A Review of "The Economic Impact of a Possible Irrigation-Water Shortage in Odessa Sub-Basin: Potato Production and Processing", Sanjoy Bhattacharjee and David Holland, School of Economic Sciences, Washington State University, June 6, 2005.

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Executive Summary

The study by Bhattacharjee and Holland (B-H) is often cited in support of proposals to provide project water to Odessa area land presently irrigated with groundwater. Their study was motivated by concerns about lands to the east of the developed part of the Columbia Basin Project (CBP) that were developed using private wells pumping ground water. There is very little natural recharge to these aquifers so they are being rapidly depleted, and pumping depths and costs are approaching prohibitive levels. Numbers from the study, $630 million in gross output impact and 3,600 jobs have been seized by supporters of proposals to "complete the Columbia Basin Project". Because of the visibility of the B-H study, I was asked to review its methodology and results. My conclusions are as follows.

The $630 million in gross output impact and 3,600 jobs numbers come from Bhattacharjee and Holland's worst case scenario (scenario 3). However, the Odessa area potato industry is very unlikely to respond as postulated in this worst case scenario. Farmers' ability and willingness to adjust to changed conditions make their other, less dire scenarios much more likely. Thus the large impact numbers that result from scenario 3 are poor indicators of the likely impact of groundwater decline in the Odessa area. There is a disconnect between the 170,000 irrigated acres that pump from the Odessa area aquifer, the 35,000 acres of potatoes that were the subject of the B-H study, and the 40,700 to 140,000 acres that the Bureau of Reclamation (BOR) is seriously considering providing with CBP water. Since current BOR proposals would irrigate only 40,700 to 140,000 acres of the 170,000 acres now being irrigated with Odessa groundwater this would leave the remaining 30,000 to 129,300 acres to rely on the declining groundwater supplies. All this means that scenario 3 of the B-H study does not match current BOR proposals and it is very inappropriate to use scenario 3 results to estimate the benefits of CBP expansion.

The $630 million gross output impact number being used by proponents of CBP expansion is a misleading number. It is misleading because scenario 3 is unrealistic. It is misleading because income and employment are better measures of impact than gross output. It is misleading because both the employment and income impacts will diminish through time as the displaced labor and other production inputs are re-employed elsewhere. Needless to say, the 7,500 jobs estimate current in some recent press releases and media stories is a misquotation of the B-H study and is completely invalid.

I have a number of serious concerns about the analytic procedures used by B-H. The four-county study area they used may not be the most appropriate study area. This limited study area means that important impacts to the wider economy of the state are ignored. If B-H had used the entire

[1] The conclusions presented in this paper are solely the work of the author. This work was neither supported nor endorsed by my former employer, the University of Idaho.

state as their study area, there would have been very little net impact. The B-H study includes forward linkages, which may have resulted in double counting of impacts. They may also have neglected to properly measure the wholesale trade sector in terms of gross margins. All these issues raise serious concerns about the credibility of the economic model results in the B-H study. The numbers now being quoted from the B-H study (especially the $630 million number and the 3,650 jobs number) are not credible, and should not be used. Hopefully, if the BOR properly analyzes the proposals to expand the CBP, it will address these issues and model them correctly.

1. Introduction

In recent discussions about proposals to "complete" the Columbia Basin Project, the study by Bhattacharjee and Holland is often cited as supporting the necessity to provide project water to land presently irrigated with groundwater.[2] Because of the visibility of the Bhattacharjee-Holland (B-H) study, I was asked to look in more detail at the study and the ways in which the results of the study have been used in the discussion.

B-H's study was motivated by concerns about lands to the east of the developed part of the Columbia Basin Project (CBP) and immediately east of the East Low Canal. These lands were developed using private wells pumping from the Wanapum and Grande Ronde Aquifers in the Odessa Ground Water Management Area of the CBP. These groundwater-irrigated lands are shown in green in figure 1. There is very little natural recharge to the aquifers underlying the Odessa Ground Water Management Area, and these aquifers are being rapidly depleted. As pumping depths increase, pumping costs are approaching prohibitive levels. Because of the growing distress of deep well irrigation in the Odessa area, the B-H study was commissioned and funded by the Washington Potato Commission.

The Bureau of Reclamation (BOR) is currently studying alternatives for providing CBP water to the Odessa region. In September 2006 the BOR issued an initial report "Initial Alternative Development and Evaluation, Odessa Subarea Special Study, Columbia Basin Project, Washington."[3] This initial report provides a very preliminary screening of several possible technical alternatives for providing CBP water to the Odessa groundwater pumpers. The "Initial" report was followed by an October 2007 "Study Update," which lays out the project alternatives in somewhat more detail, and provides an "appraisal level" estimates of construction costs.[4]

As the discussion of proposals to provide BOR water to Odessa groundwater users proceeds, proponents have seized on the Bhattacharjee-Holland as one piece of economic information that they can use to try to justify additional irrigation development in the Columbia Basin. The BOR "initial" report cites the B-H study:

> "A study conducted by Washington State University determined that continued aquifer declines will result in a reduction to current potato production and processing. The resulting economic losses to the potato processing sector are estimated at $630 million dollars annually and a loss of 3,600 jobs in the area." (Bureau of Reclamation, page 4)

[2] The B-H study can be found on the WSU web site at http://www.agribusiness-mgmt.wsu.edu/AgbusResearch/docs/PotatoCommission_finalreport.pdf
[3] http://www.usbr.gov/pn/programs/ucao_misc/odessa/report-alternatives.pdf
[4] http://www.usbr.gov/pn/programs/ucao_misc/odessa/update-oct2007.pdf

The office of Washington Governor Chris Gregoire also cited the WSU study in a press release on September 21, 2005:

> "The combined potential economic loss to the region would total approximately $630 million per year, including 3,600 jobs, were the affected acreage in the area devoted to potato production returned to dry land agricultural practices, according to a Washington State University study commissioned by the Washington State Potato Commission."[5]

The numbers from the B-H study have been picked up by the media. For example, a 2005 Capital Press guest column by Steve Shinn quoted the $630 million figure,[6] and a Seattle Times guest column by Sen. Mark Schoesler (R-Ritzville) quoted both the 3,600 jobs and the $630 million.[7] A November 1, 2007 story in the Othello Outlook also cited both the $630 million and the 3,600 jobs lost.[8]

Interestingly, the story seems to have been embellished with time. A December 12, 2007 news release from Governor Gregoire's office cites $600 million and 7,500 jobs lost.[9] There is no indication why the job loss number has doubled from the number actually estimated in the B-H study. The doubled job number was repeated in a second Gregoire news release on February 5, 2008, again citing $600 million and 7,500 jobs lost.[10] These misquotations of the B-H numbers are also being perpetuated in the media. For example, a Columbia Basin Bulletin reference on February 8, 2008 repeats the $600 million and 7,500 jobs in a story about the State of Washington-Spokane Tribe agreement.[11]

Given the visibility of the B-H study, it important to take a closer look at the study, and at how the results of the study are being used and misused in the debate about the future of the Columbia Basin Project. My comments and conclusions about the study follow.

2. Improper Use of the "Worst Case" Scenario 3

The Bhattacharjee-Holland analysis was based on three 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

[5] http://www.governor.wa.gov/news/news-view.asp?pressRelease=152&newsType=1
[6] Capitol Press (9/2/05), reprinted at http://www.bluefish.org/odessaqu.htm
[7] http://senaterepublicans.wa.gov/news/2005/schoesler/SchoeslerFarmersNeedWaterCol092605.htm
[8] http://othellooutlook.com/cgi-bin/outlook/get_story.cgi?story=Story_1&dir=11012007
[9] http://www.governor.wa.gov/news/news-view.asp?pressRelease=726&newsType=1
[10] http://www.governor.wa.gov/news/news-view.asp?pressRelease=781&newsType=1
[11] http://www.cbbulletin.com/Free/260290.aspx

> scenario the regional economic impact of the lost potato production is most damaging to the regional economy." (Bhattacharjee and Holland, page 23)

B-H say that scenario 3 is a "worst case scenario". They acknowledge that it is a worst case scenario in part because potato farmers have considerable ability adjust:

> "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." (Bhattacharjee and Holland, page 24)

This ability of farmers to adjust raises serious questions about whether the worst case scenario 3 gives a realistic picture of what would really happen if Odessa area potato production were curtailed by aquifer depletion. To the extent that potatoes can continue to be grown on some lands in the four-county study area used by B-H (scenario 1), or if potato production just moves from the four-county area to nearby cropland (scenario 2), then the worst case scenario 3 is implausible. (In my view, scenarios 1 and 2 are much more plausible than scenario 3.) However B-H give readers no guidance about the realism of the three scenarios, essentially leaving it up to the reader to choose whichever scenario they want. Project proponents have of course chosen to use the results of scenario 3 – it gives the largest damage numbers.

There are several other mismatches between the B-H study and the proposal to provide Columbia Basin Project water to the Odessa area groundwater users. There are 170,000 groundwater irrigated acres in the Odessa area (the green areas in figure 1). However, the alternatives addressed in the BOR studies propose to provide water to only 40,700 to 140,000 acres of this land, presumably leaving 30,000 to 129,300 acres to go dry.

Conclusion: The Odessa area potato industry is very unlikely to respond as postulated in scenario 3. Farmers' ability and willingness to adjust to changed conditions make scenarios 1 and 2 much more likely. Thus the large impact numbers that result from scenario 3 are poor indicators of the likely impact of groundwater decline in the Odessa area. There is a disconnect between the 170,000 irrigated acres that pump from the Odessa area aquifer, the 35,000 acres of potatoes that were the subject of the B-H study, and the 40,700 to 140,000 acres that the BOR is seriously considering providing with CBP water. Since current BOR proposals would irrigate only 40,700 to 140,000 acres of the 170,000 acres now being irrigated with Odessa groundwater this would leave the remaining 30,000 to 129,300 acres to rely on the declining groundwater supplies. All this means that scenario 3 of the B-H study does not match current BOR proposals and it is very inappropriate to use scenario 3 results to estimate the benefits of CBP expansion.

3. Improper Use of the Impact Numbers (the $630 Million).

The one number that proponents of Columbia Basin Project expansion most frequently cite is the $630 million gross output impact figure from table 14. There are a number of problems with the way the impact numbers from the B-H study are being used – especially the $630 million number.

a. Readers should focus on income impacts, not sales impacts

Bhattacharjee and Holland calculate three alternative measures of impact for both scenario 2 and scenario 3:

- Gross output or gross sales (tables 9 and 14)
- Employment (tables 10 and 15)
- Value added or income (tables 11 and 16)

The often cited $630 million figure is B-H's estimate of the impact that scenario 3 would have on regional gross output or gross sales. Gross output impact is the total value of the output, measured as sales of processed potato products that would be lost, plus the total value of the sales of other linked sectors that would be lost if those potatoes were not processed.

As a measure of economic loss this gross output impact number is seriously misleading. Gross output is certainly not what the region is trying to maximize – the effects on income and employment are much more useful measures of the economic effect on the region or state. Table 13 of the B-H report shows that for each dollar of processed potato output, 69 cents goes to pay for the necessary production inputs. Only 30 cents remains as income – broken down as 13 cents of employee compensation, 17 cents of property income and a small amount of business taxes (which are income to government entities). Setting aside for a moment the problem that scenario 3 is a terribly implausible scenario; the often quoted $630 million is still not a useful measure of regional impact. Employment or income effects would be much better measures of the impact of scenario 3. These are shown in tables 15 (3,650 jobs) and table 16 ($211 million income)

The potential that gross output impacts will be misinterpreted as income impacts by uninitiated readers of impact studies is so great that many I-O analysts choose to report only the employment and income impacts from their models and not even report the output effects. It is an unfortunate aspect of the B-H study that the authors did report output as well as income and employment, but then gave the reader no help in interpreting the meaning and relevance of these alternative measures.

The big number for scenario 2 is the $180 million impact on regional output shown in table 9, but this number has the same potential for misinterpretation. Gross output impact in scenario 2 is the total value (or sales) of the potato production lost, plus the total value of the sales of other linked sectors that would be lost if those potatoes were not produced. However table 8 shows that each dollar of potato output requires the purchase of 86 cents of inputs, leaving only 14 cents of income, broken down as 8 cents of employee compensation, 6 cents of property income and a small amount of business taxes. While the gross output impact of scenario 2 is $180 million, the income impact shown in table 11 is only $54 million. Alternatively, one can look at the estimated scenario 2 employment impact, 1,136 jobs, as shown in table 10.

Note that it is important to remember that the income impact and the employment impact are alternative ways of looking at the consequences of scenarios 2 and 3. Adding the income and employment impacts together, as some people seem to do, makes no sense.

b. The impacts would not be permanent as factors are reemployed or depreciated.

A problem with Input-Output modeling as used by B-H is that it only gives a snapshot picture at the instant when the hypothesized impact occurs – or in this case the instant when all the wells simultaneously shut down. In reality the process would be a dynamic one – it would occur gradually over time as the various individual wells reach their maximum economic pumping depth. Moreover, the groundwater decline is occurring at a rather predictable rate, so the affected farmers can more or less see how long they can continue to pump, and can plan for future options. In other words, almost all of the inputs now being used in potato production and processing will not sit around being unemployed if/when the water runs out. The labor and capital inputs will move to alternative uses. The physical infrastructure will mostly be salvaged or abandoned, but only after most of it has been fully depreciated. The I-O snapshot that assumes that all of these inputs suddenly become unemployed leads to a serious overestimate of the long term income effects.

Several recent studies have estimated that 80 percent of the instantaneous income loss will be offset by the re-employment of the displaced labor and capital over a few years following the shock, leaving only 20 percent as long-term damages. (For example, in a recent US Supreme Court case, Kansas v. Colorado, Colorado had to pay Kansas for damages equal to 20 percent of the secondary impacts resulting when Colorado used water that should have been delivered to Kansas.[12]) In the Odessa case, of the $54 million scenario 2 income impact, the 80 percent rule would leave only 20 percent or $54 million * 0.2 = $10 million as the long term damages of scenario 2. Similarly, the 1,136 employees who B-H estimated would lose their jobs under scenario 2 would mostly find alternative employment in a relatively short time. The income impacts in tables 12 and 16, and the employment impacts in tables 11 and 15, should be analyzed in terms of the dynamic re-employment that would actually occur. While the impacts might start out at the levels indicated in the tables, the annual impacts would diminish rapidly over a few years as the released labor and capital are reemployed, to nearly zero.

Conclusions: The $630 million gross output impact number being used by proponents of CBP expansion is a misleading number. It is misleading because scenario 3 is unrealistic. It is misleading because income and employment are better measures of impact than gross output. It is misleading because both the employment and income impacts will diminish through time as the displaced production inputs are re-employed elsewhere. Needless to say, the 7,500 jobs estimate current in some recent press releases and media stories is a misquotation of the B-H study and is completely invalid.

4. Concerns about the Assumptions and Methodology used by B-H

The comments above are mostly about the way that the numbers from the B-H study have been used and misinterpreted by proponents of Columbia Basin Project expansion. There are also some concerns about the assumptions and methodology used by B-H that appear to further undermine the usefulness of the study.

a. Problems with the 4-county study area.

[12] Willis, D, J. Hamilton, H. Robison, N. Whittlesey, and J. Draper, "Secondary Damages in Interstate Water Compact Litigation", Natural Resources Journal, forthcoming.

B-H defined their study area to include Adams, Grant, Lincoln and Franklin Counties (see figure 2). This region thus encompasses all four counties that have some of the Odessa area groundwater pumping. Ideally a regional input-output model should be applied to a "functional economic area" – a central place surrounded by dependent hinterland. It is true that B-H's four-county area does include much of central Washington's irrigated cropland, so the region does make some economic sense. However it is a rather odd functional economic area in the required sense. The regional central place, the Tri Cities, is located on the edge of the study area, not in the center. In fact, one of the three cities, Kennewick, is located across the river from the other two, in Benton County and outside the study area. This means that a higher than usual portion of the economic impacts will actually spill across the borders of the study area, and the economic impacts described in the B-H model are overestimated. Some impacts will spill over the border to Benton County, and a significant chunk will even spill over into Spokane, since the northern part of the Odessa groundwater land is closer to Spokane than to the Tri Cities.

The four county study area in figure 2 is split north-south almost down the middle by the East Low Canal. Immediately to the east is the Odessa groundwater area, and to the west is the existing CBP. In scenario 1, B-H assumed that potato production would shift to existing CBP land to the west of the East Low Canal, and that there would be very little impact on income and employment in their study region:

> "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. "

Scenario 2 is very similar, except that potato production is assumed to shift outside the B-H four county study area:

> "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."

However, Benton, Walla Walla and Umatilla counties are all to some degree within the Tri Cities sphere of influence.[13] If the economic model had been chosen to include these three counties, or if a state-wide economic model had been used, then the results would have looked essentially the same as for scenario 1 – that is, there would have been "virtually no change in regional income and employment".

However, as indicated in footnote 12, defining the appropriate functional economic area on which to base input-output modeling of the groundwater pumping issue is a problem – and this problem diminishes our confidence in the modeling results. The problem of an improperly defined FEA probably also means that the B-H impact estimates are overestimates of the true impacts.

[13] The most professionally accepted definitions of functional economic areas were developed by the US Bureau of Economic analysis. The BEA lists Adams, Grant, Franklin and Benton counties as within the Tri Cities FEA; while they include Lincoln County in the Spokane FEA; and Walla Walla and Umatilla counties in the Pendleton FEA.

b. The 4-county study area ignores wider state effects.

The B-H report concentrates entirely on the four-county study area. The study totally ignores the wide range of effects that may occur elsewhere in the state. If people are trying to apply the results of the B-H study to the issue of whether the CBP water should be provided to the Odessa groundwater irrigated farms, then broader state perspectives become very important.

As noted above, if a Washington State I-O model were used, the model would encompass both the Odessa area which might lose potato acreage, and other areas which would likely make up the lost production – with the result that there would be virtually no change in regional income and employment.

Because the federal government is no longer in the business of funding 100% of water projects, the only way the project has any chance of proceeding is with substantial subsidies by Washington taxpayers. Thus, one of the first important statewide impacts to look at is what alternative uses of Washington tax money have to be given up if the money is used instead to subsidize CBP expansion. Alternatively – what alternative use would Washington residents make of that money if they didn't have to pay it in the taxes needed for the subsidy?

The subsidies in question are potentially huge. In its October 2007 Study Update, the BOR presented appraisal level construction cost estimates of the four alternatives being studied for providing CBP water to the Odessa groundwater pumpers. The following table summarizes the BOR construction cost estimates:

Bureau of Reclamation's Appraisal Level Construction Cost Estimates
For Providing Columbia Basin Project Water to Odessa Area Groundwater Pumpers

	Acres Served [a]	Total Project Cost Low [b]	Total Project Cost High [c]	Cost Per Acre Low [d]	Cost Per Acre High [d]
Alternative A	140,000	$2,160,000,000	$6,700,000,000	$15,429	$47,857
Alternative B	127,300	1,944,000,000	5,800,000,000	15,271	45,562
Alternative C	70,100	1,000,000,000	2,400,000,000	14,265	34,237
Alternative C	40,700	377,000,000	1,100,000,000	9,263	27,027

Sources:
a. Table 1, BOR Study Update, October 2007, http://www.usbr.gov/pn/programs/ucao_misc/odessa/update-oct2007.pdf
b. Table 3. BOR Study Update, November 2007, http://www.usbr.gov/pn/programs/ucao_misc/odessa/update-nov2007.pdf
c. Estimated from Figure 10, BOR Study Update, October 2007, http://www.usbr.gov/pn/programs/ucao_misc/odessa/update-oct2007.pdf
d. Calculated

Irrespective of which alternative one looks at, and irrespective of whether one looks at the low or high estimates of project construction costs, the costs would be dauntingly high. Construction expenses alone would certainly exceed the value of the resulting irrigated cropland by many times. If this project is to move forward, Washington state taxpayers will certainly have to shoulder an undetermined, but significant portion of this cost – taking money away from other things that the state or the taxpayers might otherwise spend this money on. The economic impacts of this choice are not reflected in the B-H study.

Another big concern is the impact of withdrawing the required water from the Columbia on the environment, on recreation, and on endangered fish. BOR actions should not harm species listed under the federal Endangered Species Act – but whether that can be achieved remains to be seen. If a project damages the environment, recreation, or endangered fish, significant state-wide economic impacts would result.

Yet another statewide impact links to energy. Diversion of additional Columbia River water for delivery to Odessa groundwater pumpers would have large impacts on electricity use and generation. The present CBP diverts water from Lake Roosevelt at Grand Coulee Dam, and pumps it up to Banks Lake, from which it mostly flows by gravity to the CBP. Under the terms of the original CBP authorization, the CBP pays the BOR a rate of 1.5 mils per kwh for the electricity used to pump the water. 1.5 mils is 0.15 cents per kwh, less than one-thirtieth of the rate that Bonneville Power Administration charges for the rest of the electricity that is generated at Grand Coulee. It is important to note that the construction cost estimates in the October and November 2007 study updates from the BOR do not include the very large annual electricity impact on the region. Presumably if more water is pumped to Banks Lake to supply the demands in the Odessa area, the required pumping power will also be charged at this 1.5 mil rate, and BPA would have that much less electricity to provide to electricity users elsewhere in the state. Note also that the Bureau's alternatives B, C, and D involve significant additional pumping for water delivery, which would probably also come under the 1.5 mil rate, and result in even less BPA electricity supplies.

A further energy impact would occur at the dams on the Columbia River. If more water is withdrawn at Lake Roosevelt, then less water is available for electricity generation at all of the downstream dams – from Grand Coulee Dam downstream to Bonneville Dam. Again, these effects would mean less BPA electricity available to electricity users in the rest of the state of Washington.

Obviously, these effects go way beyond the intentionally limited scope of the B-H study. However, policy makers and the public who are using the results of the B-H study to draw inferences about the economic effects of expanding the CBP must also understand and consider these wider effects on the entire state of Washington. Hopefully the studies now underway by BOR will address these issues.

c. Lack of adequate explanation in the B-H study

One of the serious shortcomings with the B-H study is that the text explanation is often inadequate, making it difficult to understand the basis of the analysis. For this reason, readers can be left confused about the assumptions, analysis or conclusions. Several of the points which follow are of this type – I am not sure there is a problem, but I think there might be.

d. Confusion of forward and backward linkages

Input-output analysis makes a distinction between forward linkages and backward linkages. Backward linkages are the economic links between the primary impacted sector (potato production) and the backward linked sectors from which the impacted sector purchases inputs

(fertilizer, chemicals, labor). Forward linked sectors are those that do something further with a product after it has been produced (for example a processing sector). Input-output models are designed to address backward linkages. When forward linkages are believed to exist, the analyst must make special modifications to the I-O model to include them.

Bhattacharjee and Holland chose to include what they seem to imply are forward linkages in both scenarios 2 and 3. Their procedures are easiest to follow in scenario 2. They assert that:

> "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."

They include the $26 million as additional direct impacts in table 9, mostly allocated to the "Motor Freight Transport and Warehousing" and "Wholesale Trade" sectors, apparently implying that they are some kind of forward linkages. However in table 8 they show that growing the $97.5 million worth of potatoes requires backward linked input purchases of $6.4 million from the "Motor Freight Transport and Warehousing" sector and purchases of $4.3 million from the "Wholesale Trade" sector. B-H have not documented where these huge $21 million and $5 million numbers came from. More important, they provide no justification why these two sectors should be included both as backward and forward linkages. It seems likely that this is double counting, which would mean that the output, employment and income impacts are greatly overestimated.

Another bothersome insufficiently documented step is the allocation of $10.4 million of this $26 million to industry code 10,001 "Institutions (inclusive of imports)". This name and code do not correspond to the listing of IMPLAN codes that I have access to. After puzzling for some time, it became apparent that this $10.4 million is the part of the $26 million of the transport, warehousing and wholesale trade sectors that was provided by out of region businesses. B-H included this amount in the direct regional impacts, and thus in the regional output impacts in table 9. The logic of including imports of transport, warehousing and wholesale trade services as part of regional output totally escapes me. Including this $10.4 million in the total output impact seems to inflate this figure unjustifiably.

In addition, it is not really clear where the information for industry code 530 "Potatoes" and code 533 "Frozen Potatoes" comes from since these sectors also do not correspond to our listing of IMPLAN sectors. The text on page 27 says that the potato production function information comes from IMPLAN, but the footnote at the bottom of table 8 credits a MS thesis by Nick Beleiciks.

Another related question concerns the wholesale trade sector. Normal practice in input-output modeling is to measure economic activity in the wholesale and retail trade sectors in terms of "gross margins" instead of "gross sales". For example, gross margin in the retail grocery industry is the value of sales less the value of the products purchased for resale. It is not clear whether B-H followed that practice when they inserted $12.8 million into the wholesale trade sector direct impacts in table 9. If the number they inserted was not reduced to a gross margin figure, then this would have substantially overestimated the output, employment and income impact estimates.

Double counting and the problem with the wholesale trade number could be the reason for the surprising results in table 11. The wholesale trade and transport and warehousing sectors were

estimated to account for one third of the entire income impact in scenario 2. Wholesale trade alone was estimated to account for almost as much income impact as the potato sector itself.

The analysis of scenario 3 raises similar issues. Here the directly impacted sector was the processing of frozen potato products, which the processing sector buys as an input from potato farmers. To estimate the processed potatoes that would result from $97 million of raw potatoes, B-H refer to table 13, which shows that each dollar of processed potatoes requires 30 cents worth of raw potatoes. Thus $97 million * 1 / 0.3 = $325 million processed product. Again, the source of this very important 0.3 number is uncertain. If it is attributable to a MS thesis by Nick Beleiciks, then it may be appropriately Columbia Basin specific. However, if it is attributable to IMPLAN, as was implied earlier, then it would be based on average national production relationships with questionable applicability to the Columbia Basin potato processing industry.

B-H also included other forward linked impacts in their scenario 3 analysis:

> "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."

The locally provided portions of the trucking, railroad, and wholesale trade sectors are included as direct impacts in table 14, along with the $24 million in imported services from those sectors. The same questions remain:

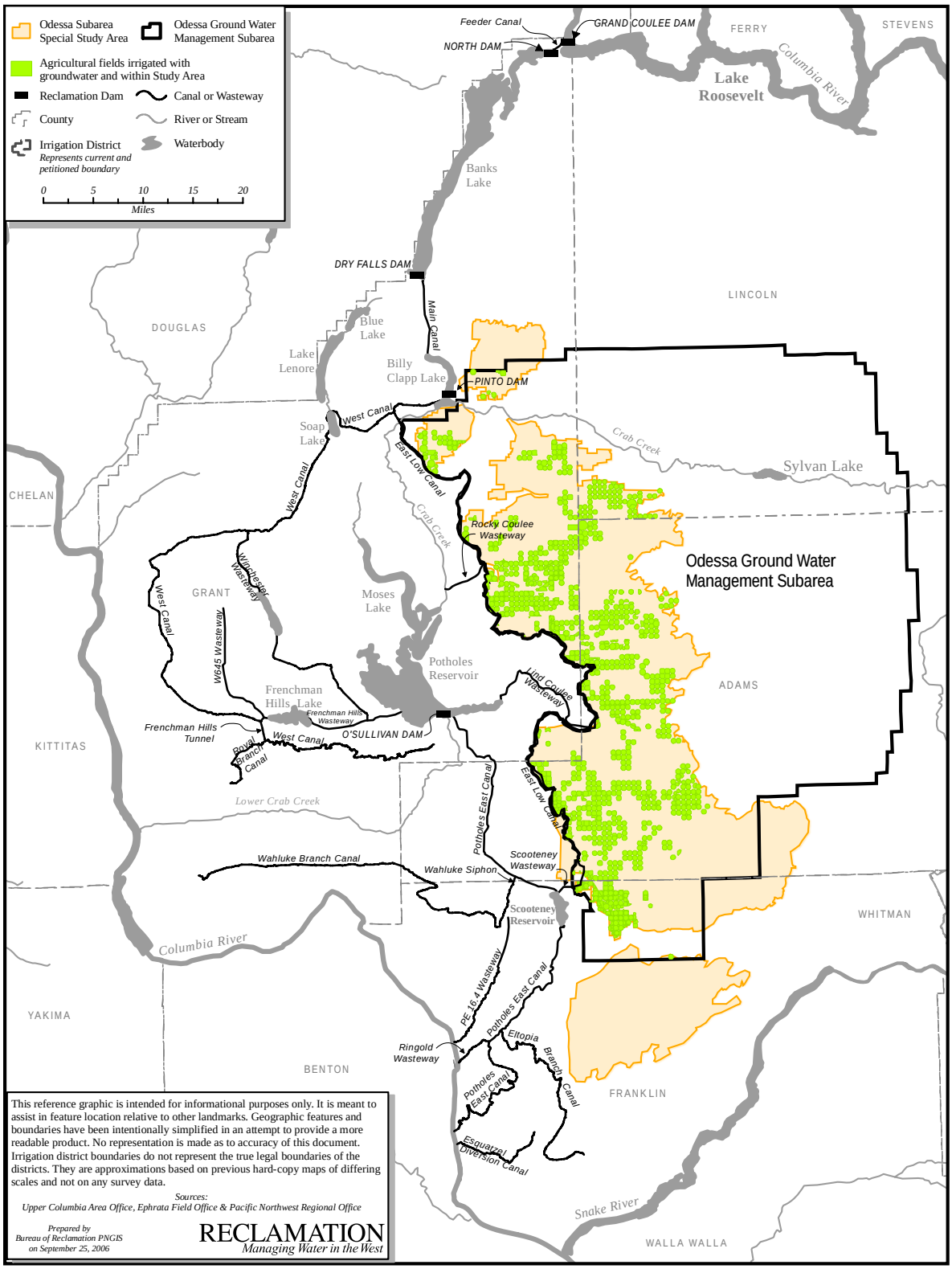
- There is the question of double counting, where B-H include both the backward and forward linkages for these sectors.
- It remains unclear whether the gross margin procedure for the wholesale trade sector were properly followed.
- The apparent inclusion of imported services in the direct and total regional output impacts figure is not a plausible procedure.
- The resulting income and jobs results look implausible, with a disproportionate number of jobs and income attributed to the transport and warehousing sectors.

Conclusions: I have a number of serious concerns about the analytic procedures used by Bhattacharjee and Holland. The four-county study area used by B-H may not be the most appropriate study area. This limited study area means that important impacts to the wider economy of the state are ignored. If B-H had used the entire state as their study area, there would have been very little impact. The B-H study includes forward linkages, which may have resulted in double counting of impacts. They may also have neglected to properly measure the wholesale trade sector in terms of gross margins. All these issues raise serious concerns about the credibility of the economic model results in the B-H study. The numbers now being quoted from the B-H study (especially the $630 million number and the 3,600 jobs number) are not credible, and should not be used. Hopefully, if the BOR properly analyzes the proposals to expand the CBP, it will address these issues and model them correctly.

See these figures on the following pages:

Figure 1: Location of the Odessa Area Groundwater Irrigated Lands
(Source: http://www.usbr.gov/pn/programs/ucao_misc/odessa/report-alternatives.pdf)

Figure 2: Boundary of the Four-County B-H Study area

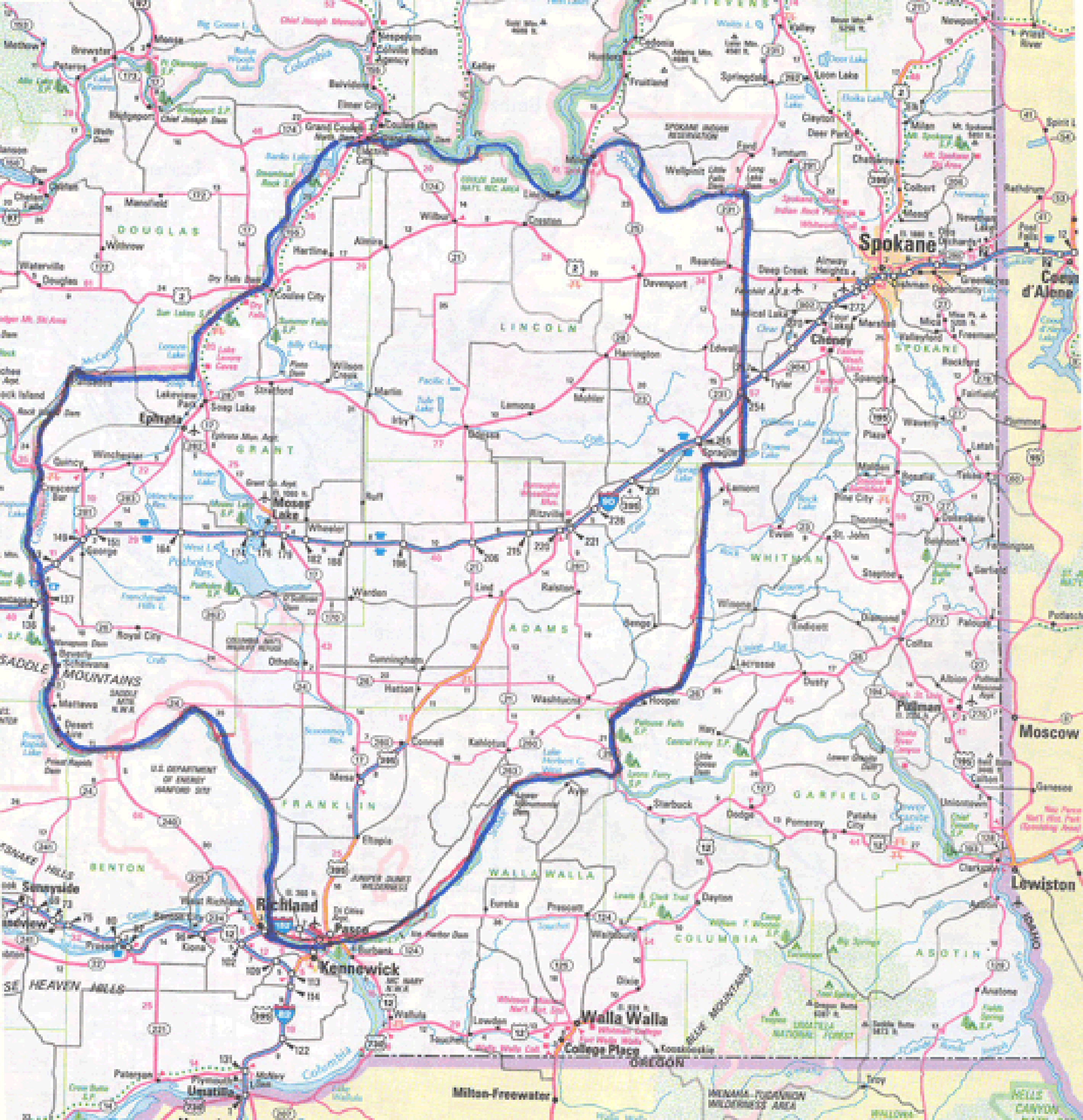


This reference graphic is intended for informational purposes only. It is meant to assist in feature location relative to other landmarks. Geographic features and boundaries have been intentionally simplified in an attempt to provide a more readable product. No representation is made as to accuracy of this document. Irrigation district boundaries do not represent the true legal boundaries of the districts. They are approximations based on previous hard-copy maps of differing scales and not on any survey data.

Sources:
Upper Columbia Area Office, Ephrata Field Office & Pacific Northwest Regional Office

Prepared by
Bureau of Reclamation PNGIS
on September 25, 2006

RECLAMATION
Managing Water in the West



Spokane
Coeur d'Alene
Moscow
Lewiston
Pullman
Richland
Pasco
Kennewick
Walla Walla
College Place
Milton-Freewater
Umatilla
Sunnyside
Prosser
Moses Lake
Ephrata
Soap Lake
Quincy
George
Wenatchee
Coulee City
Grand Coulee
Coulee Dam
Davenport
Ritzville
Sprague
Cheney
Medical Lake
Airway Heights
Deep Creek
Reardan
Harrington
Odessa
Lind
Connell
Mesa
Eltopia
Othello
Royal City
Warden
Wilbur
Creston
Almira
Hartline
Wilson Creek
Washtucna
Kahlotus
Hooper
Lacrosse
Dusty
Colfax
Rosalia
Tekoa
Oakesdale
Garfield
Palouse
Pomeroy
Dayton
Waitsburg
Prescott
Starbuck
Clarkston
Asotin
Anatone
Newport
Chewelah
Deer Park
Colville Indian Agency
Nespelem
Brewster
Bridgeport
Waterville
Mansfield
Mattawa
Benton City
West Richland
Kiona
Wallula
Touchet
Lowden
Dixie
Burbank
DOUGLAS
LINCOLN
GRANT
ADAMS
FRANKLIN
BENTON
WALLA WALLA
COLUMBIA
GARFIELD
ASOTIN
WHITMAN
SPOKANE
SADDLE MOUNTAINS
BLUE MOUNTAINS
HORSE HEAVEN HILLS
RATTLESNAKE HILLS
U.S. DEPARTMENT OF ENERGY HANFORD SITE
Potholes Res.
Columbia
Snake
OREGON
IDAHO