditions; the farm size and the associated cultural practices were chosen based on data obtained from the Washington

State Extension Service cost and return bulletins. The crop mix used for the without-project enterprise budgets was derived from information obtained from GWMA.

Three enterprise budgets were developed for with-project conditions; these budgets reflect a future crop mix expected to be prevalent after transitioning from groundwater irrigation to surface water irrigation. The crop mix for the with-project condition was derived in consultation with ECBID and included irrigated potatoes, alfalfa, and wheat.

After determining the enterprise budget farm size, gross income for the crop was calculated using average yields and expected prices received. Variable and fixed production costs were subtracted from the gross revenue to find net farm income. Residual net farm income was derived by subtracting an allowance for a return to management and labor from net farm revenues. The difference between the with-project residual net farm income and the without-project residual net farm income for the respective crop mixes is the estimate of agricultural irrigation benefits.

The crops selected for the enterprise budgets were based on the distribution of crops within the study area associated with each of five groundwater pumping status levels. Production records related to the distribution of crops were collected by Reclamation from the U.S. Department of Agriculture's National Agricultural Statistics Service (NASS) and the Columbia Basin Ground Water Management Area. Additionally, crop enterprise budgets published by Washington State University (WSU) were used to reflect typical production costs incurred in the study area.

Representative enterprise crop budgets were developed for without-project conditions for each well status level. A description of the five well status levels is available in Chapter 2 of the Odessa Final EIS (Reclamation 2012) and the National Economic Development (NED) section of the Economics Technical Report (Reclamation 2012 Economics).

The with-project condition assumed that pumping costs were minimized since surface water was delivered for irrigation purposes. Pumping lifts for the No Action Alternative came from a groundwater study prepared by Reclamation (Reclamation 2012 Groundwater). Different pumping lifts were assumed for the No Action Alternative and depended on the location of irrigated acres associated with each of the Action Alternatives. The differences in pumping lifts between the No Action and Action Alternatives were used in deriving the benefits gained from each of the action alternatives. For example, the pumping lift for the Partial-Replacement Alternative averaged 602 feet because of the location within the Odessa Subarea of the 57,000 acres served by the Partial-Replacement Alternative. The pumping lift for the Full-Replacement Alternative averaged 548 feet over the 102,000 acres served by this alternative. The pumping lift for the Modified Partial-Replacement Alternative averaged 555 feet over the 70,000 acres served by the Modified Partial Replacement Alternative.

In this analysis, the primary driver for agricultural benefits comes from a change in pumping costs. Reduced pumping costs lower farm cost, resulting in higher residual net farm incomes. A secondary driver for agricultural benefits comes from an incremental change in crop acres as wells become less dependable and the crop mix is changed. For example, if the performance of Status level 2 wells is reduced and those wells become classified as Status level 3 wells, there will be a change in the crops that can be grown on the acres served by those wells. Thus, a change in crop production will occur (different crops will be grown) along with a resultant change in residual net farm income.

5.1.1.3. Other Direct Benefits - Municipal

Municipal benefits were estimated as cost savings for the proposed action alternatives as compared to the No Action Alternative.[9] All of the information used to develop municipal costs by alternative was provided by Columbia Basin Groundwater Management Area (GWMA). Their report entitled, *General Review of Current Groundwater Supply and Potential Future Water Supply Options for the Cities of Connell, Lind, Moses Lake, Odessa, Othello, and Warden* (GWMA, 2011) provides estimates of the costs of providing deep aquifer well systems and surface water systems for six impacted towns in the area (Connell, Lind, Moses Lake, Odessa, Othello, and Warden).

Based on information from the GWMA report, alternative specific costs were estimated for drilling, well system operations and maintenance (O&M), wellhead water treatment, wellhead treatment O&M, surface water filtration/treatment, surface water system O&M, and pipeline interties by town for both deep aquifer well systems and surface water systems. The total annual cost of operating the current system in each town was also provided by GWMA. All of this information was combined to calculate the costs of running the current system and of constructing and running deep aquifer well systems and combination deep aquifer well/surface water systems for each town (see the Economics Technical Report [Reclamation, 2012 Economics] for more details).

As discussed in the *Review of Groundwater Analysis* report (Reclamation 2012 Groundwater), it was assumed that each town would move through a series of water supply systems over the study period. Due to uncertainty regarding the future water system transition path of each town, this analysis presents two progression options: Option 1—Varying Path (Dual Water Source) where the water system progression varies by town; and Option 2–Drilling Path (Deep Groundwater Source) where all towns are assumed to continue drilling wells deeper into the future. Both options are considered to be equally likely. Under Option 1-Varying Path, the towns of Connell, Moses Lake, Othello, and Warden were assumed to progress from their current system to a deep

[9] It is also likely that benefits could accrue to domestic well owners outside the municipal water systems as a result of moving groundwater irrigators on to surface water under the proposed alternatives, but that benefit is not addressed by this municipal analysis.

aquifer well system, and finally to a combined deep aquifer well and surface water system. For the towns of Lind and Odessa under Option 1-Varying Path, it was assumed that the progression would move from their current system to a deep aquifer well system, and finally a deeper well system. Under Option 2–Drilling Path, all towns were assumed to transition from their current system to a deep aquifer well system and finally to a deeper well system.

As shown in Table 5- 1, GWMA was also provided estimates of when the costs of the various water supply systems would be incurred for each town under each alternative. Note that the initial deep aquifer well system associated with all towns was assumed to last approximately 20 years, but the subsequent system was assumed to last through the end of the study period.

Table 5- 1. Conversion years by town and alternative

Alternative	Alternative #	Municipalities	Approximate Year of 1st Water System Conversion (to Deep Aquifer System)	Approximate Year of 2nd Water System Conversion (to Deeper Well System or Combined Deep Aquifer Well & Surface Water System)
No Action	1	Connell, Lind, Moses Lake, Odessa, Othello, Warden	2027	2047
Partial Replacement	2A-2B	Moses Lake, Odessa	2031	2051
		Connell, Lind, Othello, Warden	2037	2057
Full Replacement	3A-3B	Connell, Lind, Moses Lake, Odessa, Othello, Warden	2070	2090
Modified Partial	4A (Preferred) - 4B	Moses Lake, Odessa	2055	2075
		Connell, Lind, Othello, Warden	2032	2052

Source: GWMA

As can be seen from Table 5- 1, the towns shift between the four water supply systems (current, deep well, deeper well, combined deep well and surface water) across the study period. Cost differentials arise because the conversion to the various water supply systems occurs at different times for each town under each alternative.

Costs were estimated by cost component, town, and year (starting with the year of the first conversion, 2027, and continuing through the end of the period of analysis, 2118) for each water system and alternative.

Finally, the costs are added across cost components and towns within the same year for each alternative. The costs by year are then discounted back to the end of the construction period (end of year 2025) to be consistent with all the other costs and benefits presented in this study. Differences between the discounted costs of the proposed action alternatives and those of the No Action Alternative reflect the cost savings benefit used in the benefit-cost analysis.

5.1.1.4. Other Direct Benefits – Industrial

Other direct benefits for industrial water have been identified for the Study. These benefits are associated with increased flexibility in the operation of water supply conveyance facilities under the action alternatives (or, with-project conditions) as compared to the No Action Alternative (or, the without-project condition).

There are several agricultural processing plants in the Study Area including those utilizing potatoes grown within the Study Area. The nutrient content of agricultural processing water is too high to be disposed of or used for other purposes without dilution. Under the direction of the processing plants, the processing water is diluted with clean water from other sources to meet discharge requirements and then applied to irrigated crops. Several processors have interruptible contracts with Reclamation totaling 4,700 acre-feet for industrial water to dilute their processing water. The water is delivered through ECBID facilities. However, under the No Action Alternative (without-project condition), the industrial deliveries are interrupted because even though adequate water supplies are available, there is not sufficient capacity within the canal for delivery to all users along the canal during the summer months. Under the partial- and Full-Replacement Alternatives (with-project conditions), sufficient capacity would be provided to allow uninterrupted delivery of the 4,700 acre-feet of industrial water.

Since the 4,700 acre-feet of industrial water is diluted and applied to irrigated crops, the benefit for industrial water was based on the agricultural benefit per acre-foot of water ($91.72 for alternatives 2A/B, $88.83 for alternatives 3A/B, and $89.20 for alternatives 4A/B), less the cost of industrial water ($48 per acre-foot).

5.1.1.5. Cost Analyses

Project costs are composed not only of construction, interest during construction (IDC), land acquisition, and annual operating, maintenance, replacement, and power (OMR&P) costs, but also lost project benefits related to hydropower.

5.1.1.5.1 *Construction Costs and Interest During Construction*

Canal construction costs were estimated by Reclamation cost engineers and include field costs of construction contracts and noncontract costs (land purchases, construction facilities, studies/investigations/design data collection, engineering design, construction management and contract administration, etc.).

Since the majority of construction activities are associated with different canal segments, the construction period was broken down into a number of phases. Partial-Replacement Alternatives (2A/2B) and Modified Partial-Replacement Alternatives (4A/4B) were broken down into four canal construction phases and the Full-Replacement

Alternatives 3A/3B were broken down into nine canal construction phases. The canal construction period runs from 2015 to 2025 across all phases.

IDC is charged on both field costs and noncontract costs, but only during the construction period. A significant portion of the noncontract costs are incurred prior to the start of the construction period. As a result, noncontract costs incurred prior to the start of the construction period for each phase were aggregated into the first year of the construction period for that phase before calculating IDC.

IDC was calculated on the canal construction and noncontract costs incurred annually within each construction phase. Total IDC was added to the total construction and noncontract cost to estimate costs at the end of each phase. These phase-specific construction/noncontract and IDC costs were then compounded to the end of the overall canal construction period in year 2025.

In addition to canal construction, costs of purchasing lands in lieu of constructing drainage systems were also estimated. GIS modeling using topographic data was used to predict areas that could potentially become wetted. Wetted acreages for each alternative were then calculated by determining how much of the land would potentially become wetted within the water delivery areas proposed for each alternative. The acreage for each alternative was then multiplied by $2,500/acre (average cost per acre) to estimate a cost for the purchase of wetted land. These costs were estimated for years 2016 through 2035. The annual land acquisition costs by alternative were then compounded and discounted to the end of the canal construction period in year 2025.

5.1.1.5.2 ***Annual Operating, Maintenance, Replacement, and Power (OMR&P) Costs***

Average annual OMR&P costs were also estimated by Reclamation cost engineers. Since the construction phases would be completed at different times and OMR&P costs were assumed to begin immediately after completion of each construction phase, the OMR&P costs were estimated separately for each construction phase.

Annual OMR&P costs were included for each year from the end of construction on each phase until the end of the 100-year period of analysis year in 2118. The canal OMR&P costs incurred prior to year 2025 were compounded to the end of the canal construction period. The canal OMR&P costs incurred after year 2025 were discounted back to the end of the canal construction period.

5.1.1.5.3 ***Annual Lost Benefits***

Lost Hydropower Benefits: Losses in Columbia River system hydropower benefits were anticipated due to the increased pumping from the Columbia River to provide surface water supplies for agriculture. Bonneville Power Administration (BPA) ran their Columbia River System hydropower model based on operational/hydrologic changes (compared to the No Action Alternative) associated with each action alternative. Since there are two hydrologic scenarios (with Spring Diversions and with only Limited Spring Diversions), BPA had to run their model twice for each proposed alternative. Note that since each Partial-Replacement Alternative (2A/2B) would imply the same level of additional pumping out of the Columbia River, there is no difference in terms of the downstream hydropower effects for the Partial-Replacement Alternatives. The same holds true for the Modified Partial- and Full-Replacement Alternatives

For each action alternative and hydrologic scenario, BPA multiplied the changes in average monthly hydropower generation from the Columbia River System hydropower model by average monthly power values from the Final 2012 BPA Rate Case Flat Market Prices to estimate losses in average monthly hydropower benefits. The changes in monthly hydropower benefits were then aggregated into losses in average annual hydropower benefits. In addition, the cost of pumping the additional water into Banks Lake was included in the BPA analysis and not the OMR&P costs.

The average annual hydropower losses and pumping costs estimated by BPA reflect full diversion effects and were assumed to occur each year from 2025 to 2118 (end of the period of analysis). Since hydropower losses and additional pumping costs would begin at the same time as the agricultural diversions and those agricultural diversions are phased in as each canal construction phase is completed, it is logical to assume that hydropower losses and additional pumping costs would also phased in. To estimate the percentage of the full hydropower loss and additional pumping which would be phased in each year prior to 2025 for each alternative and hydrologic scenario, the cumulative number of agricultural acres associated with each phase and year were divided by the agricultural acreage associated with all phases. To allow for comparison with project benefits, the lost hydropower benefits by alternative and hydrologic scenario were converted (compounded/discounted) to the end of the canal construction period.

In addition to the lost benefits estimated by BPA associated with losses in downstream hydropower generation and increased pumping costs, estimates were also made of the increased generation and value associated with on-project hydropower facilities. Two hydropower generation facilities exist within the Odessa study area–one on the main canal and another at Summer Falls. The Grand Coulee Project Hydroelectric Authority, which manages these facilities, was provided hydrologic on-project flow data for an average year (1995) for each alternative (including No Action) from which they estimated increases in daily and monthly generation. Applying the same average monthly values as used in the BPA hydropower analysis to the estimated gains in monthly on-project generation provides estimates of the gains in monthly on-project hydropower value. Aggregating the monthly increases in hydropower value provides an estimate of the average annual increase in on-project hydropower value. These gains in average annual on-project hydropower were combined with the losses in systemwide hydropower and pumping costs estimated by BPA to provide an average annual net loss in hydropower and pumping cost. The annual net hydropower and pumping cost loss was included as a lost benefit within the BCA. These net annual lost benefits were phased in, as discussed above, and then compounded and discounted to year 2025.

Lost Recreation Benefits: The analysis presented in Section 4.14, "Recreation Resources," of the Odessa Final EIS indicates boat ramps at Banks Lake will become unavailable more frequently under the action alternatives as compared to the No Action Alternative. This would likely lead to reductions in recreation visitation and adverse recreation economic effects. To address this potential adverse effect, Reclamation and Ecology have committed to necessary mitigation measures as described in Section 4.29.10, "Environmental Commitments-Recreation Resources" of the Odessa FEIS. This mitigation assumption results in the elimination of the majority of the anticipated adverse boating access based recreation economic effects. As a result, lost recreation benefits are not included in the BCA.

5.1.2 No Action Alternative

5.1.2.1. Benefit Analyses

5.1.2.1.1 ***Agricultural Benefits***

All agricultural irrigation benefits associated with the action alternatives were measured as changes from the No Action Alternative. To start the agricultural benefits calculation, annual residual net farm income was first calculated for each year under the No Action Alternative by taking the annual change in crop acres for each pumping status level and multiplying by the associated without-project residual net farm income. This was done for each year of the 100-year period of analysis so that future projections of residual net farm income could be quantified.

Under the No Action Alternative, irrigated agriculture in the Study Area would be dramatically reduced because groundwater would not be replaced with surface water. As groundwater diminished, farmers would transition into growing dryland crops in rotation with fallow land. Ultimately, all but Status level 1 acres would grow dryland crops under the No Action Alternative because no other source of irrigation water would be available to the acres associated with the other well levels.

After forecasting the future number of irrigated and dryland acres, residual net farm income was estimated. There are 102,616 acres in the Study Area currently irrigated with groundwater. The crops represented by the NED benefits budgets include irrigated potatoes, wheat, mixed crops, and a dryland rotation of wheat and fallow.

Information about crops grown in the Study Area and the number and status of groundwater wells in the Study Area was obtained from GWMA (see NED section of the Draft Economics Technical Report). In addition to helping describe current conditions, GWMA also provided guidance and assumptions on the future status of groundwater wells and cropping patterns in the Study Area under the No Action Alternative.

Groundwater wells in the area were ranked by GWMA according to five status levels (Status levels 1 to 5) based on output and dependability. Assumptions were made about how long wells would remain in use and what crops would be grown as wells declined in output and dependability. This information was used in a spreadsheet model to predict changes in irrigated acres in the future. Subsequent changes in residual net farm income were estimated by multiplying the number of acres in each well level by the associated residual net farm income for each well level.

Table 5- 2 presents the change in the No Action Alternative groundwater-irrigated acres for the years 2019, 2020, 2022, 2023, 2025, 2050, 2075, 2100, and 2125. In each year of the analysis, a lagged transition of acres from one well status level to the next lowest well status level occurred. The lag was introduced into the analysis to show that even though a number of acres would be transitioned into the next lower well status level each year, that transition would not occur instantaneously. Instead, the transition of acres from one well status level to the next would occur at the beginning of the next year.

Table 5- 2. No Action Alternative: Groundwater-irrigated acres and dryland acres by selected years

Level	2019	2020	2022	2023	2025	2050	2075	2100	2125
Status Level 1	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131	5,131
Status Level 2	11,927	10,734	8,695	7,825	6,338	507	37	5	5
Status Level 3-4	53,007	51,285	47,659	45,792	42,021	10,018	1,493	180	19
Status Level 5 (dryland)	32,551	35,466	41,132	43,869	49,126	86,960	95,955	97,300	97,461
Total acres	102,616	102,616	102,616	102,616	102,616	102,616	102,616	102,616	102,616

The crop mix for well Status level 1 acres had irrigated potatoes and wheat on 5,13 acres (Table 5- 2).

In 2019, well Status level 2 lands had irrigated potatoes, mixed crops, and wheat on 11,927 acres.

Acres associated with well Status level 3 and well Status level 4 had a crop mix of irrigated mixed crops and wheat on 53,007 acres.

Status level 5 acres were all in a dryland wheat/fallow rotation. As more acres were transitioned into Status level 5 acres, they were put into the dryland wheat/fallow rotation. In 2019, 32,551 acres were in Status level 5; by 2125, Status level 5 acres numbered 97,461.

5.1.2.1.2 ***Other Direct Benefits – Municipal***

The municipal benefits were estimated based on the change in water system costs as compared to the No Action Alternative. No Action Alternative water system costs from 2026-2118 across all six towns discounted to year 2025 were estimated at $156.9 million under Option 1–Varying Path and $127.8 million under Option 2–Drilling Path.

5.1.2.1.3 ***Other Direct Benefits – Industrial***

There are no industrial benefits under the No Action Alternative.

5.1.2.2. Cost Analyses

All construction costs, land acquisition costs, OMR&P costs, and lost hydropower benefits associated with the action alternatives were measured as changes from the No Action Alternative. Note that the No Action Alternative has no construction costs. While there are OMR&P costs and hydropower benefits associated with the No Action Alternative, those costs and benefits would not change over time with declining groundwater levels as would the agricultural benefits. As a result, it is not necessary to estimate OMR&P costs and hydropower benefits for the No Action Alternative.

5.1.3 Partial-Replacement Alternatives

The NED BCA results for the two Partial-Replacement Alternatives based on the Federal 2011-2012 water project planning rate (4.0 percent) are presented in Table 5- 9 found in the NED BCA results section 5.1.6. Given the two hydrologic scenarios (Spring Diversions and Limited Spring Diversions) and two municipal benefit options, the Partial-Replacement Alternative involves four different benefit-cost results. Total benefits range from $1,102.4 to $1,109.3 million. Total costs also vary by alternative and range from $1,250.0 to 1,271.9 million. All of the scenarios under the Partial-Replacement Alternatives resulted in negative net benefits and BCRs less than 1 to 1. As a result, none of these alternatives would be considered economically justified.

5.1.3.1. Benefit Analyses

5.1.3.1.1 ***Agricultural Benefits***

The Partial-Replacement Alternatives 2A/2B differ only in which reservoirs provide the main water supply. All of the Partial-Replacement Alternatives would provide CBP surface water to the same approximately 57,000 acres currently using groundwater south of I-90. Thus, the agricultural benefits are the same for each of the Partial-Replacement Alternatives.

Agricultural benefits were estimated for the Partial-Replacement Alternatives by comparing the residual net farm income under the No Action Alternative to the residual net farm income under the Partial-Replacement Alternative.

All of the Partial-Replacement Alternatives are based on completing four construction phases, encompassing 57,070 acres, between 2019 and 2025. The numbers of acres for each construction phase are shown in Table 5- 3. From 2010 until 2019, when the first construction phase ends, there are no agricultural benefits because there is no difference in residual net farm income between the No Action Alternative and the Partial-Replacement Alternative. However, starting in 2019 when construction phase 1 ends, agricultural benefits begin to accrue on the acres served by the construction phase 1 canal(s) and laterals.

Before construction would be completed, there would be a loss of irrigated acreage as wells are taken offline. At the completion of construction, the acres associated with each construction phase are assumed to go into surface-water irrigated production. Table 5- 3 presents the number of acres for each of the four construction phases by well Status level that would receive surface water deliveries.

Table 5- 3. Partial-Replacement Alternative—surface and groundwater-irrigated acres, dryland acres, and expected agricultural benefits for selected years

Acres	Construction phases ending in each year				Selected years after construction ends			
	1	2	3	4				
	2019	**2022**	**2023**	**2025**	**2050**	**2075**	**2100**	**2125**
WITH project condition Surface water irrigated acres	18,713	40,716	49,647	57,070	57,070	57,070	57,070	57,070
WITHOUT project condition Groundwater irrigated acres	57,288	37,089	30,324	23,741	6,623	2,903	2,353	2,285
Dryland Acres	26,615	24,811	22,645	21,805	38,923	42,643	43,193	43,261
Total Acres	102,616	102,616	102,616	102,616	102,616	102,616	102,616	102,616
Annual irrigation benefits	$11,255,351	$25,044,723	$30,740,224	$35,732,641	$37,243,511	$37,334,622	$37,338,288	$37,924,323

When construction phase 1 ends, 18,713 acres will accrue agricultural benefits because those acres will receive surface water and no longer be served by groundwater wells. Additionally, among the 18,713 acres, those acres most affected by well performance reductions will gain from the start of surface water deliveries. Each acre previously irrigated with groundwater would receive 3 acre-feet of surface water.

Under construction phase 2, 22,003 acres will begin to receive surface water deliveries; phase 3, 8,931 acres; and phase 4, 7,423 acres. Thus, as shown in the cumulative number of acres receiving agricultural irrigation benefits in 2019, 2022, 2023, and 2025 is 18,713, 40,716, 49,647, and 57,070 acres, respectively. As each construction phase is completed, the acres previously served by groundwater wells will begin to receive 3 acre-feet of surface water per acre.

The results for the Partial-Replacement Alternatives are presented in which presents the change in irrigated and dryland acres for the years 2019, 2020, 2023, 2025, 2050, 2075, 2100, and 2125. In each year of the analysis, a lagged transition of acres from one well level to the next lowest well level occurred. The lag was introduced into the analysis to show that even though a number of acres would be transitioned into the next lower well level each year, that transition would not occur instantaneously. Instead, the transition of acres from one well level to another would occur at the beginning of the next year.

The difference in residual net farm income between the No Action Alternative and the Partial-Replacement Alternative is the estimate of agricultural benefits arising because of the implementation of any one of the Partial-Replacement Alternatives. Annual benefits to irrigated agriculture for the Partial-Replacement Alternatives are shown in

In 2019, 18,713 acres entered into a with-project condition with a cropping pattern of irrigated potatoes, alfalfa hay, and wheat after construction was completed on phase 1. That was the first year in which benefits accrued to irrigated agriculture ($11.26 million annually). In 2022, another 22,003 acres entered into a with-project condition and benefits increased to $25.04 million annually. By 2025, four construction phases had been completed and annual benefits were $35.7 million.

5.1.3.1.2 *Other Direct Benefits – Municipal*

The municipal benefits were estimated based on the change in water system costs as compared to the No Action Alternative. Partial-Replacement Alternative water system costs from 2026-2118 across all six towns discounted to year 2025 were estimated at $122.8 million under Option 1–Varying Path; this reflects a cost savings benefit of $34.1 million. Under Option 2–Drilling Path, water system costs from 2026-2118 across all six towns discounted to year 2025 were estimated at $100.6 million, which reflects a cost savings benefit of $27.2 million.

5.1.3.1.3 ***Other Direct Benefits – Industrial***

The benefit for industrial water was based on the agricultural benefit per acre-foot of water, less the cost of industrial water. This yields a benefit of $43.73 per acre-foot for industrial water or an annual benefit of $205,500. For use in the benefit-cost analysis, the annual industrial benefit was discounted to the end of the canal construction period (year 2025) using the 2011-2012 water project planning rate of 4.0 percent. For all Partial-Replacement Alternatives, this discounted stream of industrial benefits equates to $5.2 million in year 2025.

5.1.3.2. Cost Analyses

As described below, the combined canal construction, noncontract, IDC, land acquisition, and annual OMR&P costs, plus lost benefits to hydropower, total $1,250.0 million under the Spring Diversion scenario and $1,271.9 million under the Limited Spring Diversion scenario for Partial-Replacement Alternatives 2A/2B.

5.1.3.2.1 ***Construction, IDC, Land Acquisition, and OMR&P Costs***

Table 5- 4 presents the canal construction and noncontract costs, IDC, land acquisition, and annual OMR&P costs for the two Partial-Replacement Alternatives under both hydrologic scenarios.

Table 5- 4. Total costs for Partial-Replacement Alternatives (measured in $ millions at the end of the canal construction period [2025])

Cost Components	Spring Diversion		Limited Spring Diversion	
	2A	2B	2A	2B
Canal Construction, Noncontract, and IDC	886.0	886.0	886.0	886.0
Canal & Reservoir OMR&P	192.5	192.5	192.5	192.5
Land Acquisition	3.2	3.2	3.2	3.2
Cost Subtotal	1,081.7	1,081.7	1,081.7	1,081.7
Lost Hydropower	168.3	168.3	190.2	190.2
Total	1,250.0	1,250.0	1,271.9	1,271.9

Canal construction and noncontract costs were estimated by Reclamation engineers at $688.1 million. IDC in the amount of $89.1 million was calculated on the annual canal construction and noncontract costs. IDC by phase was added to the canal construction and noncontract cost totals by phase, and then compounded to the end of the canal construction period (year 2025) to obtain a total canal construction cost estimate of $886.0 million. Reclamation engineers also estimated land acquisition costs in lieu of a drainage system for Alternatives 2A and 2B at $3.2 million.

Annual OMR&P costs for the canal system were assumed to start at the end of each canal construction phase and continue through the end of the period of analysis in year 2118. Discounting these costs to the end of the canal construction period resulted in an estimate of $192.5 million. These construction, noncontract, IDC, land acquisition, and OMR&P costs, measured as of the end of the canal construction period, total $1,081.7 million for Alternatives 2A and 2B.

5.1.3.2.2 ***Annual Lost Benefits***

Lost Hydropower Benefits. BPA ran their hydropower system model once for each hydrologic scenario. Under the "Spring Diversion" scenario, BPA estimated the same $6.3 million of average annual losses in hydropower benefits and increased pumping costs for both Partial-Replacement Alternatives. Increases in hydropower generation for on-project facilities were estimated at .576 million resulting in a net hydropower and pumping cost loss of $5.8 million annually. Discounting the 100-year stream of average annual lost hydropower benefits and increased pumping costs to the end of the canal construction period results in an estimated total hydropower loss/increased pumping cost estimate of $168.3 million for each Partial-Replacement Alternative.

Under the "Limited Spring Diversion" scenario, BPA estimated the same $7.1 million of average annual losses in hydropower benefits and increased pumping costs for both Partial-Replacement Alternatives. Increases in hydropower generation for on-project facilities were estimated at .576 million, resulting in a net hydropower and pumping cost loss of $6.5 million annually. Discounting the 100-year stream of average annual lost hydropower benefits and increased pumping costs to the end of the canal construction period results in a total hydropower loss/increased pumping cost estimate of $190.2 million for each Partial-Replacement Alternative.

5.1.4 Full-Replacement Alternative

The NED BCA results for the two Full-Replacement Alternatives based on the Federal 2011-2012 water project planning rate (4.0 percent) are presented in Table 5- 9 found in the NED BCA results section (section 5.1.6). Given the two hydrologic scenarios (Spring Diversions and Limited Spring Diversions) and two municipal benefit options, the Full-Replacement Alternative involves four different benefit-cost results. Total benefits range from $1,982.5 to $2,006.0 million. Total costs range from $3,920.8 to $3,952.4 million. All of the scenarios under the Full-Replacement Alternatives resulted in negative net benefits and BCRs less than 1 to 1. As a result, none of these alternatives would be considered economically justified.

5.1.4.1. Benefit Analyses

5.1.4.1.1 *Agricultural Benefits*

The Full-Replacement Alternatives 2A/2B differ only in which reservoir provides the main water supply. The Full-Replacement Alternatives would provide CBP surface water to the same approximately 102,600 acres currently using groundwater in the study area. Thus, the agricultural benefits are the same for each of the Full-Replacement Alternatives.

Agricultural benefits were estimated for the Full-Replacement Alternatives by comparing the residual net farm income under the No Action Alternative to the residual net farm income under the Full-Replacement Alternatives.

All of the Full-Replacement Alternatives are based on completing nine construction phases, encompassing 102,616 acres, between 2019 and 2025. The numbers of acres for each construction phase are shown in Table 5- 5. From 2010 until 2019, when the first construction phase ends, there are no agricultural benefits because there is no difference in residual net farm income between the No Action Alternative and the Full-Replacement Alternatives. However, starting in 2019 when construction phase 1 ends, agricultural benefits begin to accrue on the acres served by the construction phase 1 canal(s) and laterals.

Before construction would be completed, there would be a loss of irrigated acreage as wells are taken offline. At the completion of construction, the acres associated with each construction phase are assumed to go into surface water irrigated production. Table 5- 5 presents the number of acres for each of the nine construction phases by well Status level that would receive surface water deliveries.

The results for the Full-Replacement Alternative are presented in Table 5- 5, including the change in irrigated and dryland acres and the annual agricultural benefit for each year shown in the table (2019, 2020, 2022, 2023, and 2025). In each year of the analysis, a lagged transition of acres from one well level to the next lowest well level occurred. The lag was introduced into the analysis as a means of showing that even though a number of acres would be transitioned into the next lower well level each year that transition would not occur instantaneously. Instead, the transition of acres from one well level to another would occur at the beginning of the next year.

The difference in residual net farm income between the No Action Alternative and the Full-Replacement Alternatives is the estimate of agricultural benefits arising because of the implementation of either one of the Full-Replacement Alternatives. Annual benefits to irrigated agriculture for the Full-Replacement Alternatives are shown in Table 5- 5.

Table 5- 5. Full-Replacement Alternative—Surface and groundwater-irrigated acres, dryland acres, and expected agricultural benefits for selected years

Acres	Construction phases ending in each year					Selected years after construction ends			
	1	5	2 and 8	3 and 6	4, 7, and 9				
	2019	**2020**	**2022**	**2023**	**2025**	**2050**	**2075**	**2100**	**2125**
WITH Project Conditions Surface water irrigated acres	18,713	25,798	60,557	81,158	102,616	102,616	102,616	102,616	102,616
WITHOUT project conditions									
Groundwater irrigated acre	57,288	50,268	25,200	12,285	0	0	0	0	0
Dryland acres	26,615	26,550	16,859	9,173	0	0	0	0	0
Total acres	102,616	102,616	102,616	102,616	102,616	102,616	102,616	102,616	102,616
Annual irrigation benefits	$11,119,922	$15,482,068	$36,954,139	$46,336,354	$63,818,619	$66,825,030	$67,045,289	$67,060,701	$67,060,807

When construction phase 1 ended in 2019, 18,713 acres began to accrue agricultural benefits ($11.12 million annually) because those acres began to receive surface water and were no longer served by groundwater wells. Irrigated potatoes, alfalfa, and wheat were grown on these acres.

The completion date for construction phase 5 was 2020; 7,085 additional acres of groundwater irrigated acres transitioned into surface water deliveries to produce irrigated potatoes, alfalfa, and wheat. Agricultural benefits in 2020 totaled $15.5 million on a combined 25,798 acres.

Construction phases 2 and 8 were completed in 2022; construction phase 2 had 22,003 acres receiving surface water deliveries and construction phase 8 had 12,756 acres receiving surface water deliveries. The total number of acres in a "with" project condition by 2022 came to 60557 acres. The annual irrigated agricultural benefits in 2022 were about $37 million.

Construction phase 3 had 8,931 acres, and construction phase 6 had 11,671 acres; these construction phases were completed in 2023, increasing the number of acres in a with-project condition to 81,158 acres. The annual irrigated agricultural benefits in 2023 were $46.3 million.

Construction phase 4 had 7,423 acres, construction phase 7 had 6,147 acres, and construction phase 9 had 7,887 acres receiving surface water when construction on those phases was completed in 2025. The total number of acres in a with-project condition now totaled 102,616 acres. The annual irrigated agricultural benefits came to $63.8 million.

5.1.4.1.2 *Other Direct Benefits – Municipal*

The municipal benefits were estimated based on the change in water system costs as compared to the No Action Alternative. Full-Replacement Alternative water system costs from 2026-2118 across all six towns discounted to year 2025 were estimated at $40.7 million under Option 1–Varying Path; this reflects a cost savings benefit of $116.2 million. Under Option 2–Drilling Path, water system costs from 2026-2118 across all six towns discounted to year 2025 were estimated at $35.1 million, which reflects a cost savings benefit of $92.7 million.

5.1.4.1.3 *Other Direct Benefits – Industrial*

The benefit for industrial water was based on the agricultural benefit per acre foot of water less the cost of industrial water. This yields a benefit of $40.83 per acre-foot for industrial water, or an annual benefit of $191,900. For use in the benefit-cost analysis, the annual industrial benefit was discounted to the end of the canal construction period (year 2025) using the 2011-2012 water project planning rate of 4.0 percent. For all Full-

Replacement Alternatives, this discounted stream of industrial benefits equates to $4.7 million in year 2025.

5.1.4.2. Cost Analyses

As described below, the combined canal construction, noncontract, IDC, land acquisition, and annual OMR&P costs, plus lost benefits to hydropower, total $3,920.8 million under the Spring Diversion scenario and $3,952.4 million under the Limited Spring Diversion scenario for Full-Replacement Alternatives 3A/3B.

5.1.4.2.1 *Construction, IDC, and OMR&P Costs*

Table 5- 6 presents the canal construction and noncontract costs, IDC, land acquisition, and annual OMR&P costs for the two Full-Replacement Alternatives under both hydrologic scenarios.

Table 5- 6. Total costs for Full-Replacement Alternatives (measured in $ millions at the end of the canal construction period [2025])

Cost Components	Spring Diversion		Limited Spring Diversion	
	3A	3B	3A	3B
Canal Construction, Noncontract, and IDC	3,169.3	3,169.3	3,169.3	3,169.3
Canal and Reservoir OMR&P	428.1	428.1	428.1	428.1
Land Acquisition	3.9	3.9	3.9	3.9
Cost Subtotal:	3,601.3	3,601.3	3,601.3	3,601.3
Lost Hydropower	319.5	319.5	351.1	351.1
Total:	3,920.8	3,920.8	3,952.4	3,952.4

Canal construction and noncontract costs were estimated by Reclamation engineers at $2,453.7 million. IDC in the amount of $327.8 million was calculated on the annual canal construction and noncontract costs. IDC by phase was added to the canal construction and noncontract cost totals by phase, and then compounded to the end of the canal construction period to obtain a total estimate of $3,169.3 million. Reclamation engineers also estimated land acquisition costs in lieu of a drainage system for Alternatives 3A and 3B which were compounded and discounted to the end of the construction period to provide an estimate of $3.9 million.

Annual OMR&P costs for the canal system were assumed to start at the end of each canal construction phase and continue through the end of the period of analysis in year 2118. Compounding and discounting these OMR&P costs to the end of the canal construction period resulted in an estimate of $428.1 million. These construction, noncontract, IDC, land acquisition, and OMR&P costs, measured as of the end of the canal construction period, total $3,601.3 million for Alternatives 3A and 3B.

5.1.4.2.2 *Annual Lost Benefits*

Lost Hydropower Benefits. BPA ran their hydropower system model once for each hydrologic scenario. Under the Spring Diversion scenario, BPA estimated the same $11.9 million of average annual losses in hydropower benefits and increased pumping costs for both Full-Replacement Alternatives. Increases in hydropower generation for on-project facilities were estimated at .671 million, resulting in a net hydropower and pumping cost loss of $11.2 million annually. Discounting the 100-year stream of average annual lost hydropower benefits and increased pumping costs to the end of the canal construction period results in an estimated total hydropower loss/increased pumping cost estimate of $319.5 million for each Full-Replacement Alternative.

Under the Limited Spring Diversion scenario, BPA estimated the same $13.0 million of average annual losses in hydropower benefits and increased pumping costs for both Full-Replacement Alternatives. Increases in hydropower generation for on-project facilities were estimated at .671 million, resulting in a net hydropower and pumping cost loss of $12.3 million annually. Discounting the 100-year stream of average annual lost hydropower benefits and increased pumping costs to the end of the canal construction period results in a total hydropower loss/increased pumping cost estimate of $351.1 million for each Full-Replacement Alternative.

5.1.5 Modified Partial-Replacement Alternative

The NED BCA results for the two Modified Partial-Replacement Alternatives based on the Federal 2011-2012 water project planning rate (4.0 percent) are presented in Table 5-9 found in the NED BCA results section (section 5.1.6). Given the two hydrologic scenarios (Spring Diversion and Limited Spring Diversion) and two municipal benefit options, the Modified Partial-Replacement Alternatives involve four different benefit-cost results. Total benefits range from $1,366.9 to $1,378.9 million. Total costs range from $1,367.98 to $1,399.6 million. The Spring Diversion scenario combined with the high municipal cost savings benefit generates a positive net benefit of $11.0 million and a BCR of 1.008 to 1. All of the other scenarios under the Modified Partial-Replacement Alternatives resulted in negative net benefits and BCRs less than 1. As a result, only the Spring Diversion/high municipal benefit scenario would be considered economically justified.

5.1.5.1. Benefit Analyses

5.1.5.1.1 *Agricultural Benefits*

The Modified Partial-Replacement Alternatives 4A/4B differ only in which reservoirs provide the main water supply. All of the Modified Partial-Replacement Alternatives would provide CBP surface water to the same approximately 70,500 acres currently using groundwater both north and south of I-90. Thus, the agricultural benefits are the same for each of the Modified Partial-Replacement Alternatives.

Agricultural benefits were estimated for the Modified Partial-Replacement Alternatives by comparing the residual net farm income under the No Action Alternative to the residual net farm income under the Modified Partial-Replacement Alternatives.

All of the Modified Partial-Replacement Alternatives are based on completing four construction phases, encompassing 70,515 acres, between 2019 and 2025. The numbers of acres for each construction phase are shown in Table 5- 7. From 2010 until 2019, when the first construction phase ends, there are no agricultural benefits because there is no difference in residual net farm income between the No Action Alternative and the Modified Partial-Replacement Alternatives. However, starting in 2019 when construction phase 1 ends, agricultural benefits begin to accrue on the acres served by the construction phase 1 canal(s) and laterals.

Before construction would be completed, there would be a loss of irrigated acreage as wells are taken offline. At the completion of construction, the acres associated with each construction phase are assumed to go back into irrigated production. Table 5- 7 presents the number of acres for each of the four construction phases by well Status level that would receive surface water deliveries of 3 acre-feet per acre.

The results for the Modified Partial-Replacement Alternatives are presented in Table 5-7, which presents the change in irrigated and dryland acres for the years 2019, 2020, 2023, 2025, 2050, 2075, 2100, and 2125. In each year of the analysis, a lagged transition of acres from one well level to the next lowest well level occurred. The lag was introduced into the analysis to show that even though a number of acres would be transitioned into the next lower well Status level each year that transition would not occur instantaneously. Instead, the transition of acres from one well Status level to another would occur at the beginning of the next year.

The difference in residual net farm income between the No Action Alternative and the Modified Partial-Replacement Alternatives is the estimate of agricultural benefits arising because of the implementation of any one of the Modified Partial-Replacement Alternatives. Annual benefits to irrigated agriculture for the Modified Partial-Replacement Alternatives are shown in Table 5- 7.

Table 5- 7. Modified Partial-Replacement Alternative—Groundwater-irrigated acres and expected agricultural benefits by selected years

Acres	Construction phases ending in each year				Selected years after construction ends			
	1	2	3	4				
	2019	**2022**	**2023**	**2025**	**2050**	**2075**	**2100**	**2125**
WITH project condition								
Surface water irrigated acres	25,313	41,255	60,759	70,515	70,515	70,515	70,515	70,515
WITHOUT project condition								
Groundwater irrigated acres	52,781	36,750	23,963	16,734	4,791	2,048	1,660	1,613
Dryland Acres	24,522	24,611	17,894	15,367	27,431	30,053	30,441	30,488
Total Acres	102,616	102,616	102,616	102,616	102,616	102,616	102,616	102,616
Annual irrigation benefits	**$15,060,220**	**$25,176,947**	**$37,375,493**	**$43,894,218**	**$45,934,146**	**$46,080,556**	**$46,090,154**	**$46,089,800**

In 2019, 25,313 acres entered into a with-project condition with a cropping pattern of irrigated potatoes, alfalfa hay, and wheat after construction was completed on phase 1. That was the first year in which benefits accrued to irrigated agriculture ($15.06 million annually). In 2022, another 41,255 acres entered into a with-project condition and benefits increased to $25.18 million annually. In 2023, 19,544 additional acres entered into a with-project condition; annual benefits were $37.38 million. By 2025, four construction phases had been completed and annual benefits were $43.89 million.

5.1.5.1.2 *Other Direct Benefits – Municipal*

The municipal benefits were estimated based on the change in water system costs as compared to the No Action Alternative. Modified Partial-Replacement Alternative water system costs from 2026-2118 across all six towns discounted to year 2025 were estimated at $98.3 million under Option 1–Varying Path, this reflects a cost savings benefit of $58.6 million. Under Option 2–Drilling Path, water system costs from 2026-2118 across all six towns discounted to year 2025 were estimated at $81.2 million, which reflects a cost savings benefit of $46.6 million.

5.1.5.1.3 *Other Direct Benefits – Industrial*

The benefit for industrial water was based on the agricultural benefit per acre-foot of water less the cost of industrial water. This yields a benefit of $41.20 per acre-foot for industrial water, or an annual benefit of $193,600. For use in the benefit-cost analysis, the annual industrial benefit was discounted to the end of the canal construction period (year 2025) using the 2011-2012 water project planning rate of 4.0 percent. For all Modified Partial-Replacement Alternatives, this discounted stream of industrial benefits equates to $4.9 million in year 2025.

5.1.5.2. Cost Analyses

As described below, the combined canal construction, noncontract, IDC, land acquisition, and annual OMR&P costs, plus lost benefits to hydropower, total $1,367.9 million under the Spring Diversion scenario and $1,399.6 million under the Limited Spring Diversion scenario for Modified Partial-Replacement Alternatives 4A/4B.

5.1.5.2.1 *Construction, IDC, and OMR&P Costs*

Table 5- 8 presents the canal construction and noncontract costs, IDC, land acquisition, and annual OMR&P costs for the two Full-Replacement Alternatives under both hydrologic scenarios.

Table 5- 8. Total costs for Modified Partial-Replacement Alternatives (measured in $ millions at the end of the canal construction period [2025])

Cost Components	Spring Diversion		Limited Spring Diversion	
	4A	4B	4A	4B
Canal Construction, Noncontract, and IDC	942.0	942.0	942.0	942.0
Canal and Reservoir OMR&P	228.7	228.7	228.7	228.7
Land Acquisition	2.5	2.5	2.5	2.5
Cost Subtotal:	1,173.2	1,173.2	1,173.2	1,173.2
Lost Hydropower	194.7	194.7	226.4	226.4
Total:	1,367.9	1,367.9	1,399.6	1,399.6

Canal construction and noncontract costs were estimated by Reclamation engineers at $734.2 million. IDC in the amount of $91.0 million was calculated on the annual canal construction and noncontract costs. IDC by phase was added to the canal construction and noncontract cost totals by phase, and then compounded to the end of the canal construction period to obtain a total estimate of $942.0 million. Reclamation engineers also estimated land acquisition costs in lieu of a drainage system for Slternatives 4A and 4B which were compounded and discounted to the end of the construction period to provide an estimate of $2.5 million.

Annual OMR&P costs for the canal system were assumed to start at the end of each canal construction phase and continue through the end of the period of analysis in year 2118. Compounding and discounting these OMR&P costs to the end of the canal construction period resulted in an estimate of $228.7 million. These construction, noncontract, IDC, land acquisition, and OMR&P costs, measured as of the end of the canal construction period, total $1,173.2 million for Alternatives 4A and 4B.

5.1.5.2.2 *Annual Lost Benefits*

Lost Hydropower Benefits. BPA ran their hydropower system model once for each hydrologic scenario. Under the Spring Diversion scenario, BPA estimated the same $7.3 million of average annual losses in hydropower benefits and increased pumping costs for both Modified Partial-Replacement Alternatives. Increases in hydropower generation for on-project facilities were estimated at .571 million, resulting in a net hydropower and pumping cost loss of $6.7 million annually. Discounting the 100-year stream of average annual lost hydropower benefits and increased pumping costs to the end of the canal construction period results in an estimated total hydropower loss/increased pumping cost estimate of $194.7 million for each Modified Partial-Replacement Alternative.

Under the Limited Spring Diversion scenario, BPA estimated the same $8.3 million of average annual losses in hydropower benefits and increased pumping costs for both Modified Partial-Replacement Alternatives. Increases in hydropower generation for on-project facilities were estimated at .571 million, resulting in a net hydropower and pumping cost loss of $7.8 million annually. Discounting the 100-year stream of average annual lost hydropower benefits and increased pumping costs to the end of the canal construction period results in a total hydropower loss/increased pumping cost estimate of $226.4 million for each Modified Partial-Replacement Alternative.

5.1.6 NED BCA Results

Table 5- 9 and Table 5- 10 present the results of the benefit-cost analyses for each alternative using the required current Federal FY 2011-12 water project planning rate (4 percent) and the historical planning rate in place at the time the Columbia Basin Project was authorized (3 percent). The tables display total benefits (agriculture, municipal, industrial), total costs (canal construction costs; IDC; land acquisition; OMR&P; lost hydropower benefits), net benefits, and benefit-cost ratios. Given there are two hydrologic scenarios and two municipal benefit estimates, four sets of benefit-cost results are presented for each alternative under each planning rate.

The results presented in Table 5- 9 were generated using the required Federal 2011-2012 water project planning rate of 4.0 percent. Total benefits vary by alternative and range from $1,102.4 to $1,109.3 million for the Partial-Replacement Alternatives, $1,982.5 to $2,006.0 million for the Full-Replacement Alternatives, and $1,366.9 to $1,378.9 million for the Modified Partial-Replacement Alternatives. Total costs also vary by alternative and range from $1,250.0 to 1,271.9 million for the Partial-Replacement Alternatives, $3,920.8 to $3,952.4 million for the Full-Replacement Alternatives, and $1,367.9 to $1,399.6 million for the Modified Partial-Replacement Alternatives. The Modified Partial-Replacement Alternative under the Spring Diversion and high municipal benefit (option1) scenario results in a positive net benefit of $11.0 million and a benefit-cost ratio (BCR) of 1.008 to 1. The other scenarios under the Modified Partial-Replacement Alternative result in negative net benefits and BCRs less than 1 to 1 (although the Spring Diversions and low municipal benefit (option 2) scenario comes very close to a positive result). In addition, all of the scenarios under the Partial and Full-Replacement Alternatives resulted in negative net benefits and BCRs less than 1 to 1. Bottom line, only the Modified Partial-Replacement Alternative under the Spring Diversion and high municipal benefit scenario (Option 1) would be considered economically justified. The Modified Partial-Replacement Alternative under the Limited Spring Diversion scenario is 1.5 to 2.3 percent short of achieving a positive BCR.

The results in Table 5- 10 were generated using the planning rate in place when the CBP was first authorized (3.0 percent). Since the 4.0 percent rate presented in is required for planning purposes, the results presented in Table 5- 10 are presented for informational purposes only. Total benefits vary by alternative and range from $1,352.6 to $1,359.0 million for the Partial-Replacement Alternatives, $2,438.4 to $2,463.3 million for the Full-Replacement Alternatives, and $1,676.5 to $1,688.5 million for the Modified Partial-Replacement Alternatives. Total costs also vary by alternative and range from $1,279.4 to $1,306.4 million for the Partial-Replacement Alternatives, $3,901.6 to $3,940.7 million for the Full-Replacement Alternatives, and $1,409.3 to $1,448.3 million for the Modified Partial-Replacement Alternatives. When using the historic 3 percent planning rate, all of the scenarios under the Partial-Replacement Alternatives and Modified Partial-Replacement Alternatives result in positive net benefits and BCRs greater than 1 to 1. The Full-Replacement Alternative scenarios all generate negative net benefits and BCRs less than 1 to 1.

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Table 5- 9. Results of NED BCA based on current planning rate of 4.0% ($ millions)

Benefit and Cost Components	Alternative 2A/2B - Partial-Replacement Alternative				Alternative 3A/3B - Full-Replacement Aalternative				Alternative 4A/4B - Modified Partial-Replacement Alternative			
	Spring Diversion		Limited Spring Diversion		Spring Diversion		Limited Spring Diversion		Spring Diversion		Limited Spring Diversion	
	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2
Agricultural Benefits:	1070.0	1070.0	1070.0	1070.0	1884.9	1884.9	1884.9	1884.9	1315.4	1315.4	1315.4	1315.4
Municipal Benefits:	34.1	27.2	34.1	27.2	116.2	92.7	116.2	92.7	58.6	46.6	58.6	46.6
Industrial Benefits:	5.2	5.2	5.2	5.2	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
Total Benefits:	1109.3	1102.4	1109.3	1102.4	2006	1982.5	2006	1982.5	1378.9	1366.9	1378.9	1366.9
Construction & IDC:	886	886	886	886	3,169.3	3,169.3	3,169.3	3,169.3	942.0	942.0	942.0	942.0
Land Acquisition for wetted areas:	3.2	3.2	3.2	3.2	3.9	3.9	3.9	3.9	2.5	2.5	2.5	2.5
OMR&P:	192.5	192.5	192.5	192.5	428.1	428.1	428.1	428.1	228.7	228.7	228.7	228.7
Lost Hydropower:	168.3	168.3	190.2	190.2	319.5	319.5	351.1	351.1	194.7	194.7	226.4	226.4
Total Costs:	1250	1250	1271.9	1271.9	3920.8	3920.8	3952.4	3952.4	1367.9	1367.9	1399.6	1399.6
Net Benefits:	-140.7	-147.6	-162.6	-169.5	-1914.8	-1938.3	-1946.4	-1969.9	11	-1	-20.7	-32.7
Benefit-Cost Ratio:	0.887	0.882	0.872	0.867	0.512	0.506	0.508	0.502	1.008	0.999	0.985	0.977

Table 5- 10. Results of NED BCA based on historic planning rate of 3.0% ($ millions)

Benefit and Cost Components	Alternative 2A/2B - Partial-replacement alternative				Alternative 3A/3B - Full-replacement alternative				Alternative 4A/4B - Modified Partial-replacement alternative			
	Spring Diversion		Limited Spring Diversion		Spring Diversion		Limited Spring Diversion		Spring Diversion		Limited Spring Diversion	
	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2
Agricultural Benefits:	1,321.40	1,321.40	1,321.40	1,321.40	2,337.50	2,337.50	2,337.50	2,337.50	1,625.50	1,625.50	1,625.50	1,625.50
Municipal Benefits:	31	24.6	31	24.6	119.6	94.7	119.6	94.7	56.8	44.8	56.8	44.8
Industrial Benefits:	6.6	6.6	6.6	6.6	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20
Total Benefits:	1359	1352.6	1359	1352.6	2463.3	2438.4	2463.3	2438.4	1688.5	1676.5	1688.5	1676.5
Construction & IDC:	831.8	831.8	831.8	831.8	2,972.9	2972.9	2,972.9	2972.9	885.1	885.1	885.1	885.1
Land Acquisition for wetted areas:	3.2	3.2	3.2	3.2	3.9	3.9	3.9	3.9	2.5	2.5	2.5	2.5
OMR&P:	237.2	237.2	237.2	237.2	529.5	529.5	529.5	529.5	281.9	281.9	281.9	281.9
Lost Hydropower:	207.2	207.2	234.2	234.2	395.3	395.3	434.4	434.4	239.8	239.8	278.8	278.8
Total Costs:	1279.4	1279.4	1306.4	1306.4	3901.6	3901.6	3940.7	3940.7	1409.3	1409.3	1448.3	1448.3
Net Benefits:	79.6	73.2	52.6	46.2	-1438.3	-1463.2	-1477.4	-1502.3	279.2	267.2	240.2	228.2
Benefit-Cost Ratio:	1.062	1.057	1.040	1.035	0.631	0.625	0.625	0.619	1.198	1.190	1.166	1.158

5.1.7 Financial Feasibility

After a project is found to be economically justified, analyses are undertaken to determine if the Federal project cost outlays are recoverable from the project beneficiaries. Financial feasibility is the process of analyses identifying reimbursable and nonreimbursable financial costs and the ability to recover reimbursable costs from project beneficiaries. The analyses consist of a cost allocation and subsequent repayment analyses.

5.1.7.1. Cost Allocation

Cost allocation is used as a transitional step leading from economic evaluation to repayment analysis. Cost allocation is not a means of justifying an alternative or project but follows the determination of economically feasible project alternatives.

The objective of cost allocation is to equitably distribute economically justified project costs of feasible alternatives among the purposes served. The purposes allocated to can be either reimbursable or nonreimbursable, based on existing legislative authority. Formulation of plans by incremental analysis normally assures that the cost of the plan increments is justifiable for each project purpose. Based on the assumptions that project formulation principles have been applied, equitable cost distribution may be obtained by preventing costs allocated to any purpose from exceeding corresponding benefits. This establishes, for reimbursable project functions, the cost base from which repayment schedules are developed.

The principles of cost allocation are:

- Each purpose is allocated directly—as a minimum—the identifiable separable cost (costs omitted from total project costs if one purpose is excluded) of that purpose.
- Project purposes should not be assigned costs in excess of benefits, or the assigned costs should not be greater than the cost of a single purpose alternative that could likely be built as a Federal project. Thus, the lesser of either benefits or the most likely Federal alternative cost is the justifiable expenditure or maximum allocation for a purpose.
- The costs remaining, after separable costs are identified and deducted from the justifiable expenditure, are allocated to each purpose in the same ratio as the remaining benefits.
- All costs necessary to achieve benefits claimed are included.

Based on the benefit-cost results of this study, benefits equal or exceed the costs only for the Modified Partial-Replacement Alternative under the with Spring Diversion and high municipal benefit scenario; therefore, only that alternative and scenario is economically justified. Only for that alternative and scenario can a cost allocation to reimbursable and nonreimbursable purposes pursuant to acceptable methods be made and repayment requirements determined. Given the uncertainty associated with each alternative, as evidenced by the range of scenarios evaluated, no cost allocation was conducted on the Modified Partial-Replacement Alternative with Spring Diversion and high municipal benefit scenario.

Under the Modified Partial-Replacement Alternative, 95.4 to 96.2 percent of the benefits comprising the BCR of 0.985 to 0.977 are agricultural benefits. If benefits increased by 1.6 to 2.8 percent, resulting in a positive BCR, then all but a few percent of cost would be allocated to agriculture and the remainder to municipal and industrial purposes.

For all other scenarios and alternatives, if benefits were used in an attempt to allocate annual operating costs to determine repayment requirements, a dysfunctional allocation would result because there are insufficient benefits to justify the annual operating costs, and the entire project construction cost would remain unallocated as a non-Federal investment.

5.1.7.1.1 ***Project Repayment***

A project repayment analysis usually follows the cost allocation; however, in this case, given the uncertainty associated with each alternative and the lack of cost allocation, a Modified Partial-replacement alternative with Spring Diversion and high municipal benefit scenario repayment analysis of project costs was not developed.

5.2. Regional Economic Development Impact Analysis

This section presents estimates of the regional economic impacts resulting from changes in construction expenditures, operation and maintenance expenditures, and gross farm income for each alternative compared to the No Action Alternative.

The RED account measures the effect of the alternatives on the region’s local economy, while the NED account compares the alternatives from a national perspective. The RED analysis includes not only the initial or direct impact on the primary affected industries, but also the secondary impacts resulting from those industries providing inputs to the directly affected industries as well. This analysis also includes the changes in economic activity stemming from household spending of income earned by those employed in the sectors of the economy impacted either directly or indirectly. These secondary impacts are often referred to as “multiplier effects.”

The NED economic benefits are not used directly in the RED analysis; only the physical changes are carried over from the NED analysis. For example, changes in agricultural water supply may result in a change in crop acreages, which subsequently results in a change in gross farm income. The change in gross farm income reflects the direct economic impact in the RED analysis which, after being run through the regional economic model, generates the secondary, or multiplier, effects. The NED benefits analysis uses net farm income as defined by the P&Gs as the estimate of agricultural benefits.

This section describes potential regional economic impacts associated with implementation of the alternatives to the four-county analysis area composed of Adams, Franklin, Grant, and Lincoln Counties. Socioeconomic impacts were measured as changes in regional employment, income, and output (sales) associated with implementation of the action alternatives compared to those associated with implementation of the No Action Alternative.

The regional economic analysis of the proposed alternatives focuses on economic impacts stemming from construction costs, annual O&M costs, and agricultural gross farm income. The change in agricultural income was estimated for each action alternative and compared to the No Action Alternative.

5.2.1 Economic Activity in the Analysis Area

Table 5-11 summarizes the economy in Adams, Grant, Franklin, and Lincoln Counties. The sectors of the economy are aggregated in to eight industries to summarize the activity in the counties. Industry output or sales represent the value of goods and services produced by businesses within a sector of the economy. The manufacturing sector produces the greatest level of output in the analysis area, with 34.5 percent of the total output. A portion of the manufacturing output stems from activities in industries related to food processing. Agriculture ranks second in total industry output at 20.3 percent. Ranking third is the service sector, which makes up 18.5 percent of total industry output.

Employment measures the number of jobs related to each of the industry sectors of the regional economy. In the analysis area, activities related to the service sector generate the largest number of jobs, with 27.6 percent of total regional employment. The agricultural sector ranks second in terms of overall number of jobs in the analysis area, with 23 percent of total regional employment. Government-related employment ranks third, making up 18 percent of total regional employment.

Labor income is the sum of employee compensation and proprietor income. The government-related sector generates the largest portion of labor income in the analysis area, at 23.9 percent of the total regional labor income. The service sector ranks second, with 21 percent of the total regional labor income. Ranking third is agriculture, at 15.9 percent of the total regional labor income.

Table 5- 11. 2008 Industry Output, Employment, and Labor Income For Adams, Grant, Franklin, And Lincoln Counties

Industry Sectors	Industry Output *	Percent of Total	Employment	Percent of Total	Labor Income*	Percent of Total
Agriculture	2,609	20.3	20,524	23.0	521	15.4
Mining	38	0.3	165.4	0.2	11	0.3
Construction	620	4.8	4,540.7	5.1	240	7.1
Manufacturing	4,435	34.5	8,753.50	9.8	482	14.2
Transportation, Information, and Public Utilities	544	4.2	3,646.9	4.1	192	5.7
Trade	1,040	8.1	10,907.1	12.2	419	12.4
Service	2,375	18.5	24,671.00	27.6	711	21.0
Government	1,200	9.3	16,046.7	18.0	808	23.9
Totals	12,862		89,255.3		3,385	

* Millions of Dollars
Source: 2008 IMPLAN data files

5.2.2 Methodology and Assumptions

5.2.2.1. Impact Analysis Methods

The modeling package used to assess the regional economic impacts stemming from the agricultural gross value of production, construction, and O&M expenditures for each alternative is IMPLAN (IMpact analysis for PLANning). IMPLAN is an economic input-output modeling system that estimates the effects of economic changes in a defined analysis area.

IMPLAN is a static model that estimates impacts for a snapshot in time when the impacts are expected to occur, based on the makeup of the economy at the time of the underlying IMPLAN data. Therefore, it is difficult to address dynamic impacts such as a decline in gross farm income due to progressively failing wells using IMPLAN. As the wells become less productive, farmers may adapt by using new technology or planting new crop varieties. As the economy adapts to changing farm practices, labor and capital inputs would move to alternative uses. IMPLAN measures the initial impact to the economy but does not consider long-term adjustments as labor and capital move into alternative uses.

The analysis assumes that the structure of the economy remains static between 2010 and 2025. This approach is used to compare the alternatives. Realistically, the structure of the economy will adapt and change; therefore, these numbers only can be used to compare relative changes between the No Action Alternative and the action alternatives and cannot be used to predict or forecast employment, labor income, or output (sales).

Input-output models measure commodity flows from producers to intermediate and final consumers. Purchases for final use (final demand) drive the model. Industries produce goods and services for final demand and purchase goods and services from other producers. These other producers, in turn, purchase goods and services. This buying of goods and services (indirect purchases) continues until leakages from the analysis area (imports and value added) stop the cycle. These indirect and induced effects (the effects of household spending) can be mathematically derived using a set of multipliers. The multipliers describe the change in output for each regional industry caused by a 1-dollar change in final demand.

This analysis uses 2008 IMPLAN data for the four counties which encompass the Study Area. IMPLAN data files for the analysis area are compiled from a variety of sources including the U.S. Bureau of Economic Analysis, the U.S. Bureau of Labor, and the U.S. Census Bureau.

5.2.2.2. Construction

The construction costs associated with each alternative were divided into the construction phases described in Chapter 2 of the Odessa Final EIS. The construction-related expenditures for each phase were divided into expenditures that would be made inside the analysis area. The construction expenditures inside the analysis area were used in IMPLAN to estimate employment, labor income, and regional sales stemming from construction-related activities for each phase. Construction expenditures made outside the analysis area were considered “leakages” and would have no impact on the local economy.

Reclamation’s construction cost engineers allocated the costs associated with major construction activities to within-region expenditures according to the percentages shown in Table 5- 12. The construction costs by phase assumed to be spent within the analysis area are shown in the RED section of the Final Economics Technical Report (Reclamation 2012 Economics).

Table 5- 12. Allocations by construction activity within the analysis area

Construction Activity	In-Region Expenditures
Canal Enlargement and Linings	75%
Water Service Contracts	75%
Pump Station Modifications	75%
Wasteways	30%

Table 5- 12. Allocations by construction activity within the analysis area

Construction Activity	In-Region Expenditures
Siphons	60%
Laterals	45%
Drains Subsurface	50%
Pumping Plants	35%
Switchyards and Transmission Lines	25%
Maintenance Buildings	40%
SCADA Systems	20%
Mobilization and Preparatory Work	60%

The analysis assumes that the onsite construction workforce would be hired from within the analysis area or would commute to the area from nearby communities. It is also assumed that most of the construction expenditures would be funded from sources outside the analysis area. Money from outside the analysis area spent on goods and services within the analysis area contributes to regional economic impacts, while money that originates from within the analysis area is much less likely to generate regional economic impacts. Spending from sources within the analysis area represents a redistribution of income and output rather than an increase in economic activity.

The impacts by phase would be spread over the length of the construction period and would vary year-by-year proportionate to actual expenditures. The regional impacts associated with each phase cannot be summed into a total construction impact for a particular alternative to avoid double counting.

5.2.2.3. O&M

Expenditures made inside the study region related to O&M generate positive economic impacts to the regional economy. For the purpose of this analysis, it is assumed that 80 percent of the O&M expenditures would be made inside the four-county area. As construction phases are completed, annual O&M expenditures would begin to accrue; however, this analysis measures annual O&M impacts after all the construction phases are implemented. The analysis does not quantify the positive impacts resulting from replacement costs given these are distributed over the entire study period. Like the construction related expenditures, O&M expenditures made inside the analysis area associated with each alternative were placed into categories related to the each sector of the economy and run through IMPLAN to estimate impacts to the regional economy.

5.2.2.4. Agriculture

Gross farm income estimates were used in IMPLAN to measure changes in regional impacts. The analysis also measures and includes regional economic impacts associated with potato processors within the four counties who receive potatoes from the Study Area.

The future number of irrigated and dryland acres and the associated gross farm income was estimated for each alternative using a spreadsheet model discussed in the NED agricultural section. The gross farm income for each alternative was used in IMPLAN to estimate the changes in regional economic impacts expected to occur if a partial or full replacement surface water supply was provided to lands currently irrigated with groundwater.

Potato processors in the four-county area rely on irrigated potatoes grown in the Study Area because the potatoes are high quality and have desirable storage characteristics. Local processors use all of the potatoes grown in the Study Area; therefore, the regional economy will be impacted by both changes in gross farm income and the availability of Odessa potatoes to the processing plants. This analysis measures regional economic impacts stemming from both of these changes.

The analysis measures the combined estimated employment, labor income, and output (sales) stemming from changes in gross farm income and the activities related to potato processing. Impacts were measured for year 2010, the beginning of construction, and year 2025 when all construction phases are completed for each alternative, including the No Action Alternative. Regional impacts were not estimated beyond the end of the construction phases, because of the uncertainties related to the re-employment of labor and capital.

5.2.3 Alternative 1: No Action Alternative

5.2.3.1. Construction and O&M

No regional economic impacts are anticipated because no new project facilities would be constructed under this alternative.

5.2.3.2. Agriculture

Table 5- 13 shows the change in acres and gross farm income associated with the No Action Alternative for years 2010 and 2025 assuming the current economy is static. These numbers were estimated using a spreadsheet model discussed in the NED agricultural section.

Table 5- 13. Comparison of 2010 and 2025 gross farm incomes for the No Action Alternative

Crop	2010 Acres by Crop	Year 2010 Gross Farm Income*	2025 Acres by Crop	Year 2025 Gross Farm Income
Potato	15,496	$2,527,000	4,209	$16,983,000
Wheat	42,791	$23,253,000	26,538	$14,421,000
Mixed Crops	39,198	$24,854,000	22,743	$14,421,000
Dryland Wheat Produced	2,565	$474,000	24,563	$4,535,000
Fallow Acres in Rotation	2,565	$0	24,563	$0
Total	102,616	$111,108,000	102,616	$50,359,000

Selecting the No Action Alternative would result in 1,334 jobs (1.49 percent of the employment with in the four-county area) in 2010 within the four-county area as shown in Table 5- 14. These jobs are the result of gross farm income from 102,416 acres of farmland and the jobs generated by activities related to processing of potatoes grown within the Study Area. Regional employment would decline from 1,334 jobs to 619 jobs between 2010 and 2025, or 0.80 percent within the four-county area. The job loss of 619 jobs in 2025 would be due to both losses in gross farm income and the Odessa potatoes supplied to local processors.

Table 5- 14. No Action Alternative—Regional impacts for 2010 And 2025 stemming from changes in gross farm income and associated potato processing

		Employment [a]		Labor Income [b]		Output [c]	
		Total	Percent of the Four–County Area	Total ($ millions)	Percent of the Four–County Area	Total ($ millions)	Percent of the Four–County Area
Four–County Analysis Area		89,255		$3,385		$12,862	
2010	No Action	1,334	1.49%	$37	1.08%	$211	1.64%
2025	No Action	619	0.69%	$12	0.35%	$80	0.62%
Net Change		-715	-0.80%	-25.0	-0.73	-131.0	-1.02

[a] Employment is measured in number of jobs.
[b] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self–employed individuals located within the analysis area.
[c] Output represents the dollar value of industry production.

Labor income as a result of implementation of the No Action Alternative would equal $37 million (1.08 percent of the four-county area) and would drop to $12 million (0.35 percent of the four-county area) in 2025. The No Action Alternative would result in $211 million (1.64 percent of the four-county area) of output. Output would decline to $80 million (0.62 percent of the four-county area) by 2025. The drop in both labor income and output also would be due to the loss of gross farm income and the Odessa potato supply to the local processors.

5.2.4 Alternative 2A: Partial—Banks

5.2.4.1. Construction

Construction expenditures spent within the analysis area would positively impact employment, labor income, and regional sales, as shown in Table 5- 15. These would be short-term impacts during construction phases proportional to expenditure levels during each construction year. Because construction phases would overlap, regional impacts associated with each phase cannot be summed into a total construction impact for this alternative to avoid double counting. The Tribal Employment Rights Ordinances (TEROs) of the Colville, Spokane, and Yakama Tribes may be applicable to construction of this alternative.

Table 5- 15. Total regional economic impacts stemming from Alternative 2A: Partial—Banks related to construction expenditures by phases

	Employment[a]		Labor Income[b]		Output[c]	
	Total	Percent of the four-county area	Total ($ millions)	Percent of the four-county area	Total ($ millions)	Percent of the four-county area
Four-County Analysis Area	89,255		$3,385		$12,862	
Phase 1	735	0.82%	$38.1	1.13%	$107.5	0.84%
Phase 2	870	0.98%	$45.1	1.33%	$127.0	0.99%
Phase 3	307	0.34%	$15.9	0.47%	$44.9	0.35%
Phase 4	284	0.32%	$14.7	0.43%	$41.5	0.32%

[a] Employment is measured in number of jobs. Construction-related employment estimates include the in-field workforce plus all additional jobs generated by project construction expenditures, e.g., in retail, services, manufacturing, and other related sectors throughout the economy.
[b] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[c] Output represents the dollar value of industry production.

5.2.4.2. O&M

Annual O&M expenditures required for this alternative would result in positive economic long-term impacts greater than with the No Action Alternative. Table 5- 16 summarizes the regional impacts stemming from annual O&M expenditures after all the construction phases have been implemented.

Table 5- 16. Total regional economic impacts stemming from Alternative 2A: Partial—Banks related to annual O&M expenditures

	Employment[a]		Labor Income[b]		Output[c]	
	Total	Percent of the four-county area	Total ($ millions)	Percent of the four-county area	Total ($ millions)	Percent of the four-county area
Four-County Analysis Area	89,255		$3,385		$12,862	
Annual O&M impacts	33	Less than 1%	$2.06	Less than 1%	$4.09	Less than 1%

a Employment is measured in number of jobs.
b Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
c Output represents the dollar value of industry production.

5.2.4.3. Agriculture

The change in gross farm income resulting from delivery of surface water to approximately 57,000 acres under Alternative 2A: Partial—Banks was evaluated using the spreadsheet model discussed in the NED agricultural section. It was assumed that all 57,000 acres would receive 3 acre-feet of irrigation water per acre, regardless of the existing pumping level. Estimates of gross farm income for the approximately 57,000 acres were calculated using a representative crop mix of irrigated potatoes, mixed crops, alfalfa, and wheat and are shown in Table 5- 17.

Table 5- 17. Comparison of 2010 and 2025 gross farm incomes for the No Action Alternative and Alternative 2A: Partial—Banks

Gross Farm Income by Crop	Year 2010	Year 2025
No Action Alternative Gross Farm Income		
Potato	$62,527,000	$16,983,000
Wheat	$23,727,000	$18,955,000
Mixed Crops	$24,854,000	$14,421,000
Total	**$111,108,000**	**$54,550,107**
Alternative 2A : Partial—Banks Gross Farm Income		
Potato	$62,527,000	$102,021,000
Wheat	$23,727,000	$18,644,000
Mixed Crops	$24,854,000	$25,044,000
Alfalfa	$0	$23,429,000
Total	**$111,108,000**	**$169,138,000**
Difference in Income		
Potato	$0	$85,038,000
Wheat	$0	-$311,000
Mixed Crops	$0	$10,623,000
Alfalfa	$0	$23,429,000
Total	**$0**	**$118,779,000**

Using the gross farm income estimates, IMPLAN measured the regional impacts resulting from implementing a Partial-Replacement Alternative. Implementing the Partial-Replacement Alternative would result in 1,598 jobs (1.79 percent of total employment in the four-county area) compared to the No Action Alternative of 619 jobs in year 2025, as shown in Table 5- 18. Compared to the No Action Alternative, a Partial-Replacement Alternative would result in a net change of 979 jobs in year 2025. The job increases would be due to an increase in gross farm income and an increase of Odessa potatoes supplied to the local processors in 2025, associated with implementation of a Partial-Replacement Alternative.

Table 5- 18. Partial-Replacement Alternatives—Regional impacts stemming from changes in gross farm income and associated potato processing

		Employment [a]		Labor Income [b]		Output [c]	
		Total	Percent of the Four–County Area	Total ($ millions)	Percent of the Four–County Area	Total ($ millions)	Percent of the Four–County Area
Four–County Analysis Area		89,255		$3,385		$12,862	
2025	No Action	619	0.69%	$12	0.35%	$80	0.62%
2025	Partial	1,598	1.79%	$60	1.77%	$316	2.45%
	Net Change	979	1.10%	$48	1.42%	$236	1.83%

[a] Employment is measured in number of jobs
[b] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self–employed individuals located within the analysis area.
[c] Output represents the dollar value of industry production.

Labor income in 2025 for a Partial-Replacement Alternative would equal $60 million (1.77 percent of total labor income in the four-county area) in 2025. Labor income as a result of implementation of a Partial-Replacement Alternative would increase by $48 million compared to year 2025 of the No Action Alternative.

Output in 2025 for a Partial-Replacement Alternative would equal $316 million (2.45 percent of total output in the four-county area). Implementation of a Partial-Replacement Alternative would create $236 million more in output compared to year 2025 of the No Action Alternative.

5.2.5 Alternative 2B: Partial—Banks + FDR

The regional impacts would be the same as those presented for Alternative 2A: Partial—Banks.

5.2.5.1. Changes with Limited Spring Diversion Scenario

No changes to the analysis or impacts to agriculture are anticipated from the Limited Spring Diversion Scenario

5.2.6 Alternative 3A: Full—Banks

5.2.6.1. Construction

Construction expenditures within the analysis area would positively impact employment, labor income, and regional sales, as shown in Table 5- 19. These short-term impacts would occur during construction phases proportional to expenditure levels during each year of construction. In the analysis when construction phases overlapped, construction costs were combined to measure regional economic impacts. Because not all construction phases would be concurrent, the economic impacts cannot be summed into a total construction-related regional economic impact for this alternative to avoid double counting. The TEROs of the Colville, Spokane, and Yakama Tribes may apply to construction of this alternative.

Table 5- 19. Total regional economic impacts stemming from Alternative 3A: Full—Banks related to construction expenditures by phases

	Employment[a]		Labor Income[b]		Output[c]	
	Total	Percent of the Four-County Area	Total ($ millions)	Percent of the Four-County Area	Total ($ millions)	Percent of the Four-County Area
Four-County Analysis Area	89,255		$3,385		$12,862	
Phase 1	735	0.82%	$38.1	1.13%	$107.5	0.84%
Phase 5	3,382	3.79%	$175.5	5.19%	$494.3	3.85%
Phase 2&8	1,713	1.92%	$89	2.63%	$250.7	1.95%
Phase 3 &6	1,356	1.52%	$70.3	2.08%	$198	1.54%
Phase 4, 7, & 9	1,385	1.55%	$71.8	2.12%	$202.3	1.53%

[a] Employment is measured in number of jobs. Construction-related employment estimates include the in-field workforce plus all additional jobs generated by project construction expenditures, e.g., in retail, services, manufacturing, and other related sectors throughout the economy.
[b] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[c] Output represents the dollar value of industry production.

5.2.6.2. O&M

Annual O&M expenditures required for this alternative would result in positive economic long-term impacts, which would be greater than the No Action Alternative. Table 5- 20 summarizes the regional impacts stemming from annual O&M expenditures after all the construction phases have been implemented.

Table 5- 20. Total regional economic impacts stemming from Alternative 3A Full—Banks annual O&M expenditures

	Employment[a]		Labor Income[b]		Output[c]	
	Total	Percent of the Four-County Area	Total ($ millions)	Percent of the Four-County Area	Total ($ millions)	Percent of the Four-County Area
Four-County Analysis Area	89,255		$3,385		$12,862	
Annual O&M Impacts	62	Less than 1%	$3.86	Less than 1%	$7.65	Less than 1%

[a] Employment is measured in number of jobs.
[b] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[c] Output represents the dollar value of industry production.

5.2.6.3. Agriculture

The gross farm incomes as a result of implementing Alternative 3A: Full—Banks were evaluated using the spreadsheet model discussed in the NED agricultural section and are shown in Table 5- 21. These numbers were run through IMPLAN to estimate the regional economic impacts associated with the alternative.

Table 5- 21. Comparison of 2010 and 2025 gross farm incomes for the No Action Alternative and Alternative 3A: Full—Banks

Gross Farm Income by Crop	Year 2010	Year 2025
No Action Alternative Gross Farm Income		
Potato	$62,527,000	$16,983,000
Wheat	$23,727,000	$18,955,000
Mixed Crops	$24,854,000	$14,421,000
Total	**$111,108,000**	**$54,550,107**
Alternative 3A: Full—Banks Gross Farm Income		
Potato	$62,527,000	$169,886,000
Wheat	$23,727,000	$16,341,000
Mixed Crops	$24,854,000	$0
Alfalfa	$0	$42,127,000
Total	**$111,108,000**	**$228,354,000**
Difference in Income		
Potato	$0	$152,903,000
Wheat	$0	-$2,614,000
Mixed Crops	$0	-$14,421,000
Alfalfa	$0	$42,127,000
Total	**$0**	**$177,995,000**

Implementing a Full-Replacement Alternative would result in 2,353 jobs (1.95 percent of total employment in the four-county area), as shown in Table 5- 22. Implementation of a Full-Replacement Alternative would cause a net change of 1,734 jobs, compared to the No Action Alternative in year 2025. The job increases would be due to an increase in gross farm income and an increase of Odessa potatoes supplied to the local processors in 2025.

Table 5- 22. Full-Replacement Alternatives—Regional impacts stemming from changes in gross farm income and associated potato processing

		Employment [a]		Labor Income [b]		Output [c]	
		Total	Percent of the Four–County Area	Total ($ millions)	Percent of the Four–County Area	Total ($ millions)	Percent of the Four–County Area
Four–County Analysis Area		89,255		$3,385		$12,862	
2025	No Action	619	0.69%	$12	0.35%	$80	0.62%
2025	Full	2,353	2.64%	$98	2.90%	$500	3.89%
	Net Change	1,734	1.95%	$86	2.55%	$421	3.27%

[a] Employment is measured in number of jobs.
[b] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self–employed individuals located within the analysis area.
[c] Output represents the dollar value of industry production.

Labor income in 2025 for a Full-Replacement Alternative would equal $98 million (2.90 percent of total labor income in the four-county area) in 2025. Labor income would increase by $86 million, as compared the No Action Alternative, as a result of constructing a Full-Replacement Alternative.

Full-replacement Alternatives output would equal $500 million (3.89 percent of total output in the four-county area). Implementing a Full-Replacement Alternative would result in a net change of $421 of output compared to the No Action Alternative.

5.2.7 Alternative 3B: Full—Banks + FDR

The regional economic impacts from construction, O&M, and agriculture would be the same as Alternative 3A: Full—Banks.

5.2.7.1. Changes with Limited Spring Diversion Scenario

No changes to the analysis or impacts to agriculture are anticipated from the Limited Spring Diversion Scenario

5.2.8 Alternative 4A: Modified Partial—Banks

5.2.8.1. Construction

Construction expenditures spent within the analysis area would positively impact employment, labor income, and regional sales, as shown in Table 5- 23.

These would be short–term impacts during construction phases proportional to expenditure levels during each construction year. Because construction phases would overlap, regional impacts associated with each phase cannot be summed into a total construction impact for this alternative to avoid double counting. The TEROs of the Colville, Spokane, and Yakama Tribes may be applicable to construction of this alternative.

Table 5- 23. Total regional economic impacts stemming from Alternative 4A: Modified Partial—Banks (Preferred Alternative) related construction phases.

	Employment [a]		Labor Income [b]		Output [c]	
	Total	Percent of the Four–County Area	Total ($ millions)	Percent of the Four–County Area	Total ($ millions)	Percent of the Four–County Area
Four–County Analysis Area	89,255		$3,385		$12,862	
Phase 1	724	0.81%	$37.6	1.11%	$105.8	0.82%
Phase 2	469	0.53%	$24.3	0.72%	$68.5	0.53%
Phase 3	702	0.79%	$36.4	1.08%	$102.6	0.80%
Phase 4	279	0.31%	$14.5	0.43%	$40.7	0.32%

[a] Employment is measured in number of jobs. Construction–related employment estimates include the in–field workforce defined in Chapter 2 plus all additional jobs generated by project construction in retail, services, manufacturing, and other related sectors throughout the economy.
[b] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self–employed individuals located within the analysis area.
[c] Output represents the dollar value of industry production.

5.2.8.2. O&M

Annual O&M expenditures required for this alternative will result in positive economic long-term impacts that will be greater than with the No Action Alternative. Table 5- 24 summarizes the regional impacts stemming from total annual O&M activities after all the construction phases have been implemented.

Table 5- 24. Total regional economic impacts stemming from Alternative 4A: Modified Partial—Banks (Preferred Alternative) related annual O&M expenditures

	Employment [a]		Labor Income [b]		Output [c]	
	Total	Percent of the Four–County Area	Total ($ millions)	Percent of the Four–County Area	Total ($ millions)	Percent of the Four–County Area
Four–County Analysis Area	89,255		$3,385		$12,862	
Annual O&M Impacts	39	Less than 1%	$2.45	Less than 1%	$4.86	Less than 1%

[a] Employment is measured in number of jobs.
[b] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self–employed individuals located within the analysis area.
[c] Output represents the dollar value of industry production.

5.2.8.3. Agriculture

The gross farm incomes as a result of implementing Alternative 3A: Full—Banks were evaluated using the spreadsheet model discussed in the NED agricultural section and are shown in Table 5- 25. These numbers were run through IMPLAN to estimate the regional economic impacts associated with the alternative.

Table 5- 25. Comparison of 2010 and 2025 gross farm income for the No Action Alternative and Alternative 4A: Modified Partial—Banks (Preferred Alternative)

Gross Farm Income by Crop	Year 2010	Year 2025
No Action Alternative Gross Farm Income		
Potato	$62,527,000	$16,983,000
Wheat	$23,727,000	$18,955,000
Mixed Crops	$24,854,000	$14,421,000
Total	**$111,108,000**	**$54,550,107**
Alternative 4A : Partial—Banks Gross Farm Income		
Potato	$62,527,000	$122,059,000
Wheat	$23,727,000	$17,964,000
Mixed Crops	$24,854,000	$4,511,000
Alfalfa	$62,527,000	$28,949,000
Total	**$111,108,000**	**$173,483,000**
Difference in Income		
Potato	$0	$105,076,000
Wheat	$0	-$991,000
Mixed Crops	$0	-$9,910,000
Alfalfa	$0	$28,949,000
Total	**$0**	**$123,124,000**

Implementing a Modified Partial-Replacement Alternative would result in 1,774 jobs (1.99 percent of total employment in the four–county area) in the four–county area compared to the No Action Alternative of 619 jobs in year 2025, as shown in Table 5- 26.

Compared to the No Action Alternative, a Modified Partial-Replacement Alternative would result in a net change of 1,155 jobs in year 2025. The job increases would be due to an increase in gross farm income and an increase of Odessa potatoes supplied to the local processors in 2025, associated with implementation of a Modified Partial-Replacement Alternative.

Table 5- 26. Alternative 4A: Modified Partial—Banks (Preferred Alternative) regional impacts stemming from changes in gross farm income and associated potato processing

		Employment [a]		Labor Income [b]		Output [c]	
		Total	Percent of the Four–County Area	Total ($ millions)	Percent of the Four–County Area	Total ($ millions)	Percent of the Four–County Area
Four–County Analysis Area		89,255		$3,385		$12,862	
2025	No Action	619	0.69%	$12	0.35%	$80	0.62%
2025	Modified Partial	1,774	1.99%	$68	2.02%	$356	2.77%
	Net Change	1,155	1.30%	$56	1.67%	$276	2.15%

[a] Employment is measured in number of jobs
[b] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self–employed individuals located within the analysis area.
[c] Output represents the dollar value of industry production.

Labor income in 2025 for a Modified Partial-Replacement Alternative would equal $68 million (2.02 percent of total labor income in the four–county area) in 2025. Labor income as a result of implementation of a Modified Partial-Replacement Alternative would increase by $56 million compared to year 2025 of the No Action Alternative.

Output in 2025 for a Modified Partial-Replacement Alternative would equal $356 million (2.77 percent of total output in the four–county area). Implementation of a Modified Partial-Replacement Alternative would create $276 million more in output compared to year 2025 of the No Action Alternative.

5.2.9 Alternative 4B: Modified Partial—Banks + FDR

Short– and long–term impacts for construction, O&M, and agriculture would be the same as those presented for Alternative 4A: Partial—Banks.

5.2.9.1. Changes with Limited Spring Diversion Scenario

No changes to the analysis or impacts to agriculture are anticipated from the Limited Spring Diversion Scenario

5.2.10 RED Results

Table 5- 27 presents a summary of the results of the regional economic impact analyses for the alternatives under consideration.

Table 5- 27. Regional Economic Development Account Summary

	No Action	Alternative 2A/2B - Partial Replacement Alternative				Alternative 3A/3B - Full Replacement Alternative				Alternative 4A/4B - Modified Partial Replacement Alternative			
		Spring Diversion		Limited Spring Diversion		Spring Diversion		Limited Spring Diversion		Spring Diversion		Limited Spring Diversion	
		Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2
Regional Economic Development Account													
Construction													
Phase 1													
Employment (Jobs)	No Impact	735	Same as 2A	Same as 2A	Same as 2A	Same as 2A	Same as 2A	Same as 2A	Same as 2A	724	Same as 4A	Same as 4A	Same as 4A
Labor Income ($ million)		38.1								37.6			
Regional Sales ($ million)		107.5								105.8			
Phase 2													
Employment (Jobs)	No Impact	870	Same as 2A	Same as 2A	Same as 2A	N/A	N/A	N/A	N/A	469	Same as 4A	Same as 4A	Same as 4A
Labor Income ($ million)		45.1								24.3			
Regional Sales ($ million)		127.0								68.5			
Phase 3													
Employment (Jobs)	No Impact	307	Same as 2A	Same as 2A	Same as 2A	N/A	N/A	N/A	N/A	702	Same as 4A	Same as 4A	Same as 4A
Labor Income ($ million)		15.9								36.4			
Regional Sales ($ million)		44.9								102.6			
Phase 4													
Employment (Jobs)	No Impact	284	Same as 2A	Same as 2A	Same as 2A	N/A	N/A	N/A	N/A	279	Same as 4A	Same as 4A	Same as 4A
Labor Income ($ million)		14.7								14.5			
Regional Sales ($ million)		41.5								40.7			
Phase 5													
Employment (Jobs)	No Impact	N/A	N/A	N/A	N/A	3382	Same as 3A	Same as 3A	Same as 3A	N/A	N/A	N/A	N/A
Labor Income ($ million)						175.5							
Regional Sales ($ million)						494.3							
Phase 2 & 8													
Employment (Jobs)	No Impact	N/A	N/A	N/A	N/A	1713	Same as 3A	Same as 3A	Same as 3A	N/A	N/A	N/A	N/A
Labor Income ($ million)						89							
Regional Sales ($ million)						250.7							
Phase 3 & 6													
Employment (Jobs)	No Impact	N/A	N/A	N/A	N/A	1356	Same as 3A	Same as 3A	Same as 3A	N/A	N/A	N/A	N/A
Labor Income ($ million)						70.3							
Regional Sales ($ million)						198							
Phase 4, 7, & 9													
Employment (Jobs)	No Impact	N/A	N/A	N/A	N/A	1385	Same as 3A	Same as 3A	Same as 3A	N/A	N/A	N/A	N/A
Labor Income ($ million)						71.8							
Regional Sales ($ million)						202.3							

	No Action	Alternative 2A/2B - Partial Replacement Alternative				Alternative 3A/3B - Full Replacement Alternative				Alternative 4A/4B - Modified Partial Replacement Alternative			
		Spring Diversion		Limited Spring Diversion		Spring Diversion		Limited Spring Diversion		Spring Diversion		Limited Spring Diversion	
		Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2
OM&R													
Employment (Jobs)	No Impact	33	Same as 2A	Same as 2A	Same as 2A	62	Same as 3A	Same as 3A	Same as 3A	39	Same as 4A	Same as 4A	Same as 4A
Labor Income ($ million)		2.06				3.86				2.45			
Regional Sales ($ million)		4.09				7.65				4.86			
Agriculture													
		Net Change from No Action				Net Change from No Action				Net Change from No Action			
Employment (Jobs)	-715	979	Same as 2A	Same as 2A	Same as 2A	1734	Same as 3A	Same as 3A	Same as 3A	1155	Same as 4A	Same as 4A	Same as 4A
Labor Income ($ million)	-25.0	48				86				56			
Regional Sales ($ million)	-131.0	236				421				276			

5.3. Environmental Quality Analysis

The Environmental Quality (EQ) account measures the degree to which the project benefits or adversely affects the quality of the natural and cultural resources and ecosystems of the area. These natural and cultural resources sustain and enrich human life in one of three ways:

- **Ecological:** Components of the environment and the interactions among all its living (including people) and nonliving components that directly or indirectly sustain dynamic, diverse, viable ecosystems. Surface water quantity, groundwater resources, surface water quality, geology, soils, vegetation and wetlands, wildlife and wildlife habitat, fisheries, and threatened and endangered species were analyzed.
- **Cultural:** Evidence of past and present habitation that can be used to reconstruct or preserve human lifeways. Cultural and historic resources were analyzed.
- **Aesthetic**: Perceptual stimuli that provide diverse and pleasant surroundings for human appreciation. Air quality, noise, and visual resources were analyzed.

The EQ analysis considers only resources with indicators that show significant impacts. The consequences of the alternatives, including the No Action Alternative, are fully described in Chapter 4 of the Odessa Draft EIS and summarized in Section 4.8, “Summary of Impacts,” of this Special Study Report. The EQ resources considered are:

- Groundwater Resources
- Vegetation and Wetlands
- Wildlife and Wildlife Habitat
- Visual Resources
- Noise
- Cultural Resources

(Note: The potential for adverse impacts to Indian Sacred Sites is also recognized in the Environmental Impact Statement. However, the presence of and potential for adverse impact to these resources has not been verified and/or quantified for the action alternatives to date. Because of this, these resources are not included in the numeric EQ analysis.)

5.3.1 EQ Methodology

Impacts were compared using indicators, a characteristic of an EQ resource that serves as a direct or indirect means of measuring or otherwise describing changes in the quantity and/or quality of an EQ resource. Scores within each impact indicator were assigned on a simple scale of 0 (No Impact) through +4 (most beneficial) or -4 (most adverse). For indicators where quantitative measures are used to report impacts, intermediate rankings of 1, 2, or 3/-1, -2, or -3 are assigned by dividing the impact range into 4 equal parts. This "rule" is illustrated in the following diagram.

Full impact range:	< No impact			Best/worst impact >
Impact range divided into 4 equal parts:	>0 to 25%	>25 to 50%	>50 to 75%	>75 to 100%
Impact scores:	**+1/-1**	**+2/-2**	**+3/-3**	**+4/-4**

For indicators where impacts are not reported using quantitative measures, professional judgment is used to assign relative severity of impact on the same 1 through 4 scale. For short-term impacts (e.g. noise), the same basic approach is used; however these impacts are not considered as severe or beneficial (as applicable) and a scale of 0 to +2/-2 is used.

For this impact comparison, no judgment was made regarding relative importance of one indicator compared with others. The straightforward summing of scores for all indicators treats a +4 or -4 score in one indicator as equal in importance to the same scores in other indicators. Judgments related to the importance of one indicator compared with others when making decisions are left to the discretion of the reviewer.

Only resources and indicators under which significant adverse impacts and/or important beneficial effects would occur are included in the analysis.

Total scores for each EQ resource were derived by adding the scores of all impact indicators for a resource and dividing by the number of indicators for that resource.

EQ scores were derived by adding the total scores for each EQ resource.

5.3.2 EQ Results

Table 5- 28 shows the EQ total score for each alternative.

Table 5- 28. EQ Rankings for Alternatives

Alternative	Total EQ Score
No Action	-1.3
2A: Partial—Banks	-5.7
2B: Partial—Banks + FDR	-5.7
3A: Full—Banks	-12.7
3B: Full—Banks + FDR	-11.3
4A: Modified Partial—Banks	-6.3
4B: Modified Partial—Banks + FDR	-5.6

Table 5- 29 presents a summary of results for the EQ resources for each alternative, including the total EQ score.

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Table 5- 29. Impact comparison for EQ Resources

Resource Indicator, Topic, or Measurement	No Action		Partial Groundwater Irrigation Replacement Alternatives				Full Groundwater Irrigation Replacement Alternatives				Modified Partial Groundwater Irrigation Replacement Alternatives			
			2A: Partial—Banks		2B: Partial—Banks + FDR		3A: Full—Banks		3B: Full—Banks + FDR		4A: Modified Partial—Banks		4B: Modified Partial—Banks + FDR	
	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score
Groundwater Resources		**0.0**		**1.7**		**1.7**		**4.0**		**4.0**		**2.0**		**2.0**
Groundwater level declines	Continued decline in levels and high level of discontinued use in next 10-20 years. Adverse impact.	0	Conservation of about 138,000 ac-ft/year of groundwater; level declines continue, but at slower rate with both diversion scenarios. Beneficial impact.	3	Conservation of about 138,000 ac-ft/year of groundwater; level declines continue, but at slower rate with both diversion scenarios. Beneficial impact.	3	Conservation of about 273,000 ac-ft/year of groundwater; level declines continue and may rise slightly with both diversion scenarios. Beneficial impact.	4	Conservation of about 273,000 ac-ft/year of groundwater; level declines continue and may rise slightly with both diversion scenarios. Beneficial impact.	4	Conservation of about 164,000 ac-ft/year of groundwater; level declines continue, but at slower rate with both diversion scenarios. Beneficial impact.	3	Conservation of about 164,000 ac-ft/year of groundwater; level declines continue, but at slower rate with both diversion scenarios. Beneficial impact.	3
Recharge or seepage in Black Rock Coulee	No impact	0	No impact with both diversion scenarios	0	No impact with both diversion scenarios	0	Local recharge to shallow groundwater from reservoir with both diversion scenarios	4	Local recharge to shallow groundwater from reservoir with both diversion scenarios	4	No impact with both diversion scenarios	0	No impact with both diversion scenarios	0
Municipal and industrial users	Continued decline in levels. Adverse impact.	0	Reduced rate of declining groundwater levels. Beneficial effect south of I-90. Continued decline in levels north of I-90 with both diversion scenarios. Adverse impact.	2	Reduced rate of declining groundwater levels. Beneficial effect south of I-90. Continued decline in levels north of I-90 with both diversion scenarios. Adverse impact.	2	Reduced rate of declining groundwater levels as shallow aquifer seeps into deep aquifer with both diversion scenarios. Beneficial impact.	4	Reduced rate of declining groundwater levels as shallow aquifer seeps into deep aquifer with both diversion scenarios. Beneficial effect.	4	Reduced rate of declining groundwater levels with both diversion scenarios. Beneficial effect.	3	Reduced rate of declining groundwater levels with both diversion scenarios. Beneficial effect.	3

Table 5- 29. Impact comparison for EQ Resources

Resource Indicator, Topic, or Measurement	No Action		Partial Groundwater Irrigation Replacement Alternatives				Full Groundwater Irrigation Replacement Alternatives				Modified Partial Groundwater Irrigation Replacement Alternatives			
			2A: Partial—Banks		2B: Partial—Banks + FDR		3A: Full—Banks		3B: Full—Banks + FDR		4A: Modified Partial—Banks		4B: Modified Partial—Banks + FDR	
	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score
Vegetation and Wetlands		**0.0**		**-0.6**		**-0.6**		**-4.0**		**-4.0**		**-0.6**		**-0.6**
Impact on native plant communities	No impact	0	Adverse impact on native plant communities with both diversion scenarios	-1	Adverse impact on native plant communities with both diversion scenarios	-1	Significant impact with both diversion scenarios, including Black Rock Coulee Reregulating Reservoir	-4	Significant impact with both diversion scenarios, including Black Rock Coulee Reregulating Reservoir	-4	Adverse impact on native plant communities with both diversion scenarios	-1	Adverse impact on native plant communities with both diversion scenarios	-1
Fragmentation of native plant communities	No impact	0	Minimal impact with both diversion scenarios	0	Minimal impact with both diversion scenarios	0	Adverse impact with both diversion scenarios with to construction of new canals	-4	Adverse impact with both diversion scenarios with to construction of new canals	-4	Minimal impact with both diversion scenarios	0	Minimal impact with both diversion scenarios	0
Impact on special status plants	No impact	0	Potential impacts with both diversion scenarios; not yet quantified	-1	Potential impacts with both diversion scenarios; not yet quantified	-1	Potential impacts with both diversion scenarios; not yet quantified, but approximately an order of magnitude greater than 2A	-4	Potential impacts with both diversion scenarios; not yet quantified, but approximately an order of magnitude greater than 2A	-4	Potential impacts with both diversion scenarios; not yet quantified	-1	Potential impacts with both diversion scenarios; not yet quantified	-1
Habitat restoration	No impact	0	Long time periods for restoration of disturbed habitat with both diversion scenarios	-1	Significant requirement for restoration of disturbed habitat with both diversion scenarios	-1	Long time periods for restoration of disturbed habitat over larger areas than 2A with both diversion scenarios	-4	Significant requirement for restoration of disturbed habitat over larger areas than 2A with both diversion scenarios	-4	Long time periods for restoration of disturbed habitat with both diversion scenarios	-1	Significant requirement for restoration of disturbed habitat with both diversion scenarios	-1
Long-term loss of wetland area	No impact	0	Minimal impact with both diversion scenarios	0	Minimal impact with both diversion scenarios	0	Adverse impact at Banks Lake with both diversion scenarios	-4	Adverse impact at Banks Lake with both diversion	-4	Minimal impact with both diversion	0	Minimal impact with both diversion	0

Table 5- 29. Impact comparison for EQ Resources

Resource Indicator, Topic, or Measurement	No Action		Partial Groundwater Irrigation Replacement Alternatives				Full Groundwater Irrigation Replacement Alternatives				Modified Partial Groundwater Irrigation Replacement Alternatives			
			2A: Partial—Banks		2B: Partial—Banks + FDR		3A: Full—Banks		3B: Full—Banks + FDR		4A: Modified Partial—Banks		4B: Modified Partial—Banks + FDR	
	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score
									scenarios		scenarios		scenarios	
Wildlife and Wildlife Habitat		**0.0**		**-0.8**		**-0.8**		**-4.0**		**-4.0**		**-1.0**		**-1.0**
Impact on intact shrub-steppe habitat	Minimal impact on wildlife that use farm lands because wheat fields would be fallowed every other year	0	Adverse impact with both diversion scenarios with removal of shrub-steppe habitat	-1	Adverse impact with both diversion scenarios with removal of shrub-steppe habitat	-1	Significant impact with both diversion scenarios over substantially larger area than with Alternative 2A	-4	Significant impact over substantially larger area than with Alternative 2A	-4	Adverse impact over slightly larger area than with Alternative 2A	-1	Adverse impact over slightly larger area than with Alternative 2A	-1
Barriers to unrestricted movement by wildlife	No impact	0	No impact to minimal impact with both diversion scenarios	0	No impact to minimal impact with both diversion scenarios	0	Significant impact with both diversion scenarios from extended canal system	-4	Significant impact with both diversion scenarios from extended canal system	-4	No impact to minimal impact with both diversion scenarios	0	No impact to minimal impact with both diversion scenarios	0
Impact on special status species, including migratory birds	No impact	0	Significant impact on multiple species with both diversion scenarios. Impacts to grebes would be more pronounced with the limited spring diversion scenario.	-2	Significant impact on multiple species with both diversion scenarios. Impacts to grebes would be more pronounced with the limited spring diversion scenario.	-2	Significant impact on multiple species with both diversion scenarios, involving substantially larger area and number of species than with Alternative 2A	-4	Significant impact on multiple species with both diversion scenarios, involving substantially larger area and number of species than with Alternative 2A	-4	Significant impact on multiple species with both diversion scenarios, involving slightly larger area and number of species than with Alternative 2A	-3	Significant impact on multiple species with both diversion scenarios, involving slightly larger area and number of species than with Alternative 2A	-3
Habitat fragmentation and population viability	No impact	0	No impact with both diversion scenarios	0	No impact with both diversion scenarios	0	Significant impact from extended canal system	-4	Significant impact from extended canal system	-4	No impact with both diversion scenarios	0	No impact with both diversion scenarios	0

Table 5- 29. Impact comparison for EQ Resources

Resource Indicator, Topic, or Measurement	No Action		Partial Groundwater Irrigation Replacement Alternatives				Full Groundwater Irrigation Replacement Alternatives				Modified Partial Groundwater Irrigation Replacement Alternatives			
			2A: Partial—Banks		2B: Partial—Banks + FDR		3A: Full—Banks		3B: Full—Banks + FDR		4A: Modified Partial—Banks		4B: Modified Partial—Banks + FDR	
	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score
Visual Resources		**-1.3**		**-1.7**		**-1.7**		**-2.7**		**-2.0**		**-2.3**		**-2.0**
Landscape-level change: conversion from irrigated agriculture to dryland or fallow over approximately 30-year period	About 100,000 acres would convert to dryland or fallow. Adverse impact.	-4	About 48,000 acres would convert to dryland or fallow. Adverse impact.	-2	About 48,000 acres would convert to dryland or fallow. Adverse impact.	-2	General landscape appearance does not change	0	General landscape appearance does not change	0	About 35,000 acres would convert to dryland or fallow. Adverse impact.	-2	About 35,000 acres would convert to dryland or fallow. Adverse impact.	-2
Introduction of new developed facilities	No impact	0	Pumping plants and regulating tanks south of I-90 only. Adverse impact.	-1	Pumping plants and regulating tanks south of I-90 only. Adverse impact.	-1	Canals, laterals, pumping plants, and regulating tanks north and south of I-90. Adverse impact.	-4	Canals, laterals, pumping plants, and regulating tanks north and south of I-90. Adverse impact.	-4	Pumping plants and regulating tanks north and south of I-90. Adverse impact.	-2	Pumping plants and regulating tanks north and south of I-90. Adverse impact.	-2
Changes in reservoir drawdown patterns at Banks Lake and Lake Roosevelt	Minimal Impact	0	Adverse impact at Banks Lake generally related to depth of additional drawdown. Adverse impact with both diversion scenarios.	-2	Adverse impact at Banks Lake generally related to depth of additional drawdown. Adverse impact with both diversion scenarios.	-2	Adverse impact at Banks Lake generally related to depth of additional drawdown. Impacts would be slightly more pronounced with the limited spring diversion scenario.	-4	Adverse impact at Banks Lake generally related to depth of additional drawdown. Impacts would be slightly more pronounced with the limited spring diversion scenario.	-2	Adverse impact at Banks Lake generally related to depth of additional drawdown. Adverse impact with both diversion scenarios.	-3	Adverse impact at Banks Lake generally related to depth of additional drawdown. Adverse impact with both diversion scenarios.	-2
Noise		**0.0**		**-2.0**		**-2.0**		**-2.0**		**-2.0**		**-2.0**		**-2.0**
Short-term (construction) increases in noise levels	No impact	0	Localized adverse impact	-2	Localized adverse impact	-2	Localized adverse impact	-2	Localized adverse impact	-2	Localized adverse impact	-2	Localized adverse impact	-2

Table 5- 29. Impact comparison for EQ Resources

Resource Indicator, Topic, or Measurement	No Action		Partial Groundwater Irrigation Replacement Alternatives				Full Groundwater Irrigation Replacement Alternatives				Modified Partial Groundwater Irrigation Replacement Alternatives			
			2A: Partial—Banks		2B: Partial—Banks + FDR		3A: Full—Banks		3B: Full—Banks + FDR		4A: Modified Partial—Banks		4B: Modified Partial—Banks + FDR	
	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score
Cultural and Historic Resources		**0.0**		**-2.7**		**-2.7**		**-4.0**		**-3.3**		**-3.0**		**-2.7**
Potential for construction to encounter and impact significant cultural resources														
Miles of new linear facilities with high potential	No impact	0	166 miles. Adverse impact.	-3	166 miles. Adverse impact.	-3	245 miles. Adverse impact.	-4	245 miles. Adverse impact.	-4	162 miles. Adverse impact.	-3	162 miles. Adverse impact.	-3
Acres of facility site acquisition with high potential	No impact	0	38 acres. Adverse impact.	-3	38 acres. Adverse impact.	-3	100 acres. Adverse impact.	-4	100 acres. Adverse impact.	-4	27 acres. Adverse impact.	-3	27 acres. Adverse impact.	-3
Additional acreage exposed by drawdowns at Banks Lake	No impact	0	About 560 acres exposed with spring diversion scenario and about 1,080 acres with limited spring diversion scenario. Adverse impact.	-2	About 560 acres exposed with spring diversion scenario and about 700 acres with limited spring diversion scenario. Adverse impact.	-2	About 1,400 acres exposed with spring diversion scenario and about 2,430 acres with limited spring diversion scenario. Adverse impact.	-4	About 700 acres exposed with spring diversion scenario and about 700 acres with limited spring diversion scenario. Adverse impact.	-2	About 790 acres exposed with spring diversion scenario and about 1,480 acres with limited spring diversion scenario. Adverse impact.	-3	About 700 acres exposed with spring diversion scenario and about 700 acres with limited spring diversion scenario. Adverse impact.	-2
Total EQ Score		**-1.3**		**-5.7**		**-5.7**		**-12.7**		**-11.3**		**-6.3**		**-5.6**

5.4. Other Social Effects Analysis

The OSE account displays information on effects from perspectives that are not reflected in the NED, RED, or EQ accounts. The OSE analysis considers only resources with indicators that show significant impacts. The consequences of the alternatives, including the No Action Alternative, are fully described in Chapter 4 of the Odessa Final EIS and summarized in Section 4.11, "Summary of Impacts," of this Special Study Report. The OSE resources considered are:

- Land Use and Shoreline Resources
- Recreation Resources
- Energy

5.4.1 OSE Methodology

Impacts were compared using the same analyses techniques described for the EQ Account. See Section 5.3.1, "EQ Methodology."

5.4.2 OSE Results

Table 5- 30 shows the total OSE scores for each alternative.

Table 5- 30. OSE rankings for alternatives

Alternative	Total OSE Score
No Action	-0.3
2A: Partial—Banks	-2.0
2B: Partial—Banks + FDR	-0.9
3A: Full—Banks	-5.2
3B: Full—Banks + FDR	-2.4
4A: Modified Partial—Banks	-3.3
4B: Modified Partial—Banks + FDR	-0.9

Table 5- 31 presents a summary of results for the OSE resources for each alternative, including the OSE scores and Table 5- 32 summarizes the four accounts—RED, NED, EQ, and OSE—in a comparative table.

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Table 5- 31. OSE Comparative Evaluation of Alternatives

Resource Indicator, Topic, or Measurement	No Action		Partial Groundwater Irrigation Replacement Alternatives				Full Groundwater Irrigation Replacement Alternatives				Modified Partial Groundwater Irrigation Replacement Alternatives			
			2A: Partial—Banks		2B: Partial—Banks + FDR		3A: Full—Banks		3B: Full—Banks + FDR		4A: Modified Partial—Banks		4B: Modified Partial—Banks + FDR	
	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score
Land Use and Shoreline Resources		**-0.3**		**1.3**		**1.3**		**1.3**		**1.3**		**1.3**		**1.3**
Changes in land ownership and land status	Potential for consolidation of farms	-1	About 5,150 acres acquired (easements and fee title) with both diversion scenarios. Adverse impact	-2	About 5,150 acres acquired (easements and fee title) with both diversion scenarios. Adverse impact	-2	About 17,360 acres acquired (easements and fee title) with both diversion scenarios. Adverse impact	-4	About 17,360 acres acquired (easements and fee title) with both diversion scenarios. Adverse impact	-4	About 4,740 acres acquired (easements and fee title) with both diversion scenarios. Adverse impact	-2	About 4,740 acres acquired (easements and fee title) with both diversion scenarios. Adverse impact	-2
Changes in land or shoreline uses: Protection of irrigated agriculture	Adverse impact with significant change from irrigated to dryland agriculture.	0	57,000 acres of irrigated agriculture preserved with both diversion scenarios. Beneficial effect.	3	57,000 acres of irrigated agriculture preserved with both diversion scenarios. Beneficial effect.	3	102,600 acres of irrigated agriculture preserved with both diversion scenarios. Beneficial effect...	4	102,600 acres of irrigated agriculture preserved with both diversion scenarios. Beneficial effect.	4	70,000 acres of irrigated agriculture preserved with both diversion scenarios. Beneficial effect.	3	70,000 acres of irrigated agriculture preserved with both diversion scenarios .Beneficial effect.	3
Consistency with relevant plans, policies and programs	Adverse impact from inconsistent plans across 102,614 acres.	0	Supports county comprehensive plans across 57,000 acres with both diversion scenarios. Beneficial effect.	3	Supports county comprehensive plans across 57,000 acres with both diversion scenarios. Beneficial effect.	3	Supports county comprehensive plans across 102,600 acres with both diversion scenarios. Beneficial effect.	4	Supports county comprehensive plans across 102,600 acres with both diversion scenarios. Beneficial effect.	4	Supports county comprehensive plans across 70,000 acres with both diversion scenarios. Beneficial effect.	3	Supports county comprehensive plans across 70,000 acres with both diversion scenarios. Beneficial effect.	3
Recreation		**0.0**		**-1.4**		**-1.3**		**-2.5**		**-2.8**		**-1.6**		**-1.3**
FDR: Loss of boating capacity	No impact	0	No impact with both diversion scenarios	0	No impact with both diversion scenarios	0	No impact with both diversion scenarios	0	In dry years, 6 of 22 launches unavailable for 1-3 weeks. Slight increase in impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	-4	No impact with both diversion scenarios	0	Minimal impact with both diversion scenarios	0

Table 5- 31. OSE Comparative Evaluation of Alternatives

Resource Indicator, Topic, or Measurement	No Action		Partial Groundwater Irrigation Replacement Alternatives				Full Groundwater Irrigation Replacement Alternatives				Modified Partial Groundwater Irrigation Replacement Alternatives			
			2A: Partial—Banks		2B: Partial—Banks + FDR		3A: Full—Banks		3B: Full—Banks + FDR		4A: Modified Partial—Banks		4B: Modified Partial—Banks + FDR	
	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score
FDR: Loss of usability at developed swimming areas	No impact	0	No impact with both diversion scenarios	0	Increased distance to water's edge with both diversion scenarios. Minimal impact.	0	No impact with both diversion scenarios	0	Increased distance to water's edge with both diversion scenarios. Adverse impact.	-4	No impact with both diversion scenarios	0	Increased distance to water's edge with both diversion scenarios. Minimal impact.	0
FDR: Decrease in usability or aesthetic quality at developed camping or day use facilities	No impact	0	No impact with both diversion scenarios	0	Increased distance to water's edge with both diversion scenarios. Minimal impact.	0	No impact with both diversion scenarios	0	Increased distance to water's edge with both diversion scenarios. Adverse impact.	-4	No impact with both diversion scenarios	0	Increased distance to water's edge with both diversion scenarios. Minimal impact.	0
Banks: Loss in boat launch capacity and related impacts on fishing access, camping, and day use	No impact	0	In dry years, two of five high capacity launches unavailable for 3-4 weeks with both diversion scenarios. Adverse impact.	-3	With both diversion scenarios, minimal impact at high-capacity ramps, but low-capacity ramps would be out of service for up to 5 weeks	-1	All but one boat ramp unavailable for 6 weeks with both scenarios. Adverse impact.	-4	With both diversion scenarios, minimal impact at high-capacity ramps, but low-capacity ramps would be out of service for up to 5 weeks	-1	In dry years, high capacity ramps unavailable for 1-4 weeks. Potential increased impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	-3	With both diversion scenarios, minimal impact at high-capacity ramps, but low-capacity ramps would be out of service for up to 5 weeks	-1
Banks: Exposure of boating hazards	Minimal impact	0	Drawdown exposure of hazards would last for about 3-6 weeks. Potential for increased hazard exposure with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	-2	Drawdown exposure of hazards would last for about 6-7 weeks. Potential for increased impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	-3	Drawdown exposure of hazards would last for about 10-13 weeks. Potential for increased hazard exposure with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	-4	Drawdown exposure of hazards would last for about 10-13 weeks. Potential for increased impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	-3	Drawdown exposure of hazards would last for about 4-7 weeks. Potential for increased impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	-2	Drawdown exposure of hazards would last for about 6-7 weeks. Potential for increased impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	-3

Table 5- 31. OSE Comparative Evaluation of Alternatives

Resource Indicator, Topic, or Measurement	No Action		Partial Groundwater Irrigation Replacement Alternatives				Full Groundwater Irrigation Replacement Alternatives				Modified Partial Groundwater Irrigation Replacement Alternatives			
			2A: Partial—Banks		2B: Partial—Banks + FDR		3A: Full—Banks		3B: Full—Banks + FDR		4A: Modified Partial—Banks		4B: Modified Partial—Banks + FDR	
	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score
Banks: Loss of usability at developed swimming areas	No impact	0	Three of four swimming areas unusable for about 6 weeks. Slight increase in impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	-2	Three of four swimming areas unusable for about 5-6 weeks. Potential increased impact with limited spring diversion scenario than with spring diversion scenario Adverse impact.	-2	All four swimming areas would be unusable for up to 12 weeks. Potential increased impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	-4	Three of four swimming areas unusable for about 5-6 weeks. Potential increased impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	-2	Three of four swimming areas unusable for about 6 weeks. Potential increased impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	-2	Three of four swimming areas unusable for about 5-6 weeks. Potential increased impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	-2
Banks: Decrease in usability or aesthetic quality at developed camping or day use facilities	Minimal impact	0	Distance to water's edge would be about 20-260 feet for dry years with both diversion scenarios. Adverse impact.	-2	Distance to water's edge would be about 20-260 feet for dry years with both diversion scenarios. Adverse impact.	-2	Distance to water's edge would be about 50-850 feet in dry years. Potential increased impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	-4	Distance to water's edge would be about 20-260 feet for dry years with both diversion scenarios than with spring diversion scenario. Adverse impact.	-2	Distance to water's edge would be about 50-450 feet in dry years. Potential increased hazard exposure with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	-3	Distance to water's edge would be about 20-260 feet for dry years with both diversion scenarios. Adverse impact.	-2
Banks: Decrease in usability of aesthetic quality at dispersed recreation sites	Minimal impact	0	Distance to water's edge would be about 20-445 feet for dry years with both diversion scenarios. Adverse impact.	-2	Distance to water's edge would be about 20-420 feet for dry years with both diversion scenarios. Adverse impact.	-2	Distance to water's edge would be over 50-890 feet for dry years. Potential increased impact with limited spring diversion scenario than with spring diversion scenario. Adverse impact.	-4	Distance to water's edge would be about 20-420 feet for dry years. Adverse impact.	-2	Distance to water's edge would be about 25-470 feet for dry years. Adverse impact.	-3	Distance to water's edge would be about 20-420 feet for dry years. Adverse impact.	-2
Energy		**0.0**		**-3.0**		**-2.0**		**-4.0**		**-2.0**		**-4.0**		**-2.0**
Keys PGP reserves, reliability and diurnal load shifting	No impact	0	Adverse to significant impact with both diversion scenarios	-3	Adverse impact with both diversion scenarios	-2	Significant Impact with both diversion scenarios	-4	Adverse impact with both diversion scenarios	-2	Significant Impact with both diversion scenarios	-4	Adverse impact with both diversion scenarios	-2

Table 5- 31. OSE Comparative Evaluation of Alternatives

Resource Indicator, Topic, or Measurement	No Action		Partial Groundwater Irrigation Replacement Alternatives				Full Groundwater Irrigation Replacement Alternatives				Modified Partial Groundwater Irrigation Replacement Alternatives			
			2A: Partial—Banks		2B: Partial—Banks + FDR		3A: Full—Banks		3B: Full—Banks + FDR		4A: Modified Partial—Banks		4B: Modified Partial—Banks + FDR	
	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score	Impact	Score
Total OSE Score		**-0.3**		**-2.0**		**-0.9**		**-5.2**		**-2.4**		**-3.3**		**-0.9**

Table 5- 32. Summary of Four-Account Analyses

	No Action	Alternative 2A/2B - Partial Replacement Alternative				Alternative 3A/3B - Full Replacement Alternative				Alternative 4A/4B - Modified Partial Replacement Alternative			
		Spring Diversion		Limited Spring Diversion		Spring Diversion		Limited Spring Diversion		Spring Diversion		Limited Spring Diversion	
		Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2
National Economic Development Account (Results of NED BCA Based on current planning rate: 4.0%)													
Agricultural Benefits:	N/A	1070.0	1070.0	1070.0	1070.0	1884.9	1884.9	1884.9	1884.9	1315.4	1315.4	1315.4	1315.4
Municipal Benefits:	N/A	34.1	27.2	34.1	27.2	116.2	92.7	116.2	92.7	58.6	46.6	58.6	46.6
Industrial Benefits:	N/A	5.2	5.2	5.2	5.2	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
Total Benefits:	N/A	1109.3	1102.4	1109.3	1102.4	2006	1982.5	2006	1982.5	1378.9	1366.9	1378.9	1366.9
Construction & IDC:	N/A	886	886	886	886	3,169.3	3,169.3	3,169.3	3,169.3	942.0	942.0	942.0	942.0
Land Acquisition:	N/A	3.2	3.2	3.2	3.2	3.9	3.9	3.9	3.9	2.5	2.5	2.5	2.5
OMR&P:	N/A	192.5	192.5	192.5	192.5	428.1	428.1	428.1	428.1	228.7	228.7	228.7	228.7
Lost Hydropower:	N/A	168.3	168.3	190.2	190.2	319.5	319.5	351.1	351.1	194.7	194.7	226.4	226.4
Total Costs:	N/A	1250	1250	1271.9	1271.9	3920.8	3920.8	3952.4	3952.4	1367.9	1367.9	1399.6	1399.6
Net Benefits:	N/A	-140.7	-147.6	-162.6	-169.5	-1914.8	-1938.3	-1946.4	-1969.9	11	-1	-20.7	-32.7
Benefit-Cost Ratio:	N/A	0.887	0.882	0.872	0.867	0.512	0.506	0.508	0.502	1.008	0.999	0.985	0.977
Regional Economic Development Account													
Construction													
Phase 1													
Employment (Jobs)		735								724			
Labor Income ($ million)	No Impact	38.1	Same as 2A	Same as 2A	Same as 2A	Same as 2A	Same as 2A	Same as 2A	Same as 2A	37.6	Same as 4A	Same as 4A	Same as 4A
Regional Sales ($ million)		107.5								105.8			
Phase 2													
Employment (Jobs)		870								469			
Labor Income ($ million)	No Impact	45.1	Same as 2A	Same as 2A	Same as 2A	N/A	N/A	N/A	N/A	24.3	Same as 4A	Same as 4A	Same as 4A
Regional Sales ($ million)		127.0								68.5			
Phase 3													
Employment (Jobs)		307								702			
Labor Income ($ million)	No Impact	15.9	Same as 2A	Same as 2A	Same as 2A	N/A	N/A	N/A	N/A	36.4	Same as 4A	Same as 4A	Same as 4A
Regional Sales ($ million)		44.9								102.6			
Phase 4													
Employment (Jobs)		284								279			
Labor Income ($ million)	No Impact	14.7	Same as 2A	Same as 2A	Same as 2A	N/A	N/A	N/A	N/A	14.5	Same as 4A	Same as 4A	Same as 4A
Regional Sales ($ million)		41.5								40.7			
Phase 5													
Employment (Jobs)						3382							
Labor Income ($ million)	No Impact	N/A	N/A	N/A	N/A	175.5	Same as 3A	Same as 3A	Same as 3A	N/A	N/A	N/A	N/A
Regional Sales ($ million)						494.3							
Phase 2 & 8													
Employment (Jobs)						1713							
Labor Income ($ million)	No Impact	N/A	N/A	N/A	N/A	89	Same as 3A	Same as 3A	Same as 3A	N/A	N/A	N/A	N/A
Regional Sales ($ million)						250.7							

Table 5- 32. Summary of Four-Account Analyses

	No Action	Alternative 2A/2B - Partial Replacement Alternative				Alternative 3A/3B - Full Replacement Alternative				Alternative 4A/4B - Modified Partial Replacement Alternative			
		Spring Diversion		Limited Spring Diversion		Spring Diversion		Limited Spring Diversion		Spring Diversion		Limited Spring Diversion	
		Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2	Muni - Opt 1	Muni - Opt 2
Phase 3 & 6													
Employment (Jobs)						1356							
Labor Income ($ million)	No Impact	N/A	N/A	N/A	N/A	70.3	Same as 3A	Same as 3A	Same as 3A	N/A	N/A	N/A	N/A
Regional Sales ($ million)						198							
Phase 4, 7, & 9													
Employment (Jobs)						1385							
Labor Income ($ million)	No Impact	N/A	N/A	N/A	N/A	71.8	Same as 3A	Same as 3A	Same as 3A	N/A	N/A	N/A	N/A
Regional Sales ($ million)						202.3							
OM&R													
Employment (Jobs)		33				62				39			
Labor Income ($ million)	No Impact	2.06	Same as 2A	Same as 2A	Same as 2A	3.86	Same as 3A	Same as 3A	Same as 3A	2.45	Same as 4A	Same as 4A	Same as 4A
Regional Sales ($ million)		4.09				7.65				4.86			
Agriculture													
		Net Change from No Action				Net Change from No Action				Net Change from No Action			
Employment (Jobs)	-715	979				1734				1155			
Labor Income ($ million)	-25.0	48	Same as 2A	Same as 2A	Same as 2A	86	Same as 3A	Same as 3A	Same as 3A	56	Same as 4A	Same as 4A	Same as 4A
Regional Sales ($ million)	-131.0	236				421				276			
Environmental Quality Account													
Evaluation Scores	-1.3	-5.7	-5.7	-5.7	-5.7	3A: -12.7 3B: -11.3	3A: -12.7 3B: -11.3	3A: -12.7 3B: -11.3	3A: -12.7 3B: -11.3	4A: -6.3 4B: -5.6	4A: -6.3 4B: -5.6	4A: -6.3 4B: -5.6	4A: -6.3 4B: -5.6
Other Social Effects Account													
Evaluation Scores	-0.3	2A: -2.0 2B: -0.9	2A: -2.0 2B: -0.9	2A: -2.0 2B: -0.9	2A: -2.0 2B: -0.9	3A: -5.2 3B: -2.4	3A: -5.2 3B: -2.4	3A: -5.2 3B: -2.4	3A: -5.2 3B: -2.4	4A: -3.3 4B: -0.9	4A: -3.3 4B: -0.9	4A: -3.3 4B: -0.9	4A: -3.3 4B: -0.9

Chapter 6: Findings and Conclusions

This chapter explains the findings and conclusions of the analysis that Reclamation and Ecology have on the alternatives.

6.1. Findings

6.1.1 Technical Viability

Based on feasibility-level engineering and design, all of the six action alternatives are technically viable.

6.1.2 Economically Justified

A potentially economically justified configuration was suggested before informal ESA consultation; however, to minimize potential impacts to listed species, an alternate configuration with a slightly lower benefit-cost ratio of 0.985 to 0.977 is being suggested as the Preferred Alternative.

6.1.3 Financially Feasible

Repayment of the Federal investment would be a consideration of future contracts under section 9 of the Reclamation Projects Act of 1939. Funding to implement will be provided by Federal and/or non-Federal funding sources.

A likely funding scenario would consist of Federal and state funding conveyance infrastructure (widening canals, siphons and appurtenant structures) and irrigators funding distributions systems from the canal to the farm through local improvement districts, bank loans or other means. Potentially, this funding would result in the irrigators paying for 90 percent of project costs through private means.

6.1.4 Four-Account Analysis

6.1.4.1. National Economic Development (NED) Account

Benefit-cost comparisons of alternatives were made by dividing total project benefits by total project costs—resulting in the benefit-cost ratio (BCR). For benefits to exceed costs, a BCR greater than one is required. Before comparison, all benefits and costs were converted to a common point in time across all alternatives – that is, the year 2025, which is assumed as the end of the construction period for any of the action alternatives.

- The highest BCR of 1.008 to 1 was calculated for two of the Modified Partial-Replacement Alternatives—Alternatives 4A and 4B under the Spring Diversion and high municipal benefit scenario. The BCR for Alternatives 4A and 4B under the Limited Spring Diversion is 0.977. These two alternatives would utilize existing facilities for water supply (that is, Banks Lake for Alternative 4A, and Banks Lake and Lake Roosevelt for Alternative 4B). The rest of the Modified Partial-Replacement Alternatives under the other scenarios resulted in BCRs approaching 1:1.

- Lower BCRs were calculated for partial and Full-Replacement Alternatives compared to the Modified Partial-Replacement Alternatives. BCRs ranging from .867 to .887 were calculated for Alternatives 2A and 2B, and BCRs ranging from .502 to .512 were calculated for Alternatives 3A and 3B. Although the Full-Replacement Alternatives would provide from $616 to $627 million more in benefits than the Modified Partial-Replacement Alternatives, the Full-Replacement Alternatives would cost at least $2.5 billion more for construction and operation of delivery and storage facilities, including a new 80-mile East High Canal.

6.1.4.2. Regional Economic Development (RED) Account

This account evaluates the beneficial and adverse impacts of each alternative on the economy of the affected region, with particular emphasis on income and employment measures. The affected region reflects the geographic area where significant impacts are expected to occur. Impacts can be measured in both monetary and nonmonetary terms.

The RED analysis includes not only the initial or direct impact on the primary affected industries, but also the secondary impacts resulting from those industries providing inputs to the directly affected industries as well. This analysis also includes the changes in economic activity stemming from household spending of income earned by those employed in the sectors of the economy impacted either directly or indirectly. These secondary impacts are often referred to as “multiplier effects.” The common measures of regional economic impacts include employment (jobs), income, and regional output (sales).

The No Action Alternative would have minimal adverse impacts from a regional perspective. The four-county analysis area would see a small (less than 1 percent) decrease in jobs, labor income, and sales. The Partial-Replacement Alternatives would have minimal beneficial effects. There would be less than a 2 percent increase in jobs, labor income, and regional sales for the four-county area compared to the No Action Alternative. The Full-Replacement Alternatives would have minimal beneficial effects. There would be less than 4 percent increase in jobs, labor income, and regional sales for the four-county area compared to the No Action Alternative. The Modified Partial-

Replacement Alternative would also have minimal beneficial effects. There would be less than 4 percent increase in jobs, labor income, and regional sales for the four-county area compared to the No Action Alternative. These impacts are summarized in Chapter 5 of this report.

6.1.4.3. Environmental Quality (EQ) Account

This account displays the effects on ecological, cultural, and aesthetic attributes of significant natural and cultural resources which cannot be adequately measured in monetary terms within the NED and RED accounts. The EQ analysis considers only resources with indicators that show significant impacts. The consequences of the alternatives, including the No Action Alternative, are fully described in Chapter 2 of the Odessa Final EIS and summarized in Section 4.8, “Summary of Impacts,” of this Special Study Report. The EQ resources considered are groundwater, vegetation and wetlands, wildlife and wildlife habitat, visual resources, noise and cultural resources

Impacts were compared using indicators, a characteristic of an EQ resource that serves as a direct or indirect means of measuring or otherwise describing changes in the quantity and/or quality of an EQ resource. Scores within each impact indicator were assigned on a simple scale of 0 (No Impact) through +4 (most beneficial) or -4 (most adverse). The EQ score for No Action was -1.3. EQ scores for the Partial-Replacement Alternatives were all -5.7; scores for the Full-Replacement Alternatives ranged from -11.3 to -12.7; and scores for the Modified Partial-Replacement Alternatives ranged from -5.7 to -6.3.

Alternatives 2A, 2B, and 4B have similar EQ scores. Alternatives 2A and 2B have less drawdown at Banks Lake; thus, there would be fewer impacts to resources there. Conversely, it also provides surface water to fewer acres, so it does not address the declining aquifer issue and results in the loss of more irrigated acres.

Alternatives 4A/4B serves approximately 13,000 acres more than Alternatives 2A/2B, addressing the declining aquifer drawdown issue more thoroughly and preserving much of the existing irrigated agriculture. While serving more acres and diverting more water, Alternatives 4A/4B have only slightly deeper drawdowns at Banks Lake under some conditions, because of the use of Lake Roosevelt storage. Thus, the EQ score is slightly less than 2A/2B.

Alternatives 3A/3B have more impacts due to greater drawdown in Banks Lake and more construction related to development of a new canal system.

6.1.4.4. Other Social Effects (OSE) Account

This account displays plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts. Like the EQ account, the OSE analysis considers only resources with indicators that show significant impacts. The consequences of the alternatives, including the No Action Alternative, are fully described in Chapter 2 of the Odessa Final EIS and summarized in Section 4.8, "Summary of Impacts" of this Special Study Report. The OSE resources considered are land use and shoreline resources, recreation resources, and transportation.

Impacts were compared using the same analyses techniques described for the EQ Account. The OSE score for No Action was 0.3. The OSE scores for the Partial-Replacement Alternatives ranged from -0.9 to -2.0, scores for the Full-Replacement Alternatives ranged from -2.4 to -5.2 while scores for the Modified Partial-Replacement Alternatives ranged from -0.9 to -3.3.

Alternatives 2B and 4B have the same OSE score. Of all the alternatives, they have the least impacts to recreation, the John Keys Pump-Generating Plant, and land and shoreline resources. As previously discussed, Alternative 4B serves approximately 13,000 more acres than Alternative 2B, and addresses the declining aquifer drawdown issue more thoroughly and preserves more of the existing irrigated agriculture. Thus, Alternative 4B scores higher with respect to land and shoreline resources than Alternative 2B. Serving more acres and diverting more water under Alternative 4B does result in slightly greater drawdowns in some years at Banks Lake and Lake Roosevelt compared to Alternative 2B. As a result, the values used in the OSE analysis to evaluate impacts to recreation are slightly more negative for Alternative 4B compared to Alternative 2B. With respect to impacts to the Keys Pump-Generating Plant, Alternatives 2B and 4B have similar minimal impacts.

Alternatives 3A/3B have more impacts to these resources due to greater drawdown in Banks Lake and more construction related to development of a new canal system.

6.2. Conclusions

Alternative 4A: Modified Partial—Banks, Limited Spring Diversion is the Preferred Alternative because it:

- Provides the most benefits to the aquifer with the least impacts to other environmental resources as compared to the partial and full replacement alternatives.
- Delivers water to the most acreage as possible with existing infrastructure.
- Has a Benefit-Cost Ratio approaching 1:1.
- No additional drawdown of Lake Roosevelt.

The Modified Partial-Replacement Alternative is technically feasible. An economically justified and financially feasible configuration was suggested before informal ESA consultation; however, to minimize potential impacts to listed species, an alternate configuration with a slightly lower benefit-cost ratio is being suggested as the Preferred Alternative.

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