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THE ECONOMIC IMPACT OF A POSSIBLE IRRIGATION-WATER SHORTAGE IN ODESSA SUB-BASIN: POTATO PRODUCTION AND PROCESSING

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The Economic Impact of a Possible Irrigation-Water Shortage in Odessa Sub-Basin: Potato Production & Processing

ABSTRACT

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The Columbia Basin Project (CBP) was one of the single largest projects undertaken by the Bureau of Reclamation. The venture, which started in the 1930s in Central Washington, did not entirely turn out as expected. In fact, almost half of the proposed irrigable area, located mainly in the northeastern portion of the original plan, doesn't have any water supply from the project

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for irrigation purposes. The Odessa Sub-area is one of those areas. The land in this area is fertile and produces very high quality potatoes. Over the last couple of decades, potato production in this Odessa sub-region has been possible primarily because of irrigation based on deep wells. However, the underground water is drawing down and potato production may shut down as a result. Therefore, an economic threat on the economy of the Columbia Basin is in the offing, unless alternative water sources are negotiated. In this paper, we will mainly explore the regional economic impacts of the possible losses of potato production and its associated processing in the Odessa Sub-area. In section A, we briefly discuss the current status of the Columbia Basin Project. In section B, we discuss ground water level decline issues. In section C, we enumerate the economic impacts of the possible losses in potato production in the Odessa Sub-area and associated loss of potato processing. Summary and conclusions are in the final section.

Keywords: potato production, potato processing, regional economic impact, input-output models.

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Section A: Columbia Basin Project, where we stand now!

Earlier Days:

Completed in 1941 Grand Coulee Dam (GCD) was a multipurpose project. The major project objectives are hydropower, irrigation, flood control, wildlife enhancement and other recreational uses. However, if the history could be followed in more minute detail, we could examine the political thinking behind these objectives.

The 1930's were marked by depression and a diverse political objective. In 1932 Hoover, the outgoing President, was wary of opening new lands to irrigation for agricultural purposes. He was apprehensive about the consequences of agricultural surplus generated from expansion of irrigable land following the GCD construction. However, when President Roosevelt took office priorities changed and the drop in employment nationally became the political focus. Roosevelt foresaw dam construction as a mechanism for putting people to work so he authorized a project, which involved a low dam at Grand Coulee. Its main purpose was to generate power, and the initial plan had no provisions for irrigation. As time passed, around mid-30s, irrigation, especially for the "Dust Bowl" refugees, gained in priority along with other issues. President Roosevelt's plan was to shift those "Dust Bowl" refugees to the "Planned Promised Land" of the Northwest, where irrigation could be a good option for these people to lead a better life.

In some early project authorization documents "CBP" referred to both GCD and the CB Irrigation Project. However, over time, people have come to refer to the irrigable area of the project as CBP. GCD has come to mean the portion of the overall project that deals with Hydroelectric Power, flood control, and recreational benefits associated with Lake Roosevelt. A

key feature of the basin is the Columbia plateau that contains the land served by the project's irrigation command area. The plateau was a semi-arid, sparsely vegetated area of nearly 100,000 sq. miles.

The US Army Corps of Engineers (ACE) and the US Bureau of Reclamation planned both GCD and CBP. The ACE reports, known as Butler Report (named after Major Butler), were officially completed in 1932 and later were followed by the feasibility report released by the Reclamation Bureau. The plans outlined in these studies provided the background for the actual construction of the dam and the irrigation project. Revenue from power generation was the main theme for both the reports. They found that unless power revenues were generated, the cost of irrigation development in Columbia Plateau would be too high for the farmers. In fact, both of the reports indicated the postponement of irrigation work until the power generation was well underway.

The Butler report explored multiple methods for irrigating the Columbia Basin area through the construction of GC Dam. Their plan, which also closely resembled the Reclamation Report Plan, outlined a total irrigation area of almost 1.2 Million acres of land (precisely 1,199,430 acres), out of which 1,034,110 acres would be irrigated from the dam water and the remaining 140,520 acres by diverting water from the Priest Rapids Reservoir downstream[1]. Unlike the Reclamation Report, the Butler Report gave more priority to water for irrigation purposes rather than water for power generation, while, the Reclamation Report urged for assurance of substantial power revenue before proceeding with any further comprehensive irrigation development.

[1] WCD Case Studies, GC Dam And CBP, 2000, pp 2-4.

Incidentally, CBP is the single largest reclamation project in the U.S. As of now, the total amount of officially irrigable land within the project area is 1,095,000 acres and out of that 660,794 are being irrigated. The project consists of several dams, reservoirs and it covers a huge amount of land through its extensive delivery system network. To facilitate the project water delivery within Washington State, the Bureau developed 14 storage reservoirs, 7 diversion dams, 39 major pumping plants, 795 miles of water carriage facilities inclusive of canals, pipeline and tunnels, and 3,913 miles of distribution facilities made of open and pipe laterals. In addition to this, they have also installed 3,500 miles of agricultural drainage for prevention of ground water buildup.[2]

On August 10, 1951, the first test water flowed into the main canal of Banks Lake toward the Columbia Basin Farmland. Between 1950 and 1958, irrigation service became available annually for 50,000 to 65,000 irrigable acres of new land, followed by a rather slow but steady growth of around 5000 acres in the 1960's and 1970's. The later slow growth of development of irrigable land had a positive effect because it allowed time for development of markets to absorb the increased production.

The next major shift in CBP came in the year 1969. After almost 20 years of being operated by the Government, responsibility for operation maintenance of the irrigation system was transferred to the three project irrigation districts, namely Quincy, East Columbia and South Columbia Basin Irrigation District (CBID). However, the federal government kept responsibility for the remainder of the project, including the maintenance and operation of GC Pumping Plant, Banks Lake, the Main Canal and the Pothole Reservoirs. According to the 2000 records, Quincy

[2] Washington, Bureau of Reclamation, US Department of the Interior, 1983, page 17.

CBID is the largest, serving 246,415 acres of land, followed by South CBID, covering 219,817 acres of land and East CBID, serving 151,596 irrigable acres of land (Table1). Besides these three irrigation districts is a fourth district, which is primarily a groundwater pumping district, known as Grant County Black Sand Irrigation District serving 30,500 irrigated acres.[3]

Table 1. CBP, Irrigation Data, Year 2000.[4]

	Total District Acres	Irrigable Acres	Agricultural Acres	Non-agricultural Acres	Multi-cropped Acres	Acres Irrigated by Sprinkler	Acres Irrigated but not Harvested	Acres not Irrigated
Quincy CBID	760,000	246,415	233,300	2,977	6,236	182,452	3,319	5,432
South CBID	810,000	219,817	212,377	2,272	9,213	200,314	7,290	3,203
East CBID	740,000	151,596	140,610	4,382	0	94,645	786	4,730

During this period there was a tremendous growth in value of agricultural output in this region and a shift in production type. There was also a change in cropping pattern; different agricultural products emerged compared to what was predicted initially. The CBP plays a significant role in respect to the State of Washington total agricultural Gross Value Product (GVP). In 1992, CBP produced 12% of the state's GVP, and for some crops its contribution is even more. Going by 1992 USBR crop report, CBP contributed toward 17% of Washington's GV of apple, 28% of its potato value and 32% of its hay value.[5] In the most recent Crop and Water Data (BOR, USDOI, 2000) the picture remains almost the same (Table 2A & 2B).

[3] Crop and Water Data, Page 14, US DOI, BOR , 2000; The Story Of the CBP, US DOI, BOR, 1978; Page 2-9, WCD Case Studies, GC Dam And CBP, 2000.
[4] Source : Crop and Water Data, BOR, USDOI, 2000.
[5] Page 3.1-4, WCD Case Studies, GC Dam And CBP, 2000.

Table 2A. Selective Crop Production: CBP, 4 Counties, State of WA, Year 2000.

Year 2000	Quincy CBID	South CBID	East CBID	Total CBP	4 Counties	WA State
Apple (ton)	354,371	269,982	46,288	670,641	NA	2,678,105
Total Potato (Cwt)	10,525,201	15,410,045	9,752,316	35,687,562	68,875,000	105,000,000
Alfalfa Hay (ton)	340,343	512,262	230,921	1,083,526	1,524,000	2,350,000
Wheat (Bu)	2,913,844	785,953	2,362,465	6,062,262	64,981,000	164,880,000

Source: http://www.nass.usda.gov/wa/rlsetoc.htm#histcoest.

Table 2B. Summary of Selective Crop Production (in Percentage).

Year 2000	Quincy CBID	South CBID	East CBID	Total CBP	4 Counties	WA State
Apple	13.23	10.08	1.73	25.04	NA[6]	2,678,105 (ton)
Total Potato	10.02	14.68	9.29	33.99	65.60	105,000,000 (Cwt)
Alfalfa Hay	14.48	21.80	9.83	46.11	64.85	2,350,000 (ton)
Wheat	1.77	0.48	1.43	3.68	39.41	164,880,000 (Bu)

Source: http://www.nass.usda.gov/wa/rlsetoc.htm#histcoest

Economic conditions in the CBP area verify that the scenario envisioned by the planners has been realized, at least partially. Today agri-business scattered over the area of CBP thrives. According to a study by Dr. Darryll Olsen (made in 1996), the "basic sectors" of agriculture, agricultural services, and food processing account for 30% to 50% of all the income in the counties in which CBP is located. Total income from the basic sectors of the CBP area, according to this study, is almost $617 Million. There was also some multiplier effects from investment made in the basic sectors. According to the Olsen study, these sectors generate between 1.5 to 1.7 dollars of total income within the local area for each dollar produced by the basic sectors.

[6] For the year 2000, apple production data was not available for county level. The respective counties in the "4 counties" set up are Adams, Grant, Franklin and Lincoln. Data source, http://www.nass.usda.gov/wa/rlsetoc.htm#histcoest .

Also, because of CBP, land value has increased over the time periods. This increased land values resulted in substantial local social benefits. Between 1990 and 1992, these increased land values, in 1998-dollar terms, provided about $8,250,000 in funding to local services like schools and hospitals. In fact, the increase in land value has been much greater than what was originally expected. The Butler Report originally predicted an increase in land value of about $440,476,000 or $370 per acre, for the entire 1.2 million acres (precisely 1,199,400) of land. However, today, the increased per-acre assessed value of CBP land due to irrigation is about $870, that is more than double what was predicted for its acreage value. The total area currently receiving CBP water is 660,800 acres. Thus, using the $870 rate, this represents an aggregate increased value of $574,896,000, which is almost 30% higher than projected on half as much land included in the original area to be irrigated.[7]

However, irrespective of all the detailed plans, at the end, the recent picture is much different than what had been projected during the Final stages of Estimation in 1968. From approximately 1,200,000 acres of land, only 660,800 acres is currently receiving CBP water (560,000 acres), or the Bureau of Reclamation has developed slightly less than 50% of the proposed original. The remaining 100,000 acres of farmed land is being developed mainly by private individuals primarily because of the advancement in irrigation technology, like the introduction of the Center-Pivot sprinkler. The major reason for such a shortfall of planned acreage irrigation is attributed to non-completion of the Second Half of the project.

[7] Darryll Olsen. "The Columbia Basin Project: Project Operation and Economic Benefits." The Pacific Northwest Project, 1996.

Delay of the Second Half:

As noted previously, during 1950s the CBP exhibited rapid development, however in the following decade the rate of irrigation block development slowed down considerably. The already existing irrigation facility, which was incidentally at its full capacity, was unable to irrigate new land. Thus, as a solution to this possible mismatch of demand and supply CBP moved into its "Second Half." Construction of the Second Bacon Siphon and Tunnel was planned, along with some possible extensions of East Low Canal, which was already serving some area of the eastern side. During the late 60s and early 70s, Congress appropriated funds for the necessary construction; but the Bureau of Budget cut them. Finally, in 1976, once the funding became secured and the way was cleared, construction of the Second Bacon Siphon was started and completed in 1980.[8] Completion of Second Bacon Siphon cost the state of Washington almost $15 million, which, given the non-completion of the project, eventually became a sunk cost.[9]

During 1984, when Reclamation started reviewing the development of the Second Half, initially there were two alternative proposals; one was the completion of the entire project and full development of the second-half lands, the second was the enlargement and extension of the East Low canal. The second alternative turned out to be the preferred option. When completed it would be able to irrigate 87,000 acres of land, mainly in the East District. Of course, a third alternative of "no further action" was considered as well.

[8] Grand Coulee: Harnessing a Dream, Pitzer, P.C. 1994.
[9] Whittlesy et al., Water Project Supply: How they Develop and Grow, Illahee, Vol. 11, 1&2, 1995.

Failure to complete the entire second phase (over 500,000 additional acres) was due to economic reasons. The second half would have required a huge amount of public investment. Some economic studies calculated that when the projected benefits from the proposed increased irrigation were compared with projected costs, the project might not pass a benefit-cost test. For example in 1982, Findeis and Whittlesey evaluated the economic viability of the completion of East High Project[10](EHP). They concluded, "if irrigation is undertaken in either the EHP or the HHH, and especially in EHP, development will need to be heavily subsidized by the public sector. In return, taxpayers will receive the additional output, employment, and income generated throughout Washington State. However, because of the competitive nature of water use in the state, the economic gains from the irrigation that could have been achieved in the past will be progressively eroded away if electricity rates increase in the future. As electricity energy becomes scarcer, public investment in other investment alternatives will most likely to be more beneficial to long-run economic growth in Washington State than irrigation development."[11]

Also in recent years legal issues regarding restoring and dealing with water rights have arisen. In 1993, at the request of Northwest Power Planning Council and National Marine Fisheries Service, the Bureau of Reclamation put on a moratorium and suspended the issuance of additional water service contracts and groundwater licenses. Since then, CBP's irrigated acreage remains at present levels. Recently the Bureau has lifted the 1993 moratorium, thus making it

[10] In their evaluation report they have also included HHH, Horse Heaven Hills along with EHP. However, in particular, they found economic feasibility for the completion of EHP is bleaker than HHH. "Project Completion Report, Competition between Irrigation and Hydropower water use in Washington State", J.L. Findeis & N. Whittlesey, 1982. OWRT Project Number: A-100-WASH.

[11] Page 192, Findeis & Whiilesey, 1982, OWRT Project Number: A-100-WASH.

possible for the Columbia Basin Project to compete with other claims on Columbia River water, such as the Tri-Cities and the Black Rock reservoir.

This brings us to the Odessa Sub-area. Irrigated farming in this area is primarily dependent on ground water usage, and because of this reliance on groundwater, the ground water levels in this area are dropping. In the following section we briefly outline the genesis of the ground water development in Odessa Sub-area.

Section B: earlier history of ground water usage

The irrigation network of Columbia Basin Project was the main source of surface water for the irrigation of the Central Washington region. However, since the 1960's, along with the development of the Columbia Basin Project, another type of irrigation technique using ground water from privately funded wells, also started to develop.

In 1945, the state of Washington enacted a law to regulate public groundwater (Chapter 90.44 RCW), which later in 1985, was revised to include provisions for identifying and designating groundwater management areas in order to protect groundwater quality, to assure groundwater quantity, and to effectively manage water resources to meet future needs (RCW 90.44.130 and 90.44.400). Also in 1985, the Department of Ecology (Ecology) publicized regulations (Chapter 173-100 WAC) to implement RCW 90.44.130 and 90.44.400. These regulations, revised in 1988, establish guidelines, criteria, and procedures for designating groundwater management areas.

Anticipating a ground water problem, in 1969, the state of Washington publicized a rule (Chapter 508-14 WAC) to curtail groundwater development in a defined area of the Columbia Basin project area known as the Quincy Basin, comprising mostly the north-west portion of the area under CBP. Following completion of the groundwater investigation, Ecology identified a "practical groundwater management unit in the Quincy Basin area" and in 1973 promulgated regulations (Chapter 173-124 WAC) to establish aerial boundaries and depth zones for that groundwater management unit. In 1988, WAC 173-124 was revised and the Quincy Groundwater Management Sub-area was formally designated.

Next to the selection of Quincy Basin unit, another groundwater management unit, the Odessa Groundwater Management Sub-area was subsequently designated by Chapter 173-128A WAC for the region of roughly 1800 sq. miles area under the Columbia Basin Project, commonly known as "Odessa Area" or "Odessa-Lind Area." The area extends from Odessa on the North to Lind on the South, and from the East Low Canal on the west to Ritzville on the East. This area is semi-arid with a higher precipitation on its Eastern side than that on its West. At the same time, the western part of this Odessa Area is bordering with the fully completed portion of Columbia Basin Project.

Besides the division of Quincy and Odessa Groundwater management, 508-14 WAC was then revised to define the boundaries of the area remaining in the Columbia Basin project outside the formally designated Quincy and Odessa Groundwater Management Sub areas (WAC 508-14-030 [3]). Instead of giving it any name, they designate the area by a number. The area then became

informally known as the 508-14. It occupies parts of Franklin, Grant, and Adams Counties, primarily the southern portion of CBP.

The early days of settlement in Odessa area could be traced back to 1880's, and while groundwater was used, its use was limited. Initially it was used primarily for domestic needs and stock uses and only later for irrigation. In earlier days most of the wells were, on average, 6 inch in diameters and were cased through the unsolicited materials overlying the basalt. The depth of penetration varied according to the water depth. In the coulees, the wells that penetrated only a few feet of basalt yielded enough water for all needs. While in the higher parts of the area, wells were drilled to the depths ranging from 100 to 200 feet. However, in Crab Creek Valley, because of the presence of sufficiently permeable saturated alluvium, shallow dug wells turned out to be good enough for all purposes. In the beginning, all these domestic wells were fitted with windmill powered plunger pumps and they were installed directly atop the casings, or bolted to concrete or plank foundations. Over time technology changed and people started replacing their old technology of windmill powered plunger pumps by the electric driven option and older pumps were replaced by submersible versions. Because most of these submersible pumps yield more water than the old plunger type, draw down in the wells became larger.[12]

Until the 1960's, dry land farming was practiced exclusively for wheat, when for the first time, through the use of Sprinkler technology wheat growers discovered the remarkable impact of supplementary water on crop yield. Since then, wells with diameters as great as 16 inches are drilled to a depth ranging from 200 to 700 feet. The pumps for these wells are run by an electric

[12] Page 2 & 13, Ground Water withdrawal in the Odessa Area, A. A. Garrett, USGS, Water Resource Division, 1968.

motor having power up to 200 HP. Generally, the large capacities "deep wells" are made for irrigation and "shallow wells" are for domestic purposes. However, sometimes because of the large yield found in some domestic wells, some irrigation wells were also located next to those domestic wells. Although the wells were expensive, the economic returns were high. Various reasons could be cited behind such economic gain. Electricity was cheap, an outcome of CBP, and the land quality, along with farming technique, resulted in high yields. Economic incentives to use groundwater became so lucrative that between the 1960's and the 1970's, pumpage of ground water increased almost tenfold (Table3).

Table 3. Ground Water Pumpage at Odessa Sub-area, in Acre-feet.

		Grand Ronde	Wanapum	Over Burdened unit	Total		Grand Ronde	Wanapum	Over Burdened unit	Total
1960	Adams	1,980	5,920	50	7,950	1970	16,480	34,190	0	50,670
	Franklin	100	1,800	0	1,900		700	3,450	0	4,150
	Grant	2,150	2,590	1,340	6,080		9,030	15,420	2,110	26,560
	Lincoln	1,430	2,400	100	3,930		15,840	9,360	550	25,750
		5,660	12,710	1,490	19,860		42,050	62,420	2,660	107,130
1975	Adams	49,560	46,360	0	95,920	1984	78,590	42,920	0	121,510
	Franklin	700	2,400	0	3,100		3,970	8,730	0	12,700
	Grant	17,910	18,520	1,150	37,580		26,350	17,970	370	44,690
	Lincoln	25,070	11,230	0	36,300		24,940	8,650	0	33,590
	Total	93,240	78,510	1,150	172,900		133,850	78,270	370	212,490

Source: D.R. Cline & C.A. Collins, Ground Water Pumpage from Columbia Plateau.

Ground water in the Odessa–Lind Area is part of a large system that covers much of east-central Washington. The groundwater moves slowly down gradient towards the southwest and toward the Columbia and Snake River. "Contrary to belief, surface water bodies to the North, such as Roosevelt Lake and Spokane River, cannot be the source of ground water because they are 600

to 900 feet lower than ground water levels on the plateau just to the south."[13] Most of the groundwater is contained within layered basalt rocks. These layers are generally dense and limit the vertical movement of water. However, between the layers, many porous zones occur that contain broken basalt or sediment. These zones permit the movement of the groundwater and yield water to most of the large production wells in the area. Pumping takes place during the 7 months in the spring, summer and fall, peaking during July and August and stops for the five winter months. Most of the replacement water, necessary for water level rise, moves into the area by lateral underground flow, which is slow depending upon the gravity and sometimes is restricted by the rock material through which the water flows.

Ground water pumpage, mostly for irrigation, increased from the central Washington project area, from about 25,000-acre feet of water in 1963 to about 387,000-acre feet in 1977, causing continuing water level declines in parts of the Odessa-Lind Area. The number of large capacity wells in the project area increased from 170 in 1963 to 618 in 1977. Few wells in 1967 were deeper than 1000 feet, but by 1977 many were deeper. Most of the water pumped in 1967 was from the wells tapping Wanapum Basalt, but by 1977 most was from wells tapping both the Wanapum Basalt and the underlying Grand Ronde Basalt aquifers.[14] In response to concerns regarding water level decline in 1968 Washington Department of Ecology (DOE) adopted a policy of deferring all new permits to drill new wells. However, after doing some economic and geological studies, in 1975 DOE revoked the existing ban on groundwater withdrawals[15] and started issuing new permits. Those permits were issued subject to the constraint that withdrawals

[13] Ground Water Survey, Odessa Lind Area, Luzier et al., WA State Department of Water Resources, Water- Supply Bulletin No. 36.
[14] Ground-water levels and pumpage in East-Central Washington, including the Odessa-Lind area, 1967 to 1981 / by Denzel R. Cline ; USGS in cooperation with the Washington State Department of Ecology.
[15] Page 13 &16, Report No. 27, Washington Water Research Center Report, Whittlesey et al. 1976.

of water were not to cause decline in the water level in excess of 10 feet per year, the limit suggested by 1974 DOE Study.

In general, the ground water in this area came from a big aquifer, underlying most of the area and was accessible from virtually any of the irrigable lands in the Odessa-Lind Area. Possibilities of effective recharging of water were assumed to be almost zero, and in fact, in the deeper aquifer water was estimated to be two to seven thousands years old, and pumping out of the deeper aquifer resulted in constant depletion of the water level.

However, over the years, Columbia Basin Project water and well irrigation together culminated into an interesting situation. Wells in some areas of the Odessa-Lind area dried up completely. At the same time, however, irrigation water coming through the network of canals and ditches built for the Columbia Basin project eventually infiltrated into the ground where it started commingling with natural groundwater.[16] The result of recharging was most pronounced in the southern side of 508-14 area, where the groundwater system throughout much of the basin now has a large component of "artificially stored" water that was not present before the Columbia Basin project began. According to a study conducted by the United States Geological Survey (USGS Water-Resources Investigations Report 96-4086),[17] the volume of groundwater in storage in the Pasco Basin, which includes the southern half of the 508-14 Area, has increased by approximately five million acre-feet since the project began. The vast majority of the increase is the result of seepage from water delivery canals and ditches and from infiltration of irrigation

[16] Report to the Legislature: Allocating Accumulated Columbia Basin Groundwater, DOE, 2002; George Schlender, John Covert, Keith Stoffel, http://www.ecy.wa.gov/pubs/0311002.pdf.
[17] Induced infiltration from the Rockaway River and water chemistry in a stratified-drift aquifer at Dover, New Jersey, Joel E. Dysart and Stephen J. Rheaume ; US DOI, USGS; 1999.

water, but groundwater levels have also risen locally within the Pasco Basin as a result of the formation of reservoirs behind dams constructed on the Columbia and Snake Rivers. USGS WRI Report 86-4086 includes estimates of the volumes of "naturally occurring" and "stored" groundwater in the Pasco Basin. It also includes data that demonstrates by the late 1980s, the volume of groundwater flowing into and out of the Pasco Basin (and the southern half of the 508-14 Area) had nearly reached equilibrium, and groundwater levels had essentially stabilized. The Columbia Basin project water imported into the Pasco Basin (and the southern half of the 508-14 Area) has resulted in some benefits, including an increase in the volume of water available for beneficial use and a decrease of nitrate concentrations in groundwater as a result of dilution. On the other hand, the imported irrigation water has raised groundwater levels throughout much of the Pasco Basin that has had some negative effects, including an increase in slope instability and a decrease in the amount of arable land as a result of water ponding in areas with poor drainage. In order to deal with allocation of groundwater that has accumulated as a result of the importation of surface water from the Columbia Basin project, in 2002, the Washington state legislature enacted SHB 2874 to amend Chapter 89.12 RCW, with the intent to authorize the Department of Ecology to enter into agreements with the United States Bureau of Reclamation (USBR) to allocate groundwater permits within the geographic area of the WAC 508-14. The legislature, through passage of SHB 2874, required Ecology to report annually in December on progress to implement the legislation.

The situation was complicated in the 1990s when the Bureau of Reclamation and the Washington State Department of Ecology both put moratoriums on new withdrawals from the Columbia River to protect fish under the federal Endangered Species Act. However, the moratoriums were

lifted in November 2003, and the push to gain access to the Columbia Basin Irrigation Project water gained momentum. According to local farmers, the deep wells draw down of the aquifer threatens the area and the long-term viability of the agriculture sector in the region.

The Columbia Basin includes more than 2,000 farms that grow more than 60 crops, including most of the state's potato production. The basin is a major producer of apples, grapes, hay, wheat and other grains, stone fruit, corn, mint and vegetables. The region is home to major processing plants that depend on the crops produced nearby. "The annual Farm Gate value of agriculture in the basin is estimated at about $3 billion, more than half of the nearly $5.8 billion value estimated for the entire state in 2003."[18] According to Senator Maria Cantwell, completion of the Second Phase project could cost $400 million and take several years. Funding is also critical to upgrade the project's existing infrastructure. Congressman Doc Hastings, R-Wash., has included $250,000 in a bill that includes Bureau of Reclamation's 2005 budget. The money is earmarked for an appraisal of the Odessa Sub-Area situation. Cantwell pledged her support on the Senate side. "Sen. Patty Murray, D-Wash., also supports the funding request," said Judy Olsen, Murray's Eastern Washington director. The federal funding, if approved, would be added to per-acre pledges from farmers and landowners in the region. According to Alice Parker, Columbia Basin Development League Executive Secretary in Moses Lake, the league hopes to raise $300,000 in private pledges and is well on the way towards its goal. According to the Columbia Basin Development League, switching to surface water would dramatically reduce demands on groundwater, which in turn will help to recharge the aquifer over time, allow farmers to diversify crops while stimulating the economy, attract new processors and create jobs.

[18] Senator Maria Cantwell's estimate, October 29, 2004, Peggy Steward, http://www.capitalpress.info/Main.asp?SectionID=67&SubSectionID=619&ArticleID=13186 .

There are approximately 170,000 total irrigated acres, which include 35,611[19] acres of irrigated potato land in this Odessa Sub-area. The ground water below this particular area is declining. Besides the water level issue among the growers in this region, "water rights issue" could also become a serious matter of concern. It may happen that the farmers may start taking legal action against each other in order to prevent water level declines in their own ground water, which they think is being caused by water usage in nearby fields. If farmers start moving to the courts the situation will be a loss-loss situation rather than a win-win. At the same time, DOE doesn't have enough manpower to keep an eye on the wells and water usage by the farmers. In order to make it a win-win situation, some would argue that additional extraneous water supply is necessary. Unless the potato growers of this area can find alternative sources of water, potato production in Odessa Sub-area could diminish or even cease to exist. The potato yield is high in this Odessa Sub-area and so is the quality. The economic returns on potato production are high. Potato production generates a considerable amount of income in this region. If potato production in the Odessa Sub basin were to stop, the economic impact on the entire economy may be significant. In the following section we will examine alternative possible economic impacts of such loss of potato production in the Odessa Sub area.

C1: The Columbia Basin Economy Including the Odessa Sub-Area

In order to determine the regional economic impact of possible potato production losses in Odessa Sub-area, we have chosen a local economic region comprising the four centrally-east located counties of Adams, Grant, Lincoln and Franklin. The reasons behind choosing a four-

[19] 35,611 acres of irrigated potato land comprises of some deep well land, which is actually, beyond the geographical map of Odessa Sub Area. Potato acreage estimate obtained from Paul Stoker of the Columbia Basin Ground Water Management Area.

county economy rather than isolating Odessa Sub-area for our economic impact analysis are twofold. First, Odessa Sub-area is contained within parts of the counties but the regional data are available only for county units. Second, there are various economic activities located beyond the Odessa Sub region, like potato processing, that are in the larger related region. If we chose only the Odessa Sub-area, the four-county economic activities that are taking place beyond this Odessa region, could not be counted, and in that case, the resultant economic impact would be understated. For example, potatoes that are produced in the Sub area are processed in plants largely outside the Sub area, but inside the four county regions. To examine the economic impact of potato production in the Sub area and the resulting potato processing, it was appropriate to examine the four county regional economies.

An economic impact analysis at regional level requires a detailed illustration of economic data at regional level, a proper economic methodology and a necessary tool to implement that methodology using those data sets. In this regard we have used an economic impact assessment modeling system known as IMPLAN. Apart from its operational flexibility, IMPLAN has a very reliable and detailed disaggregated state and county level data for up to 528 industries and commodities, featuring its employment, output, value added and institutional demand, which are some of the necessary elements to make regional social accounts complete. In addition, it shows the regional "Use Matrix" (matrix showing input absorption by these industries) and the corresponding regional "Make Matrix" (Matrix showing all primary and by-products produced in these industries) at the regional level. IMPLAN also gives detailed employee compensation by industry, indirect business tax, proprietary income and other property type income generated by

each industry in the regional economy. Basic demographic features, starting from the county level to national level, are also available from IMPLAN[20] data set.

Table 4. Basic Demographic Features, County and State level, State of WA.

	WA State	Adams	Franklin	Grant	Lincoln	4 Counties Total
Population	5,894,121	16,428	49,347	74,698	10,184	150,657
No. of HH	2,272,261	5,217	14,870	25,207	4,180	49,474
Personal Income ($M)	184,517.689	334.209	932.083	1,507.484	223.919	2,997.696
Average HH Income ($)	81,204	64,062	62,682	59,804	53,569	60,591
Average HH Size	2.59	3.15	3.32	2.96	2.44	3.05
Area (Sq. Miles)	66,581	1,925	1,242	2,676	2,311	8,155
Population/Sq. Mile	89	9	40	28	4	18

Data Source: IMPLAN, year 2000.

Table 4 shows basic demographic and income data for Washington State and the four counties in the regional economy. The average Household (HH) personal income is higher at the state level than it is in the county or regional level. At the regional level Personal Income is defined as "the income received by all persons from working (participating in production), from government and business transfer payments, and from interest, dividends and rent. Personal Income is the sum of net earnings by place residence, rental incomes of persons, personal dividend payments, personal interest income, and transfer payments. Examples of transfer payments are Social Security payments, Medicare payments, unemployment insurance payments and veterans' pensions. Personal income is measured before the deduction of personal income taxes and other personal taxes."[21]

[20] Minnesota IMPLAN Group, Inc.
[21] http://niip.wsu.edu/cgi-bin/broker.exe .

The local economy of four-counties has a more agrarian economic base, in comparison to the state level economy (2000 data, source: IMPLAN). While 36.44% of total employees (Table 5a and Table 5b) of the Local economy are involved in Agriculture and food related sectors, the corresponding figure for the overall State level is only 12.55%.

Table 5a. Overall Pattern of Industry Output, Employment etc.,(Regional Level).

4 Counties	Industry Output (m$)	Employment	% of Total Counties employment	Employee Compensation (m$)	% of Total employee Compensation	Average Wage ($)	Total Value Added (m$)	% of Total Value Added
1. Farm Products	1,336	14,073	17.70	115.18	6.55	8,185	384	11.48
2. Other Agricultural related	219	5,430	6.83	45.39	2.58	8,359	157	4.69
3. Food Processing	1,112	4,243	5.34	156.69	8.91	36,931	280	8.38
4. Other food related	181	5,223	6.57	73.53	4.18	14,076	120	3.58
Food & Agriculture (1-4)	2,848	28,970	36.44	390.79	22.21	13,490	940	28.13
Rest of the Economy	3,981	50,539	63.56	1,369	77.79	27,082	2,403	71.87
Total	6,829	79,509	100.00	1,759.47	100.00	22,129	3,343	100.00

Table 5b. Overall Pattern of Industry Output, Employment etc., (State Level).

WA State	Industry Output (m$)	Employment	% of Total Counties employment	Employee Compensation (m$)	% of Total employee Compensation	Average Wage ($)	Total Value Added (m$)	% of Total Value Added
1. Farm Products	4,766	71,092	1.98	896.10	0.69	12,605	1,863	0.87
2. Other Agricultural related	3,450	66,023	1.84	783.63	0.60	11,869	2,589	1.20
3. Food Processing	10,277	42,409	1.18	1,571.97	1.21	37,067	2,652	1.23
4. Other food related	11,623	270,280	7.54	4,993.95	3.84	18,477	7,807	3.63
Food & Agriculture (1-4)	30,116	449,804	12.55	8,245.65	6.34	18,332	14,912	6.94
Rest of the Economy	341,553	3,133,146	87.45	121,863	93.66	38,895	200,067	93.06
Total	371,669	3,582,950	100.00	130,108.52	100.00	36,313	214,978	100.00

Data Source for Table 5A & B: IMPLAN, Year 2000.

Besides employment generation, agriculture and food related sectors are also very important for trade reasons. The region is a significant exporter of agriculture and food related products (Table 6).

Table 6. Overall Trade Pattern.

4 Counties, Year 2000	Total Exports (m$)	Total Imports (m$)	Trade Balance (m$)
Farm Products	873.18	166.61	706.58
Greenhouse and Nursery Products	18.25	2.59	15.66
Forestry Products	2.12	2.38	-0.26
Agricultural- Forestry- Fishery Services	0.36	14.65	-14.29
Landscape and Horticultural Services	0.07	5.37	-5.31
Food Processing	1,078.22	296.95	781.27
4 Counties Total (inclusive of rest of the economy)	**3,127.56**	**3,513.21**	**-385.65**

Source: IMPLAN, Year 2000.

Potato production is one of the most important agricultural crops in the Odessa Sub-area. Over 35, 000 acres of land in this region are used for potato production. The yields are above the state average. The quality of potato is high and virtually all of these potatoes go to potato processing plants and are made into frozen potato products. Potatoes grown in this area can be stored in the raw form for many months allowing potato-processing plants to operate on a year-around basis. Potatoes grown in other areas of the Columbia Basin, on the lighter soils and older ground tend to have a shorter storage life and are used first by the processing plants.

In the following section we will determine the economic consequences on the entire four county regional economy resulting from potential losses in potato production in the deep well area. We will measure the potential loss of regional sales and regional employment including ripple effects if production ceases on 35,000 acres of potatoes.

The economic impact will be summarized for three alternative scenarios. In scenario 1, production in the sub-area is assumed to be replaced by increased potato production elsewhere in the project area. From a regional impact perspective there is virtually no change in regional

income and employment. In scenario 2, we assume that potatoes formerly produced in the Odessa Sub basin are replaced by potatoes outside the region such as Benton, Walla Walla or Umatilla counties, so that potato processing in the region is not affected, but total potato production in the region is reduced. In scenario 3 we assume that the loss of potato production in the Odessa Sub basin cannot be replaced by production in any other region or county and this leads to the loss of processing of those potatoes into frozen potato product in the four-county region. In this scenario the regional economic impact of the lost potato production is most damaging to the regional economy.

Just how the region would react to the hypothetical reduction in sub-area potato production is a matter of some uncertainty. That is why we have included the three alternative scenarios. In the real world, the process of adjustment would involve the ability of growers to grow potatoes in different regions of the Columbia basin or in other counties that fit the needs of the processors. Also important would be the ability of the processors to adjust their production process to potato quality differences and still earn an acceptable return. Experience has shown growers have considerable ability to adapt to new situations by adjusting production methods, varieties grown and location of production.

C2: Economic Impacts

In a regional economy, production loss in any industry has two major impacts on that economy. First, a loss occurs in the payments that the industry pays to buy the intermediate inputs such as fertilizer and fuel. This could be considered as payment to the inputs or the monetized value of gross absorption. At the same time, industry loses payment to the primary inputs, which are

capital and labor, or the "value-added" impact. In our case, value-added impacts are comprised of four factors, Indirect Business taxes, Property incomes, Proprietary income and Employee Compensation.

Under the above circumstances, the regional economic impact mainly consists of two major effects – direct and secondary.

Direct effects: the changes in economic activity that takes place in the directly affected industry. For our case, this involves the impacts on the potato industry.

Secondary effects: these changes in economic activity emanate from the subsequent ripple effect of changes in directly affected industry spending. There are two types of secondary effects – indirect and induced.

Indirect effects are the changes in sales, income, or employment within the region connected through "backward-link" to the industry of concern. These "backward-linked" industries are those who supply goods and services to our direct industry. For example, the decreased sales of the fertilizer industry or the drop in agricultural services resulting from a decreased production in the potato industry.

Induced effects reflect the change in sales within the region resulting from changes in household spending of the income earned in potato and supporting industries. Employees in the potato industry and the supporting industries base their consumption spending on the income they earn from these industries.

Scenario 2 The Economic Impact of The Loss of 35,600 Acres of Potato Production on the Region

In the Odessa Sub-area, roughly 35,600 acres of land are being farmed for potato production. On average, the yearly yield is 595 Cwt/Acre (Table 7).

Table 7. Odessa Sub-basin, Potato Data.

YIELD	cwt/acre					
		2000	2001	2002	2003	Ave
	Adams	610	590	580	585	591
	Grant	610	600	605	580	600
	Lincoln	630	610	620	600	615
	Franklin	605	590	550	555	576

Source: Washington Agricultural Statistics Service Annual Bulletin 'Acreage, Yield & Production by Counties 2000-2003 (Provided by Dennis Conley, Dennis Conley LLC).

The 4-year weighted average yield for Odessa Sub basin is 595 cwt/acre.[22] Thus there will be an average loss of 21,188,545 cwt of potato production, if the entire 35,600 acres of potato-land ceases to have any irrigation. If we consider the usual 8% tare and shrink, we will then be left with 19,493,400 cwt of potatoes, the market value of which, at the assumed rate of $5/cwt will be equal to $97.46 million ($97,467,300). If the entire 35,600-acre of land goes dry, then the first shock that we will have on our local economy is the loss of this $97.5 million from producers' side. In addition, the production of $97.5 million worth of potatoes is associated with an additional $21 million worth of handling and storage and almost $5 million worth of trucking businesses. Thus, there will be a loss of almost $119 million of direct sales in the local

[22] Figure provided by Dennis Conley, L.L.C.

economy. We consider this loss as the direct impact of zero potato production over 35,600 acres of land.

If we look at the production function of Potato industry (Table8), from the IMPLAN economic model then we can see that $1 worth of potato production generates $0.14/$ of value-added income and makes $0.86/$ as its input payments. Throughout our analysis we are assuming constant return to scale technology in potato production. Following this, we can get an equi-proportionate scaled up effect on the input payment and value-added income that resulted from the loss of $97 million of business in potato production. Among all input payments, from Table 8, we can see the major impacts will be on agricultural services, fertilizer industry and agricultural chemical industry. However, impact on the agricultural chemical industry won't be felt to a great extent at least at the local regional level, since the majority of its supply is being provided by out-of-the-region suppliers (as seen in Table 8 the corresponding RPC[23] for agricultural chemicals is only 0.008). On the value-added side, there will be a loss of $6 million in property income. Employee compensation is relatively insignificant in comparison to the total output. Later we will show that in the potato processing industry employee compensation is much higher.

[23] The Regional Purchase Coefficients (RPCs) indicates the portion of the regional demand for goods and services that is met by regional production. Usually, as the region size increases, the value of RPC also increases. An RPC 1.00 indicates entire local demand is being met by local supply, while on the other, RPC 0.0 indicates entire demand is met through imports.

Table 8. Potato Production Function ($97.47 Million), Commodity Demand and Input Payments.

Commodity Code	Description	Gross Absorption Coefficient	Gross Inputs ($m)	RPC	Reg Abs Coef	Regional Inputs ($m)
26	Agricultural- Forestry- Fishery Services	0.04545	4.430	0.686	0.031	3.038
189	Inorganic Chemicals Nec.	0.03235	3.153	0.103	0.003	0.326
202	Nitrogenous and Phosphatic Fertilizers	0.07847	7.648	0.017	0.001	0.131
204	Agricultural Chemicals- N.E.C	0.14973	14.593	0.008	0.001	0.121
209	Chemical Preparations- N.E.C	0.00036	0.035	0.541	0.000	0.019
210	Petroleum Refining	0.00954	0.929	0.006	0.000	0.005
309	Farm Machinery and Equipment	0.01705	1.662	0.078	0.001	0.129
433	Railroads and Related Services	0.00592	0.577	0.721	0.004	0.416
435	Motor Freight Transport and Warehousing	0.08898	8.672	0.739	0.066	6.411
436	Water Transportation	0.00048	0.047	0.199	0.000	0.009
437	Air Transportation	0.00021	0.021	0.462	0.000	0.010
438	Pipe Lines- Except Natural Gas	0.00009	0.009	0.275	0.000	0.002
443	Electric Services	0.01880	1.832	0.916	0.017	1.679
445	Water Supply and Sewerage Systems	0.01429	1.392	0.416	0.006	0.579
447	Wholesale Trade	0.07606	7.413	0.582	0.044	4.311
451	Automotive Dealers & Service Stations	0.00002	0.002	0.950	0.000	0.002
456	Banking	0.04005	3.903	0.608	0.024	2.371
459	Insurance Carriers	0.00108	0.105	0.071	0.000	0.007
462	Real Estate	0.16919	16.489	0.329	0.056	5.428
473	Equipment Rental and Leasing	0.00038	0.037	0.561	0.000	0.021
18	Potato Seeds (Vegetable Sector)	0.11241	10.956	0.853	0.096	9.346
	Total Commodity Demand	0.86091	83.90		0.35	34.36

Value-Added	Coefficients	Inputs($M)
Employee Compensation	0.0751	7.315
Proprietary Income	0.0000	0.000
Other Property Income	0.0608	5.926
Indirect Business Taxes	0.0032	0.315
Total Value Added	**0.1391**	**13.556**

Production Function Source: The Economic Impact of Potato in Washington State, Masters Thesis of Nick Beleiciks, WSU, 2005.

If $97 million worth of potato production is eliminated from the Odessa Sub-area, as an indirect effect, this production loss will eventually have a negative impact on the regional industries that supply the commodities as required inputs to the potato industry.

Reduction in the production of Potato industry	→	Reduction in the commodity demand for inputs in Potato industry
Reduction in the production of all the industries that produce the inputs demanded by Potato Industry	→	Reduction in the commodity demand for the inputs in these input-supplying industries to Potato Industry and so on

As we have mentioned earlier, along with the production loss in Potato industry, there are also two other industries that will be affected directly. One of them is the Transport industry (trucking, motor freight, etc.), and the other is the Wholesale Trade Industry (handling and storage). However, for both these industries, not all of the associated production supplies are generated within the four-county region. In fact, following IMPLAN's estimate, roughly 74% of trucking services ($3.6m out of $4.87m dollar) is provided by within-region suppliers, and 58% of wholesale trade ($12.75m out of $21.93m) related to the potato industry is controlled by regional business.

The total (direct, indirect and induced) impact on the regional economy is a loss of $179.65 million of regional sales (Table 9). This represents the annual loss in total regional sales compared to the baseline regional economy that stems from the hypothesized loss in potato production. The economic impact can also be measured in terms of jobs. There is an estimated loss of almost 1136 jobs in the regional economy (Table 10), which is roughly 1.328% of the total employment (85,532) of the regional economy. In our earlier analysis (Table 3), we discussed the way a continuum of production losses manifest, starting from the main industry

and later, rippled throughout all the industries connected with the main industry and the input supply chains. In a similar fashion, the value-added (regional income) is also going to be changed. The estimated loss in regional income (Value Added) is roughly $54.26 million (Table 11). Value Added includes the loss of labor income plus capital income plus indirect business taxes. The change in value-added is a proxy for the change in gross domestic product for the region.

Table 9. Output Impact (Potato).

		Output Impact			
Industry Code	Industry[24]	Direct ($)	Indirect ($)	Induced ($)	Total ($)
1	Agriculture	0	-14,231,835	-291,721	-14,523,556
28	Mining	0	-782	-71	-853
48	Construction	0	-584,751	-134,537	-719,287
58	Manufacturing	0	-1,199,381	-365,427	-1,564,808
433	Railroads and Related Services	0	-499,108	-21,669	-520,777
434	Local, Interurban Passenger Transit	0	-5,369	-12,336	-17,705
435	Motor Freight Transport and Warehousing	-3,603,067	-8,441,200	-160,769	-12,205,034
436	Water Transportation	0	-13,256	-4,113	-17,369
437	Air Transportation	0	-100,117	-78,874	-178,991
438	Utilities and other Communications	0	-655,850	-183,499	-839,349
447	Wholesale Trade	-12,753,501	-5,514,255	-508,307	-18,776,064
448	Other Trade	0	-154,812	-1,822,184	-1,976,996
450	Food Stores	0	-6,423	-357,598	-364,021
456	Financial & other banking Services	0	-8,565,906	-2,350,118	-10,916,024
463	Services	0	-2,453,320	-3,153,642	-5,606,962
510	Government	0	-2,919,593	-565,910	-3,485,503
516	Other	0	0	-18,260	-18,260
530	Potatoes	-97,467,304	0	-1,030	-97,468,336
533	Frozen Potatoes	0	0	-3,373	-3,373
10,001	Institutions (inclusive of imports)	-10,446,941	0	0	-10,446,941
	Total	-124,270,813	-45,345,957	-10,033,436	-179,650,207

[24] In Tables 9, 10, and 11 reported industries are aggregated. Details of industry aggregation are given in Appendix 2.

Table 10. Employment Impact (Potato).

		Employment Impact			
Industry Code	Industry	Direct	Indirect	Induced	Total
1	Agriculture	0	-217	-3	-221
28	Mining	0	0	0	0
48	Construction	0	-8	-2	-10
58	Manufacturing	0	-7	-2	-9
433	Railroads and Related Services	0	-3	0	-3
434	Local, Interurban Passenger Transit	0	0	0	0
435	Motor Freight Transport and Warehousing	-33	-77	-1	-112
436	Water Transportation	0	0	0	0
437	Air Transportation	0	-1	-1	-2
438	Utilities and other Communications	0	-3	-1	-4
447	Wholesale Trade	-149	-65	-6	-220
448	Other Trade	0	-4	-50	-54
450	Food Stores	0	0	-9	-10
456	Financial & other Banking Services	0	-61	-8	-69
463	Services	0	-46	-63	-109
510	Government	0	-10	-2	-12
516	Other	0	0	-2	-2
530	Potatoes	-301	0	0	-301
533	Frozen Potatoes	0	0	0	0
10,001	Institutions (inclusive of imports)	0	0	0	0
	Total	-483	-503	-150	-1,136

Table 11. Value-added Impact (Potato).[25]

		Value-added Impact			
Industry Code	Industry	Direct ($)	Indirect ($)	Induced ($)	Total ($)
1	Agriculture	0	-6,622,651	-90,251	-6,712,902
28	Mining	0	-346	-40	-386
48	Construction	0	-367,286	-68,611	-435,897
58	Manufacturing	0	-383,707	-84,263	-467,970
433	Railroads and Related Services	0	-233,811	-10,151	-243,962
434	Local, Interurban Passenger Transit	0	-3,294	-7,568	-10,862
435	Motor Freight Transport and Warehousing	-1,560,149	-3,655,089	-69,614	-5,284,851
436	Water Transportation	0	-2,756	-855	-3,611
437	Air Transportation	0	-58,706	-46,250	-104,956
438	Utilities and other Communications	0	-407,760	-109,208	-516,968
447	Wholesale Trade	-8,716,178	-3,768,630	-347,395	-12,832,203
448	Other Trade	0	-100,292	-1,224,557	-1,324,850
450	Food Stores	0	-5,841	-325,231	-331,072
456	Financial & other Banking Services	0	-5,916,152	-1,683,981	-7,600,133
463	Services	0	-1,447,726	-1,893,919	-3,341,645
510	Government	0	-1,230,233	-248,249	-1,478,481
516	Other	0	0	-18,030	-18,030
530	Potatoes	-13,557,035	0	-143	-13,557,178
533	Frozen Potatoes	0	0	-1,040	-1,040
10,001	Institutions (inclusive of imports)	0	0	0	0
	Total	-23,833,362	-24,204,278	-6,229,357	-54,266,996

Scenario 3: The Loss of 35,600 Acres of Potatoes and Associated Loss from the Frozen-potato Processing Industry:

There are large frozen-potato processing industries situated in and around the Odessa Sub-area. These industries depend on raw potatoes as their primary input. In the first scenario we assumed

[25] Source for Table 9,10 & 11: Impact analysis based on IMPLAN Data Source, Year 2000.

that these industries wouldn't be affected because as their input supply as the potatoes from the Odessa Sub-area goes down that supply is replaced by potato production elsewhere in the Basin. In the second scenario, as potato supply from the Odessa Sub-area goes down it is assumed that supply is replace by potato production elsewhere in Washington or possibly in Oregon. The regional economy experiences a loss of income and employment from the loss of potato production, but not from frozen-potato processing. But this may be an unreasonable assumption, especially given the locational advantages of production in the Sub-area. In our third scenario we assume that these processing industries, if potato production ceased to occur in the Odessa Sub area, are unable to replace potato production lost from the Sub-area and have to reduce their production as a result.

The potatoes produced in the Odessa Sub-area are high in quality, high in dry matter (specific gravity), which is a requirement for frozen-potato products and are very desirable as they are suitable for long term storage, so virtually all the potatoes grown in the area are utilized by this industry. From our earlier figure, we have seen an average 21 million Cwt of potatoes are produced. The input-output production function (Table 12) for frozen product transforms the value of the raw potato into approximately $324.891million worth of frozen-potato product at the factory gate.[26]

[26] Production Function source: The Economic Impact of Potato Production and Processing in Washington State, Masters Thesis by Nick Beleiciks, WSU, 2005.

Table 12. Value of Frozen Potato Product.

Total 4 county (in Odessa Sub-Area) Potato Production	21,188,545 Cwt
8% tare	1,695,084 Cwt
Remaining after 8% tare	19,493,461 Cwt
Value of potato after 8% tare @ $5 /Cwt	$ 97.46 Million
Value of Frozen Potato	$ 324.891 Million
Railroad business associated with frozen potato product	$ 7.49 Million
Trucking business associated with frozen potato product	$40.81 Million
Wholesale Trade associated with frozen potato product	$ 26.66 Million

Assuming the entire acreage of potato land went dry, the initial direct impact would be a loss of $324 million of frozen potato product sales. Additionally, $40 million of trucking business, $7.5 million of railroad business, and $27 million of wholesale trade business are directly associated with the frozen-potato industry's loss of production. Following the IMPLAN estimate, 72% of railroad service, 74% of trucking and 58% of wholesale business is being locally supplied.

Unlike the Potato Industry, the frozen-potato product industry generates more employee-compensation in its value-added (Table13). For every dollar worth of sales in this industry, it makes a payment of $.13 for employee compensation, while in potato industry, the corresponding figure is only $.07. Quite naturally, the potato is the main input for frozen-potato product industry. It constitutes almost 30% of the required input cost for the frozen product industry. We have assumed all potatoes for the frozen-potato industry are locally supplied. Thus $97 million of potatoes as input into the frozen product industry generate $324 million of frozen industry production.

Table 13. Frozen-potato Production Function ($324.891 Million), Commodity Demand & Input Payments.

Commodity Code	Description	Gross Absorption Coefficient	Gross Inputs ($m)	RPC	Reg Abs Coef	Regional Inputs ($m)
72	Flour and Other Grain Mill Products	0.00782	2.540	0.0046	0.0000	0.0117
81	Sugar	0.00817	2.653	0.0142	0.0001	0.0376
90	Shortening and Cooking Oils	0.09560	31.059	0.0038	0.0004	0.1172
103	Food Preparation-N.E.C	0.00570	1.854	0.1050	0.0006	0.1946
122	Cordage and Twine	0.00464	1.508	0.0000	0.0000	0.0000
164	Paperboard Containers and Boxes	0.04618	15.005	0.0807	0.0037	1.2104
167	Bags - Plastic	0.02077	6.748	0.0000	0.0000	0.0001
168	Bags - Paper	0.02596	8.435	0.0000	0.0000	0.0001
189	Inorganic Chemicals - N.E.C	0.00789	2.564	0.1035	0.0008	0.2653
205	Adhesives and Sealants	0.00457	1.484	0.0043	0.0000	0.0064
209	Chemical Preparations - N.E.C	0.00573	1.863	0.5414	0.0031	1.0084
433	Railroads and Related Services	0.00221	0.718	0.7210	0.0016	0.5177
435	Motor Freight Transport and Warehousing	0.04413	14.336	0.7393	0.0326	10.5993
436	Water Transportation	0.00032	0.103	0.1992	0.0001	0.0206
437	Air Transportation	0.00015	0.048	0.4621	0.0001	0.0224
443	Electric Services	0.04430	14.392	0.9163	0.0406	13.1870
444	Gas Production and Distribution	0.03433	11.153	0.0281	0.0010	0.3139
445	Water Supply and Sewerage Systems	0.01343	4.365	0.4158	0.0056	1.8147
446	Sanitary Services and Steam Supply	0.00276	0.895	0.8929	0.0025	0.7995
447	Wholesale Trade	0.01414	4.592	0.5816	0.0082	2.6707
476	Detective and Protective Services	0.00276	0.895	0.5607	0.0015	0.5021
530	Potato	0.30000	97.467	1.0000	0.3000	97.4673
	Total Commodity Demand	0.69155	224.68		0.4025	130.77

Value Added	Coefficients	Inputs ($M)
Employee Compensation	0.12800	41.587
Proprietary Income	0.00000	0.000
Other Property Income	0.16597	53.923
Indirect Business Taxes	0.01448	4.704
Total Value Added	**0.3085**	**100.214**

Frozen potato production Function Source: The Economic Impact of Potato in Washington State, Masters Thesis, School of Economic Sciences, W.S.U. Nick Beleiciks, 2005.

Apart from raw-potato, “electric service” is one of the major locally supplied inputs for frozen-potato industry. Paperboard container and boxes is another important input for this industry. Though “shortening and cooking oil” is quite an important input for the frozen industry, the RPC for “shortening and cooking oil” is almost zero (0.0038) indicating that most of the cooking oil is not produced locally.

Table 14. Output (Sales) Impact (Frozen-potato Product).

		Output Impact			
Industry Code	Industry[27]	Direct ($)	Indirect ($)	Induced ($)	Total ($)
1	Agriculture	0	-14,425,147	-1,007,244	-15,432,391
28	Mining	0	-2,701	-244	-2,945
48	Construction	0	-1,982,841	-464,231	-2,447,073
58	Manufacturing	0	-5,869,170	-1,277,237	-7,146,407
433	Railroads and Related Services	-5,587,692	-1,544,187	-74,788	-7,206,666
434	Local, Interurban Passenger Transit	0	-15,182	-42,568	-57,751
435	Motor Freight Transport and Warehousing	-30,173,464	-25,918,224	-555,137	-56,646,824
436	Water Transportation	0	-49,089	-14,190	-63,279
437	Air Transportation	0	-253,007	-272,146	-525,153
438	Utilities and other Communications	0	-3,021,683	-633,254	-3,654,937
447	Wholesale Trade	-15,503,992	-9,647,912	-1,754,603	-26,906,508
448	Other Trade	0	-469,482	-6,286,738	-6,756,220
450	Food Stores	0	-20,860	-1,233,995	-1,254,855
456	Financial & other Banking Services	0	-9,951,724	-8,108,113	-18,059,838
463	Services	0	-7,089,544	-10,881,645	-17,971,190
510	Government	0	-17,828,276	-1,953,101	-19,781,378
516	Other	0	0	-62,969	-62,969
530	Potatoes	0	-97,467,288	-3,486	-97,470,776
533	Frozen Potatoes	-324,891,008	0	-11,640	-324,902,656
10,001	Institutions (inclusive of imports)	-23,955,924	0	0	-23,955,924
	Total	-400,112,080	-195,556,318	-34,637,329	-630,305,739

[27] For tables 14, 15 and 16 we use the same industry aggregation that we have used earlier.

From Table 14, we see that there will be an approximate loss of $630 million of sales in the regional economy. This includes the roughly $325 million of frozen product at the factory gate plus transportation and marketing charges that bring the total direct effect to roughly $376 million exclusive of imports ($23.9 million). Indirect effects include the inputs necessary to produce the frozen product including for example $97 million of potatoes (Table 14).

Table 15. Employment Impact (Frozen-potato Product)

		Employment Impact			
Industry Code	Industry	Direct	Indirect	Induced	Total
1	Agriculture	0	-220	-12	-232
28	Mining	0	0	0	0
48	Construction	0	-30	-5	-35
58	Manufacturing	0	-29	-6	-35
433	Railroads and Related Services	-34	-9	0	-43
434	Local, Interurban Passenger Transit	0	0	-1	-1
435	Motor Freight Transport and Warehousing	-276	-237	-5	-518
436	Water Transportation	0	0	0	0
437	Air Transportation	0	-2	-3	-5
438	Utilities and other Communications	0	-13	-3	-16
447	Wholesale Trade	-182	-113	-21	-315
448	Other Trade	0	-12	-173	-185
450	Food Stores	0	-1	-33	-33
456	Financial & other Banking Services	0	-73	-26	-99
463	Services	0	-137	-216	-353
510	Government	0	-42	-8	-50
516	Other	0	0	-6	-6
530	Potatoes	0	-301	0	-301
533	Frozen Potatoes	-1,421	0	0	-1,421
10,001	Institutions (inclusive of imports)	0	0	0	0
	Total	-1,912	-1,220	-518	-3,650

Table 16. Value-added Impact (Frozen-potato Product).[28]

		Total Value Added Impact			
Industry Code	Industry	Direct ($)	Indirect ($)	Induced ($)	Total ($)
1	Agriculture	0	-6,697,573	-311,522	-7,009,095
28	Mining	0	-1,111	-139	-1,249
48	Construction	0	-1,315,367	-236,777	-1,552,144
58	Manufacturing	0	-1,703,241	-293,328	-1,996,570
433	Railroads and Related Services	-2,617,594	-723,385	-35,035	-3,376,014
434	Local, Interurban Passenger Transit	0	-9,314	-26,115	-35,429
435	Motor Freight Transport and Warehousing	-13,065,285	-11,222,742	-240,378	-24,528,406
436	Water Transportation	0	-10,204	-2,950	-13,154
437	Air Transportation	0	-148,358	-159,580	-307,937
438	Utilities and other Communications	0	-2,093,444	-376,881	-2,470,325
447	Wholesale Trade	-10,595,957	-6,593,713	-1,199,156	-18,388,826
448	Other Trade	0	-307,968	-4,224,877	-4,532,845
450	Food Stores	0	-18,972	-1,122,304	-1,141,276
456	Fire	0	-6,807,633	-5,809,794	-12,617,427
463	Services	0	-4,361,798	-6,535,063	-10,896,860
510	Government	0	-7,628,107	-856,765	-8,484,872
516	Other	0	0	-62,178	-62,178
530	Potatoes	0	-13,557,033	-485	-13,557,518
533	Frozen Potatoes	-100,213,824	0	-3,590	-100,217,416
10,001	Institutions (inclusive of imports)	0	0	0	0
	Total	-126,492,660	-63,199,961	-21,496,915	-211,189,540

The total job loss in the regional economy is estimated to be roughly 3650 jobs (Table 15). Value-added or regional income is also changed resulting from the loss in frozen-potato product industry. The estimated total loss in total regional income is roughly $211 million (Table 16).

[28] Source for Table nos. 14,15 & 16: Economic analysis based on IMPLAN data, Year 2000.

Alternative use of the Land Impact:

If potato production on over 35,000 acres of land disappears, the impact analysis indicates that the region would experience a loss in total sales of $179 million as well as the accompanying loss in jobs (Tables 10 and 11). However, through alternative land usage some of the forgone economic activity could be recovered. Non-irrigated wheat production is one likely possibility to replace the lost potato production. In fact, starting from the very early days of farming in this region, dry land wheat was one of the major crops.

The average Non-irrigated yield (of All Wheat) over the last five years for this 4-county region is 45 Bushels/Acre.[29] However, in this region farmers can only use a summer-fallow rotation to produce wheat. This means, effectively two acres of land are used to product one acre of crop. The average price received for All-wheat over the last five years in WA State is $3.26/Bushel. Assuming that price, the total production value of wheat on 35,600 acres would be $ 2,616,874 (had there been no summer-fallow restriction it would have been a $5,233,749 worth of wheat production). There are also other businesses associated with wheat production through the forward-linkages. Two major businesses are Marketing (storage and handling) and Transportation (trucking and shipping). For Storage and Handling, the rate varies from $.02-.05/Bushel and in the "trucking and shipping" industry, it costs on average, $.30-.35 /Bushel to ship from Eastern WA to Portland, OR.[30] Thus, we will have $40,062 (@ $.05/Bushel) worth of "Storage and Handling" business, and $240,374 (@ $.30/Bushel) for the Trucking business, directly

[29] There is Spring-Wheat as well as Winter Wheat in WA State. We took the combination of these two, referred as All Wheat. Data Source: http://www.nass.usda.gov/wa/coest/whtco04.pdf (Wheat Production, Yield, County wise, WA state 99 –'03).

[30] This rate is a rough estimate, given by Dr. Eric Jessup, School of Economic Sciences, Washington State University, Pullman, WA 99164-6210.

associated $2.6 million of wheat production. Tables 17, 18 and 19 show the respective output, employment and value-added impact of such alternative wheat production.

Table 17. Output Impact (Wheat)

Industry	Direct ($)	Indirect ($)	Induced ($)	Total ($)
Agriculture	0	93,275	8,034	101,309
Potato	0	1	0	1
Wheat	2,616,874	14,099	202	2,631,176
Mining	0	42	2	44
Frozen Potato Products	0	1	0	2
Construction	0	37,574	4,299	41,873
Manufacturing	0	23,538	10,405	33,943
Transportation	33,573	106,052	14,596	154,221
Trade	182,645	247,707	83,446	513,798
Financial Service	0	177,301	70,758	248,059
Services	0	81,411	93,115	174,525
Government	0	32,358	17,214	49,572
Other	0	0	533	533
Institutions (inclusive of imports)	64,218	0	0	64,218
Total	**2,897,310**	**813,359**	**302,605**	**4,013,274**

Table 18. Employment Impact (Wheat)[31]

Industry	Direct	Indirect	Induced	Total
Agriculture	0	3	0	3
Potato	0	0	0	0
Wheat	40	0	0	40
Mining	0	0	0	0
Frozen Potato Products	0	0	0	0
Construction	0	1	0	1
Manufacturing	0	0	0	0
Transportation	0	1	0	1
Trade	2	3	2	7
Financial Service	0	1	0	2
Services	0	1	2	3
Government	0	0	0	0
Other	0	0	0	0
Institutions (inclusive of imports)	0	0	0	0
Total	**42**	**11**	**5**	**58**

Table 19. Value Added Impact (Wheat)

Industry	Direct ($)	Indirect ($)	Induced ($)	Total($)
Agriculture	0	54,897	2,469	57,366
Potato	0	0	0	0
Wheat	939,235	5,060	73	944,368
Mining	0	26	1	27
Frozen Potato Products	0	0	0	0
Construction	0	25,126	2,245	27,371
Manufacturing	0	6,892	2,452	9,345
Transportation	14,537	49,089	7,631	71,258
Trade	124,826	169,192	58,740	352,757
Financial Service	0	123,628	50,669	174,298
Services	0	47,134	55,843	102,977
Government	0	13,859	7,503	21,361
Other	0	0	526	526
Institutions (inclusive of imports)	0	0	0	0
Total	**1,078,598**	**494,905**	**188,152**	**1,761,655**

[31] Source for Table nos. 17,18 & 19: Economic analysis based on IMPLAN data, Year 2000.

Certainly, $4 million of total sales generation is quite a low recovery given the loss in regional sales that would occur due to the closing down of potato production in the Odessa Sub-area. In our preceding impact analysis the value of the regional sales loss is $179 million. Table 20 indicates the net result. The loss in regional income associated with shifting from potatoes to dry land wheat is roughly $52 million per year (Table 20).

Table 20. Net Result from Scenario 2.

	Output Impact			
	Direct ($)	Indirect ($)	Induced ($)	Total ($)
Losses stemming from Potato Production	-124,270,813	-45,345,957	-10,033,436	-179,650,207
Gain from alternative Wheat Farming	2,897,310	813,359	302,605	4,013,274
Net Loss	-121,373,503	-44,532,598	-9,730,831	-175,636,933
	Employment Impact			
	Direct	Indirect	Induced	Total
Losses stemming from Potato Production	-483	-503	-150	-1,136
Gain from alternative Wheat Farming	42	11	5	58
Net Loss	-441	-492	-145	-1,078
	Value Added Impact			
	Direct ($)	Indirect ($)	Induced ($)	Total ($)
Losses stemming from Potato Production	-23,833,362	-24,204,278	-6,229,357	-54,266,996
Gain from alternative Wheat Farming	1,078,598	494,905	188,152	1,761,655
Net Loss	-22,754,764	-23,709,373	-6,041,205	-52,505,341

Summary and Conclusions:

Essentially an economic impact analysis helps us to trace a particular economic shock on the economy and measure the cumulative effects of that shock. In our case the economic shock is the possible loss of potato production from the deep wells in the Odessa Sub-area. We have assumed that all of the potato acreage is lost. It should be recognized that this is a very strong assumption and it is not at all clear just how potato production in the area will change in the

future. It is likely that some production would leave the area but the loss of the entire acreage as assumed in this report is an upper bound.

The regional economy for which we developed an economic input-output model represents the four centrally located counties in the Columbia Basin in state of Washington. The region includes Grant, Adams Franklin and Lincoln. The Odessa Sub-area is contained within this region. We have shown how the overall vigor of the local economy would be affected from the possible losses in potato production. As a measurement of such loss we predicted the number of job losses and value of total regional income in individual industries and over the entire local economy.

In Scenario 1 we assumed that the hypothetical loss of 35,000 acres of potato production in the Odessa Sub-area was replaced by potato production elsewhere in the region—in the Columbia Basin project. As a result, most of the negative regional impact would be eliminated as the loss of potato production in one part of the region is simply replaced by production in another part of the region.

In the second scenario, we assumed that possible shortage of water supply would affect the supply of raw potatoes in the region but not the frozen product industry. Particularly, it won't affect the supplies of raw potatoes to frozen-potato product industries, as these frozen-potato product industries will find an alternative source of potatoes outside the regional economy. The estimated regional economic impact stemming from the loss of potato production is a loss of roughly 1100 jobs and a loss of regional income of $54 million. As an alternative use of land, in

absence of potato production, we explored the possibility of wheat production. Dry land wheat production provides little regional recovery in comparison to what would be lost from possible loss of potato production (Table 20).

In scenario 3, we assumed that the frozen-potato product industry was unable to find substitute potato production for the potatoes lost from the Odessa Sub-area. The overall impact on the economy is more severe than in the second alternative scenario because of the loss of frozen-potato product production as well as the potato loss. In comparison to the potato industry, the frozen product industry generates more employment, as well as more value-added. The estimated regional impact is a loss of regional sales of roughly $630 million, a loss of 3600 jobs and a loss of regional income of $211 million.

It may be noted that the range of possible impact is large as we go from scenario 1 to scenario 3. This is a function of the extent the growers in the region are assumed to be able to replace the assumed lost production and the extent that the processing of frozen product would be negatively affected by the potato shock. In terms of regional economic impact, scenario 1 represents the best case scenario and scenario 3 the worst-case scenario. The economic model used to estimate the alternative impact is silent on which of the three scenarios or a combination of them is most likely. The economic model can only address “what if” kinds of questions. It cannot tell the economist what the question should be. That is why we have developed the alternative scenarios.

Those who believe that the potatoes produced in the Odessa Sub-area are very special (in terms of the operation of frozen-product production) and that they cannot be economically replaced by production either elsewhere in the Columbia Basin or in regions outside the Basin should concentrate on the economic impacts from scenario 3. It is also possible that the region would react to a possible loss of potato production in the Sub-area with a combination of scenarios 1, 2 and 3. That is, some production would be shifted to the Columbia Basin product, some production would be shifted out of the region, and there would be some loss of frozen product production. However, the question of which of the three scenarios, or which combination of the three, is most representative of expected regional impact is one on which this study is silent. To answer that question would require an investigation into the economic feasibility of each scenario as well as combinations of scenarios and that is beyond the scope of this study.

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Appendix I: All-Wheat Data (4 Counties, WA State).

		Harvested (Acre)			**Yield (Bushels/Acre)**			Production (Bushels)		
			Non-Irrigated			Non-Irrigated			Non-Irrigated	
Adams	1999	59,700	237,800	297,500	83.79	34.34	44.26	5,002,000	8,165,000	13,167,000
	2000	64,100	254,100	318,200	84.87	50.26	57.23	5,440,000	12,770,000	18,210,000
	2001	49,200	266,700	315,900	80.08	31.72	39.26	3,940,000	8,461,000	12,401,000
	2002	44,900	255,400	300,300	70.42	34.88	40.19	3,162,000	8,908,000	12,070,000
	2003	52,300	237,900	290,200	83.58	44.54	51.57	4,371,000	10,596,000	14,967,000
Average		54,040	250,380	304,420	80.5	39.1	46.5	4,383,000	9,780,000	14,163,000
Franklin	1999	28,000	94,900	122,900	94.96	29.32	44.27	2,659,000	2,782,000	5,441,000
	2000	27,500	82,200	109,700	109.38	39.88	57.3	3,008,000	3,278,000	6,286,000
	2001	NA	NA	86,400	NA	NA	47.85	NA	NA	4,134,000
	2002	NA	NA	76,000	NA	NA	46.55	NA	NA	3,538,000
	2003	NA	NA	89,600	NA	NA	55.3	NA	NA	4,955,000
Average		27,750	88,550	96,920	102.2	34.6	50.3	2,833,500	3,030,000	4,870,800
Grant	1999	69,000	113,600	182,600	109.43	39.47	65.91	7,551,000	4,484,000	12,035,000
	2000	65,200	129,700	194,900	107.32	63.22	77.97	6,997,000	8,200,000	15,197,000
	2001	57,500	117,500	175,000	105.48	42.23	63.01	6,065,000	4,962,000	11,027,000
	2002	66,700	106,800	173,500	92.61	46.56	64.27	6,177,000	4,973,000	11,150,000
	2003	70,000	108,700	178,700	112.63	61.21	81.35	7,884,000	6,654,000	14,538,000
Average		65,680	115,260	180,940	105.5	50.5	70.5	6,934,800	5,854,600	12,789,400
Lincoln	1999	28,800	198,000	318,000	103.78	57.01	57.15	2,989,000	11,288,000	18,173,000
	2000	NA		364,200	NA	NA	69.43	NA	NA	25,288,000
	2001	20,200	331,100	351,300	92.92	51.15	53.56	1,877,000	16,937,000	18,814,000
	2002	16,800	373,500	390,300	88.99	51.64	53.25	1,495,000	19,288,000	20,783,000
	2003	25,000	381,600	406,600	84.2	54.17	56.01	2,105,000	20,670,000	22,775,000
Average		22,700	321,050	366,080	92.5	53.5	57.9	2,116,500	17,045,750	21,166,600

WA State Price Received ($/Bushels), All-wheat

1999	2.77
2000	2.7
2001	3.23
2002	3.83
2003	3.8
Average	3.266

Appendix-2: Industry Aggregation.

Industry Code	Industry Name/ Aggregated	Industry Name/ Un-aggregated
1	Agriculture[32]	Dairy Farm Products
2	"	Poultry and Eggs
3	"	Ranch Fed Cattle
4	"	Range Fed Cattle
5	"	Cattle Feedlots
6	"	Sheep- Lambs and Goats
7	"	Hogs- Pigs and Swine
8	"	Other Meat Animal Products
9	"	Miscellaneous Livestock
10	"	Cotton
11	"	Food Grains
12	"	Feed Grains
13	"	Hay and Pasture
14	"	Grass Seeds
15	"	Tobacco
16	"	Fruits
17	"	Tree Nuts
18	"	Vegetables
19	"	Sugar Crops
20	"	Miscellaneous Crops
21	"	Oil Bearing Crops
22	"	Forest Products
23	"	Greenhouse and Nursery Products
24	"	Forestry Products
25	"	Commercial Fishing
26	"	Agricultural- Forestry- Fishery Services
27	"	Landscape and Horticultural Services
28	Mining	Iron Ores
29	"	Copper Ores
30	"	Lead and Zinc Ores
31	"	Gold Ores
32	"	Silver Ores
33	"	Ferroalloy Ores- Except Vanadium
34	"	Metal Mining Services
35	"	Uranium-radium-vanadium Ores

[32] Aggregation we used are mentioned in gray block. Each aggregated sector is from one gray block to another, e.g. Agriculture is from industry no. 1 to industry no. 27 and mining is from sector no. 28 to 47 and so on.

36	"	Metal Ores- Not Elsewhere Classified
37	"	Coal Mining
38	"	Natural Gas & Crude Petroleum
39	"	Natural Gas Liquids
40	"	Dimension Stone
41	"	Sand and Gravel
42	"	Clay- Ceramic- Refractory Minerals- N.E.C.
43	"	Potash- Soda- and Borate Minerals
44	"	Phosphate Rock
45	"	Chemical- Fertilizer Mineral Mining- N.E.C.
46	"	Nonmetallic Minerals (Except Fuels) Service
47	"	Misc. Nonmetallic Minerals- N.E.C.
48	Construction	New Residential Structures
49	"	New Industrial and Commercial Buildings
50	"	New Utility Structures
51	"	New Highways and Streets
52	"	New Farm Structures
53	"	New Mineral Extraction Facilities
54	"	New Government Facilities
55	"	Maintenance and Repair- Residential
56	"	Maintenance and Repair Other Facilities
57	"	Maintenance and Repair Oil and Gas Wells
58	Manufacturing	Meat Packing Plants
59	"	Sausages and Other Prepared Meats
60	"	Poultry Processing
61	"	Creamery Butter
62	"	Cheese- Natural and Processed
63	"	Condensed and Evaporated Milk
64	"	Ice Cream and Frozen Desserts
65	"	Fluid Milk
66	"	Canned Specialties
67	"	Canned Fruits and Vegetables
68	"	Dehydrated Food Products
69	"	Pickles- Sauces- and Salad Dressings
70	"	Frozen Fruits- Juices and Vegetables
71	"	Frozen Specialties
72	"	Flour and Other Grain Mill Products
73	"	Cereal Preparations
74	"	Rice Milling
75	"	Blended and Prepared Flour
76	"	Wet Corn Milling

77	"	Dog – Cat - and Other Pet Food
78	"	Prepared Feeds - N.E.C
79	"	Bread - Cake - and Related Products
80	"	Cookies and Crackers
81	"	Sugar
82	"	Confectionery Products
83	"	Chocolate and Cocoa Products
84	"	Chewing Gum
85	"	Salted and Roasted Nuts & Seeds
86	"	Cottonseed Oil Mills
87	"	Soybean Oil Mills
88	"	Vegetable Oil Mills - N.E.C
89	"	Animal and Marine Fats and Oils
90	"	Shortening and Cooking Oils
91	"	Malt Beverages
92	"	Malt
93	"	Wines- Brandy- and Brandy Spirits
94	"	Distilled Liquor - Except Brandy
95	"	Bottled and Canned Soft Drinks & Water
96	"	Flavoring Extracts and Syrups- N.E.C.
97	"	Canned and Cured Sea Foods
98	"	Prepared Fresh or Frozen Fish or Seafood
99	"	Roasted Coffee
100	"	Potato Chips & Similar Snacks
101	"	Manufactured Ice
102	"	Macaroni and Spaghetti
103	"	Food Preparations - N.E.C
104	"	Cigarettes
105	"	Cigars
106	"	Chewing and Smoking Tobacco
107	"	Tobacco Stemming and Redrying
108	"	Broadwoven Fabric Mills and Finishing
109	"	Narrow Fabric Mills
110	"	Women’s Hosiery - Except Socks
111	"	Hosiery - N.E.C
112	"	Knit Outerwear Mills
113	"	Knit Underwear Mills
114	"	Knit Fabric Mills
115	"	Knitting Mills - N.E.C.
116	"	Yarn Mills and Finishing of Textiles - N.E.C.
117	"	Carpets and Rugs

118	"	Thread Mills
119	"	Coated Fabrics - Not Rubberized
120	"	Tire Cord and Fabric
121	"	Non-woven Fabrics
122	"	Cordage and Twine
123	"	Textile Goods - N.E.C
124	"	Apparel Made From Purchased Materials
125	"	Curtains and Draperies
126	"	House furnishings - N.E.C
127	"	Textile Bags
128	"	Canvas Products
129	"	Pleating and Stitching
130	"	Automotive and Apparel Trimmings
131	"	Schiffi Machine Embroideries
132	"	Fabricated Textile Products - N.E.C.
133	"	Logging Camps and Logging Contractors
134	"	Sawmills and Planing Mills - General
135	"	Hardwood Dimension and Flooring Mills
136	"	Special Product Sawmills - N.E.C
137	"	Millwork
138	"	Wood Kitchen Cabinets
139	"	Veneer and Plywood
140	"	Structural Wood Members - N.E.C
141	"	Wood Containers
142	"	Wood Pallets and Skids
143	"	Mobile Homes
144	"	Prefabricated Wood Buildings
145	"	Wood Preserving
146	"	Reconstituted Wood Products
147	"	Wood Products - N.E.C
148	"	Wood Household Furniture
149	"	Upholstered Household Furniture
150	"	Metal Household Furniture
151	"	Mattresses and Bedsprings
152	"	Wood TV and Radio Cabinets
153	"	Household Furniture - N.E.C
154	"	Wood Office Furniture
155	"	Metal Office Furniture
156	"	Public Building Furniture
157	"	Wood Partitions and Fixtures
158	"	Metal Partitions and Fixtures

159	"	Blinds - Shades- and Drapery Hardware
160	"	Furniture and Fixtures - N.E.C
161	"	Pulp Mills
162	"	Paper Mills- Except Building Paper
163	"	Paperboard Mills
164	"	Paperboard Containers and Boxes
165	"	Paper Coated & Laminated Packaging
166	"	Paper Coated & Laminated N.E.C.
167	"	Bags - Plastic
168	"	Bags - Paper
169	"	Die-cut Paper and Board
170	"	Sanitary Paper Products
171	"	Envelopes
172	"	Stationery Products
173	"	Converted Paper Products - N.E.C
174	"	Newspapers
175	"	Periodicals
176	"	Book Publishing
177	"	Book Printing
178	"	Miscellaneous Publishing
179	"	Commercial Printing
180	"	Manifold Business Forms
181	"	Greeting Card Publishing
182	"	Blankbooks and Looseleaf Binder
183	"	Bookbinding & Related
184	"	Typesetting
185	"	Plate Making
186	"	Alkalies & Chlorine
187	"	Industrial Gases
188	"	Inorganic Pigments
189	"	Inorganic Chemicals Nec.
190	"	Cyclic Crudes- Interm. & Indus. Organic Chem.
191	"	Plastics Materials and Resins
192	"	Synthetic Rubber
193	"	Cellulose Man-made Fibers
194	"	Organic Fibers - Noncellulosic
195	"	Drugs
196	"	Soap and Other Detergents
197	"	Polishes and Sanitation Goods
198	"	Surface Active Agents
199	"	Toilet Preparations

200	"	Paints and Allied Products
201	"	Gum and Wood Chemicals
202	"	Nitrogenous and Phosphatic Fertilizers
203	"	Fertilizers - Mixing Only
204	"	Agricultural Chemicals - N.E.C
205	"	Adhesives and Sealants
206	"	Explosives
207	"	Printing Ink
208	"	Carbon Black
209	"	Chemical Preparations - N.E.C
210	"	Petroleum Refining
211	"	Paving Mixtures and Blocks
212	"	Asphalt Felts and Coatings
213	"	Lubricating Oils and Greases
214	"	Petroleum and Coal Products - N.E.C.
215	"	Tires and Inner Tubes
216	"	Rubber and Plastics Footwear
217	"	Rubber and Plastics Hose and Belting
218	"	Gaskets- Packing and Sealing Devices
219	"	Fabricated Rubber Products - N.E.C.
220	"	Miscellaneous Plastics Products
221	"	Leather Tanning and Finishing
222	"	Footwear Cut Stock
223	"	House Slippers
224	"	Shoes - Except Rubber
225	"	Leather Gloves and Mittens
226	"	Luggage
227	"	Womens Handbags and Purses
228	"	Personal Leather Goods
229	"	Leather Goods - N.E.C
230	"	Glass and Glass Products - Exc Containers
231	"	Glass Containers
232	"	Cement - Hydraulic
233	"	Brick and Structural Clay Tile
234	"	Ceramic Wall and Floor Tile
235	"	Clay Refractories
236	"	Structural Clay Products - N.E.C
237	"	Vitreous Plumbing Fixtures
238	"	Vitreous China Food Utensils
239	"	Fine Earthenware Food Utensils
240	"	Porcelain Electrical Supplies

241	"	Pottery Products - N.E.C
242	"	Concrete Block and Brick
243	"	Concrete Products - N.E.C
244	"	Ready-mixed Concrete
245	"	Lime
246	"	Gypsum Products
247	"	Cut Stone and Stone Products
248	"	Abrasive Products
249	"	Asbestos Products
250	"	Minerals- Ground or Treated
251	"	Mineral Wool
252	"	Nonclay Refractories
253	"	Nonmetallic Mineral Products - N.E.C.
254	"	Blast Furnaces and Steel Mills
255	"	Electrometallurgical Products
256	"	Steel Wire and Related Products
257	"	Cold Finishing of Steel Shapes
258	"	Steel Pipe and Tubes
259	"	Iron and Steel Foundries
260	"	Primary Copper
261	"	Primary Aluminum
262	"	Primary Nonferrous Metals - N.E.C.
263	"	Secondary Nonferrous Metals
264	"	Copper Rolling and Drawing
265	"	Aluminum Rolling and Drawing
266	"	Nonferrous Rolling and Drawing - N.E.C.
267	"	Nonferrous Wire Drawing and Insulating
268	"	Aluminum Foundries
269	"	Brass- Bronze- and Copper Foundries
270	"	Nonferrous Castings- N.E.C.
271	"	Metal Heat Treating
272	"	Primary Metal Products - N.E.C
273	"	Metal Cans
274	"	Metal Barrels- Drums and Pails
275	"	Cutlery
276	"	Hand and Edge Tools - N.E.C.
277	"	Hand Saws and Saw Blades
278	"	Hardware - N.E.C.
279	"	Metal Sanitary Ware
280	"	Plumbing Fixture Fittings and Trim
281	"	Heating Equipment- Except Electric

282	"	Fabricated Structural Metal
283	"	Metal Doors- Sash- and Trim
284	"	Fabricated Plate Work (Boiler Shops)
285	"	Sheet Metal Work
286	"	Architectural Metal Work
287	"	Prefabricated Metal Buildings
288	"	Miscellaneous Metal Work
289	"	Screw Machine Products and Bolts - Etc.
290	"	Iron and Steel Forgings
291	"	Nonferrous Forgings
292	"	Automotive Stampings
293	"	Crowns and Closures
294	"	Metal Stampings- N.E.C.
295	"	Plating and Polishing
296	"	Metal Coating and Allied Services
297	"	Small Arms Ammunition
298	"	Ammunition- Except For Small Arms - N.E.C.
299	"	Small Arms
300	"	Other Ordnance and Accessories
301	"	Industrial and Fluid Valves
302	"	Steel Springs- Except Wire
303	"	Pipe- Valves- and Pipe Fittings
304	"	Miscellaneous Fabricated Wire Products
305	"	Metal Foil and Leaf
306	"	Fabricated Metal Products - N.E.C.
307	"	Steam Engines and Turbines
308	"	Internal Combustion Engines - N.E.C.
309	"	Farm Machinery and Equipment
310	"	Lawn and Garden Equipment
311	"	Construction Machinery and Equipment
312	"	Mining Machinery - Except Oil Field
313	"	Oil Field Machinery
314	"	Elevators and Moving Stairways
315	"	Conveyors and Conveying Equipment
316	"	Hoists- Cranes- and Monorails
317	"	Industrial Trucks and Tractors
318	"	Machine Tools - Metal Cutting Types
319	"	Machine Tools - Metal Forming Types
320	"	Industrial Patterns
321	"	Special Dies and Tools and Accessories
322	"	Power Driven Hand Tools

323	"	Rolling Mill Machinery
324	"	Welding Apparatus
325	"	Metalworking Machinery - N.E.C.
326	"	Textile Machinery
327	"	Woodworking Machinery
328	"	Paper Industries Machinery
329	"	Printing Trades Machinery
330	"	Food Products Machinery
331	"	Special Industry Machinery N.E.C.
332	"	Pumps and Compressors
333	"	Ball and Roller Bearings
334	"	Blowers and Fans
335	"	Packaging Machinery
336	"	Power Transmission Equipment
337	"	Industrial Furnaces and Ovens
338	"	General Industrial Machinery - N.E.C
339	"	Electronic Computers
340	"	Computer Storage Devices
341	"	Computer Terminals
342	"	Computer Peripheral Equipment-
343	"	Calculating and Accounting Machines
344	"	Typewriters and Office Machines N.E.C.
345	"	Automatic Merchandising Machine
346	"	Commercial Laundry Equipment
347	"	Refrigeration and Heating Equipment
348	"	Measuring and Dispensing Pumps
349	"	Service Industry Machines - N.E.C.
350	"	Carburetors- Pistons- Rings- Valves
351	"	Fluid Power Cylinders & Actuators
352	"	Fluid Power Pumps & Motors
353	"	Scales and Balances
354	"	Industrial Machines N.E.C.
355	"	Transformers
356	"	Switchgear and Switchboard Apparatus
357	"	Motors and Generators
358	"	Carbon and Graphite Products
359	"	Relays & Industrial Controls
360	"	Electrical Industrial Apparatus- N.E.C.
361	"	Household Cooking Equipment
362	"	Household Refrigerators and Freezers
363	"	Household Laundry Equipment

364	"	Electric House wares and Fans
365	"	Household Vacuum Cleaners
366	"	Household Appliances- N.E.C.
367	"	Electric Lamps
368	"	Wiring Devices
369	"	Lighting Fixtures and Equipment
370	"	Radio and TV Receiving Sets
371	"	Phonograph Records and Tape
372	"	Telephone and Telegraph Apparatus
373	"	Radio and TV Communication Equipment
374	"	Communications Equipment N.E.C.
375	"	Electron Tubes
376	"	Printed Circuit Boards
377	"	Semiconductors and Related Devices
378	"	Electronic Components - N.E.C.
379	"	Storage Batteries
380	"	Primary Batteries - Dry and Wet
381	"	Engine Electrical Equipment
382	"	Magnetic & Optical Recording Media
383	"	Electrical Equipment - N.E.C.
384	"	Motor Vehicles
385	"	Truck and Bus Bodies
386	"	Motor Vehicle Parts and Accessories
387	"	Truck Trailers
388	"	Motor Homes
389	"	Aircraft
390	"	Aircraft and Missile Engines and Parts
391	"	Aircraft and Missile Equipment-
392	"	Ship Building and Repairing
393	"	Boat Building and Repairing
394	"	Railroad Equipment
395	"	Motorcycles- Bicycles- and Parts
396	"	Complete Guided Missiles
397	"	Travel Trailers and Camper
398	"	Tanks and Tank Components
399	"	Transportation Equipment - N.E.C
400	"	Search & Navigation Equipment
401	"	Laboratory Apparatus & Furniture
402	"	Automatic Temperature Controls
403	"	Mechanical Measuring Devices
404	"	Instruments to Measure Electricity

405	"	Analytical Instruments
406	"	Optical Instruments & Lenses
407	"	Surgical and Medical Instrument
408	"	Surgical Appliances and Supplies
409	"	Dental Equipment and Supplies
410	"	X-Ray Apparatus
411	"	Electromedical Apparatus
412	"	Ophthalmic Goods
413	"	Photographic Equipment and Supplies
414	"	Watches- Clocks- and Parts
415	"	Jewelry- Precious Metal
416	"	Silverware and Plated Ware
417	"	Jewelers Materials and Lapidary Work
418	"	Musical Instruments
419	"	Dolls
420	"	Games- Toys- and Childrens Vehicles
421	"	Sporting and Athletic Goods- N.E.C.
422	"	Pens and Mechanical Pencils
423	"	Lead Pencils and Art Goods
424	"	Marking Devices
425	"	Carbon Paper and Inked Ribbons
426	"	Costume Jewelry
427	"	Fasteners- Buttons- Needles- Pins
428	"	Brooms and Brushes
429	"	Signs and Advertising Displays
430	"	Burial Caskets and Vaults
431	"	Hard Surface Floor Coverings
432	"	Manufacturing Industries - N.E.C.
433	Railroads and Related Services	Railroads and Related Services
434	Local, Interurban Passenger Transit	Local- Interurban Passenger Transit
435	Motor Freight Transport and Warehousing	Motor Freight Transport and Warehousing
436	Water Transportation	Water Transportation
437	Air Transportation	Air Transportation
438	Utilities and other Communications	Pipe Lines- Except Natural Gas
439	"	Arrangement Of Passenger Transportation
440	"	Transportation Services
441	"	Communications- Except Radio and TV
442	"	Radio and TV Broadcasting
443	"	Electric Services
444	"	Gas Production and Distribution
445	"	Water Supply and Sewerage Systems

446	"	Sanitary Services and Steam Supply
447	Wholesale Trade	Wholesale Trade
448	Other Trade	Building Materials & Gardening
449	"	General Merchandise Stores
450	Food Stores	Food Stores
451	"	Automotive Dealers & Service Stations
452	"	Apparel & Accessory Stores
453	"	Furniture & Home Furnishings Stores
454	"	Eating & Drinking
455	"	Miscellaneous Retail
456	Financial & other banking Services	Banking
457	"	Credit Agencies
458	"	Security and Commodity Brokers
459	"	Insurance Carriers
460	"	Insurance Agents and Brokers
461	"	Owner-occupied Dwellings
462	"	Real Estate
463	Services	Hotels and Lodging Places
464	"	Laundry- Cleaning and Shoe Repair
465	"	Portrait and Photographic Studios
466	"	Beauty and Barber Shops
467	"	Funeral Service and Crematories
468	"	Miscellaneous Personal Services
469	"	Advertising
470	"	Other Business Services
471	"	Photofinishing- Commercial Photography
472	"	Services To Buildings
473	"	Equipment Rental and Leasing
474	"	Personnel Supply Services
475	"	Computer and Data Processing Services
476	"	Detective and Protective Services
477	"	Automobile Rental and Leasing
478	"	Automobile Parking and Car Wash
479	"	Automobile Repair and Services
480	"	Electrical Repair Service
481	"	Watch- Clock- Jewelry and Furniture Repair
482	"	Miscellaneous Repair Shops
483	"	Motion Pictures
484	"	Theatrical Producers- Bands Etc.
485	"	Bowling Alleys and Pool Halls
486	"	Commercial Sports Except Racing

487	"	Racing and Track Operation
488	"	Amusement and Recreation Services - N.E.C.
489	"	Membership Sports and Recreation Clubs
490	"	Doctors and Dentists
491	"	Nursing and Protective Care
492	"	Hospitals
493	"	Other Medical and Health Services
494	"	Legal Services
495	"	Elementary and Secondary Schools
496	"	Colleges- Universities- Schools
497	"	Other Educational Services
498	"	Job Trainings & Related Services
499	"	Child Day Care Services
500	"	Social Services - N.E.C.
501	"	Residential Care
502	"	Other Nonprofit Organizations
503	"	Business Associations
504	"	Labor and Civic Organizations
505	"	Religious Organizations
506	"	Engineering - Architectural Services
507	"	Accounting - Auditing and Bookkeeping
508	"	Management and Consulting Services
509	"	Research- Development & Testing Services
510	Government	Local Government Passenger Transit
511	"	State and Local Electric Utilities
512	"	Other State and Local Gov't Enterprises
513	"	U.S. Postal Service
514	"	Federal Electric Utilities
515	"	Other Federal Government Enterprises
516	Other	Non-comparable Imports
517	"	Scrap
518	"	Used and Secondhand Goods
519	"	Federal Government - Military
520	"	Federal Government - Non-Military
521	"	Commodity Credit Corporation
522	"	State & Local Government - Education
523	"	State & Local Government - Non-Education
524	"	Rest Of The World Industry
525	"	Domestic Services
526	"	Dummy
527	"	Dummy

528	"	Inventory Valuation Adjustment
530	"	Potato
533	"	Frozen Potato
10,001	Institutions (inclusive of imports)	Foreign Trade
28001		Domestic Trade
		Total