

SUPPLEMENTAL REPORT ON THE  
ANALYSIS OF WATER RIGHT SURVEYS OF THE ZUNI INDIAN TRIBE  
AND THE UNITED STATES ON BEHALF OF THE ZUNI INDIAN TRIBE

Prepared for:

State of New Mexico Office  
of the State Engineer Santa  
Fe, New Mexico

By:

A handwritten signature in black ink, appearing to read 'J. McNees', is written over a horizontal line. The signature is stylized and cursive.

James F McNees

Bureau Chief, Hydrographic Survey and Mapping Bureau  
Litigation and Adjudication Program  
Office of the State Engineer May  
10, 2013

## **I. Overview**

### **A. Introduction**

This report is a supplement to a report titled "**ANALYSIS OF WATER RIGHT SURVEYS OF THE ZUNI INDIAN TRIBE AND THE UNITED STATES ON BEHALF OF THE ZUNI INDIAN TRIBE BY THE STATE OF NEW MEXICO, OFFICE OF THE STATE ENGINEER**" prepared by Ben Wear and dated February 26, 2010 (Wear 2010). Mr. Wear is no longer employed by the OSE and I have prepared this report in my capacity as Bureau Chief of the Hydrographic Survey and Mapping Bureau of the Litigation and Adjudication Program of the Office of the State Engineer. This report reviews and adopts the previous conclusions of Mr. Wear and it replies to certain comments made by Dr. L. Neil Allen in his report titled "**ZUNI INDIAN RESERVATION REVIEW OF AND REBUTTAL TO EXPERT REPORTS FOR PAST AND PRESENT IRRIGATED LANDS SERVED BY PERMANENT IRRIGATION WORKS**" dated November 1, 2011 (Allen 2011).

I agree with the following conclusions in Mr. Wear's report:

1. The Points of Diversion are actual diversion points. (Wear 2010, pages 7 and 10.)

In addition to Mr. Wear's conclusion I would like to add that the point for Tekapo Reservoir is not mapped and an additional point of diversion for Pescado Reservoir off the Pescado River is not shown.

2. I agree with Mr. Wear that 3 of the ditch segments are identified incorrectly. (Wear 2010, pages 7 and 10.) Dr. Allen also agrees with Mr. Wear's statements (page 52 & 53, Allen 2011).

In addition to Mr. Wear's conclusions I would like to add that a segment of the Zuni River below the Tekapo Reservoir is identified as a ditch and shown as a ditch on NRCE Map 5B-1F, Zuni River Basin Hydrographic Survey, Irrigated Acreage-Zuni Indian Reservation, dated March 2007 by Natural Resources Consulting Engineers, Inc. Also, a ditch that conveys water from the Rio Pescado to the Pescado Reservoir and a ditch that conveys water to Tekapo Reservoir from the Zuni River were not mapped by NRCE.

3. I agree with Mr. Wear that the annual tabular crop reports prepared by the BIA are the most reliable measure of the actual irrigation and that the maximum acreage historically irrigated in any one year from permanent works was 2904 acres reported in the 1949 crop report. (Wear 2010,page 10)

4. I agree with Mr. Wear's final statement". . . the HSMB staff does not agree with the survey of irrigated lands conducted by NRCE."

## **B. Additions to Wear Report**

In addition to supplementing Mr. Wear's report I would like to respond to some of the statements made by Dr. Allen in his 2011 report. (Allen 2011)

Dr. Allen states in his 2011 report:

{Page 1) "... the major differences between Wear's approach and NRCE's

concerns the definition of past and present irrigated lands, not the fact that the

Zuni have irrigated the lands in question." (Allen 2011)

I think that Dr. Allen's focus on the definition of "past and present irrigated lands" overlooks important technical differences in the two reports. That is shown by the second half of his statement that implies there is no difference of opinion on the fact of whether the lands mapped by NRCE have been irrigated or not. I do not think this statement is accurate and misrepresents

Mr. Wear's views, views that I share. While Mr. Wear's opinion of the NRCE mapped lands may not have been stated as strongly as it could have been, Dr. Allen ignores the fact that Mr. Wear qualified his statement by saying the land delineated by NRCE appear to be *irrigable* and *may* have been irrigated in the past. Mr. Wear states in his report:

(page 8) – "Based on the historical aerial imagery review and the location of irrigation conveyance works, the HSMB concludes that, while the reasoning behind some delineation in the mapping is not quite clear, the areas delineated by NRCE appear to be *irrigable lands under constructed works* that *may* have been irrigated in the past." (Wear 2010) Emphasis added, restated in similar language on page 10.)

One of the primary tasks of a hydrographic survey of Zuni Pueblo lands should be to collect, analyze and present the data that may be available to describe the past and present irrigation on Zuni Pueblo. There is a large body of information in the form of crop reports as well as other technical reports made on Zuni Pueblo farming and irrigation that have been left out of the NRCE report. In this report I will outline that information more fully than Mr. Wear did in his report. In addition there are errors and inconsistencies in the NRCE hydrographic survey maps I will discuss in this report.

Mr. Wear and Dr. Allen do both agree that the lands mapped by NRCE were never all irrigated in any one year. Mr. Wear states in his report;

". . . there is no evidence to suggest that the total acreage surveyed was ever irrigated in any one year." (page 10)

Dr. Allen makes that statement in both his reports (Allen 2008, Allen 2012);

Page 2-3-2008 "...the aerial photography acreage data represents a composite total of all acreages determined to have been irrigated, as opposed to the total acreage in any one year."

Page 6 (2012)-"The irrigated acreage presented by NRCE is a composite acreage and does not purport to represent land that the Zuni have irrigated in any single year."

Page 52 (2012)-"The total cumulative acreage (7,018 acres) surveyed for the Zuni does not represent the amount of land that is cultivated or irrigated in any single year."

Dr. Allen also states that NRCE made no attempt to determine how many acres may have been irrigated in any one year by Zuni Pueblo.

Page 1 -"NRCE did not estimate the maximum acreage irrigated in a single year."

Not only did Dr. Allen not estimate the maximum acreage irrigated in a single year, but he appears to have left out of his report any analysis of any previous reports that may have included a reference to annual farming or irrigation.

## **II. Available Technical Data**

There are a number of reports and documents that list information on Zuni Pueblo irrigation. One is a set of annual tabular reports made by various agencies including the US Indian Irrigation Service and the BIA. Some are just titled "Fifth Irrigation District" or "Irrigation Project Data." There are also several technical reports about Zuni irrigation, many of which include information on irrigable land, irrigated land, land under ditch and/or cropped land.

### **A. Annual Tabular Crop Reports**

Mr Wear described these reports in his 2010 report on pages 9 and 10 and lists the reports he had in Appendix III of his report. These reports have a fairly common tabular format and list

acres, yield and value. Some give an overall summary for the Zuni Reservation and some give information for the individual projects of Zuni, Pescado, Nutria, Tekapo and Ojo Caliente.

Some of the crop reports include additional information. The 1924 report includes a hand written statement; "3885 acres under the Zuni Project, 3596 acres cultivated outside the project. About one third under irrigation and the balance dry fanning." Those acreages result in a total of 7481 acres cultivated, with 2493 acres irrigated. Many of the reports also include a listing for "School or Agency," "School Farm" or just "Other." Starting in 1948 there are no acreages reported in this "Other" category. I believe this category refers to lands that were eventually taken under the jurisdiction of the pueblo and should be included in the total for cropped land for that year. The 1926 report for the Zuni Area project has a hand written note "\*Irrigated from Zuni Reservoir" and the report for projects other than the Zuni Area Project lists 3676 acres and has a hand written note that "These are both irrigated and dry fanning." The 1931 crop report includes a note "(1) Include irrigated pasture as a regular item of crops." The 1932 report includes a category for "Pasture Irrigated" and the acreage for that crop is included in the total for the cropped acreage. The 1932 report is also the first report we have that includes separate reports for each of the individual projects. The 1934 report includes an overall Pueblo Summary and well as a table for each project area and is the first year that starts to report double cropped lands. The 1934 Summary report notes that 365 acres were double cropped and does not include that acreage in the Net area irrigated. At the bottom of the report there is a hand written note that says that 9.7% of the net area irrigated was in pasture. This hand written note uses the acreage reported in the table as "Pasture: Irrigated" to make the calculation. I have no crop reports for 1935-1946. The 1947 crop report is made in the same format that the 1934 report used. The 1947 report lists acreage under a category titled "Irrig. not cropped" and those acreages are included in

the "Total Irrigated." It also lists the Alfalfa and Com lands used for pasture. The 1947 report includes a summary report and individual reports for each irrigation project area. At the bottom of the summary report for 1947 Fallow acreages of 360 and 78 acres are listed next to the totals. I have no report for 1951. The 1952 report changes the format of the table slightly. The report includes a note to "include irrigated pasture lands" and has a note typed in at the bottom of the report that it was a poor com crop and there was a lack of water. The 1952 report only has a summary page and does not give any detailed information on the individual irrigation projects. I have no report for 1954. The 1955 report adds categories for "Idle, not irrigated" and "Total farm area." I do not have any reports for 1956 to 1980.

The 1981 crop report is different from any of the previous or later reports. It was provided to us attached to an undated Memorandum from the Natural Resources Manager, Pueblo of Zuni to the Area Director, Albuquerque Area Office, Attn: Br. of Irrigation. It includes categories for "Dry Lands," "Irrigated Lands," "Total Acres Cropped" and "Idle Acres," and gives acres for each of the individual irrigation project areas. There is no category for Fallow or "Irrigated not cropped" that is included in the reports following 1981. It is of note that "Irrigated Acres" in this report does not mean actual cropped irrigated acres, but appears to more likely mean irrigable acres. A different category is given for "Total Acres Crops." "Irrigated Acres" is actually a sum of "Total Acres Crops" and "Idle Acres." This report also indicates that there are a substantial amount of "Dry Lands" in every irrigation project area. The amount of acreage reported as "Total Acres Cropped" in the 1981 crop report are also high compared to any of the years that follow. The "Total Acres Cropped" for the Nutria Project area is 20 times higher than the amount of acreage reported in 1982 for this category. The irrigable acreage reported for the Nutria Project area is 6 times higher than the same category reported in every year after 1981 for

which we have a crop report. Even given the high number of "Irrigated Lands" reported in 1981, the 1804 acre sum for the "Total Acres Crops" still below the total amount of cropped or irrigated acres reported during the mid 1930s through the 1950s for which we have crop reports.

I have also reviewed crop reports from 1982 to 1993 and 1997 to 2001 and 2003 and 2004. All years have separate reports for each project area; there is no report for Tekapo for 1984, for Pescado in 1992 or Zuni or Nutria for 2004. The details of the tabular format change in appearance, but all include the same categories. All have a note to include irrigated pasture. The 1982 report includes a category for "IRRIG. NOT CROPPED" instead of the category of "Fallow Acres" used on the reports from 1983 onward. The reports also include categories for double cropped, idle not irrig. and "TOTAL IRRIGABLE" or "Total Irr. Ac." Starting in 1991 several of the reports have comments put on them with a hand stamp. The 1991 report for Tekapo has "NON IRRIGABLE FOR THE RECORD" stamped on it, but shows 11.5 ac. cropped. In 1992 all the reports for the various areas have "FOR OUR RECORD-DRY FARMING" stamped on them and list crops and acreage under that heading that are not included in the "Acres Cropped" category of the reports. Some of the reports also have "NON-IRRIGABLE CROPS" stamped on them. The 1997 reports all include some kind of note for the given units. For instance the Ojo Caliente report notes "NOTE: Due to abundance of water source and pvc pipeline in the area, all crops were irrigable. Again another good year for the unit." Several of the reports also state "NOTE-ELK DAMAGE ON HAY AND CORN PRODUCTION." All of the reports for this time period also list a "TOTAL IRRIGABLE" for the unit. The total irrigable for each area is; Ojo Caliente always lists 400 ac.; Nutria always lists 200 ac.; Zuni always lists 1600 ac.; Tekapo lists either 100 ac. or 300 ac.; Pescado lists either 200 ac. or 300 ac. The acreage for the total irrigable acreages for all the projects varies from a



low of 2300 acres reported in 1992 to a high of 2800 acres reported in 1987. 1985 reports a total irrigable of 2700 acres with the rest of the years reporting 2500 or 2600 acres.

The BIA crop reports are listed by Dr. Allen in his 2008 report under the section on "Lands Irrigated by Permanent Works" on page 2-3, but no description is given on how they were used in Dr. Allen's analysis. It appears they were not used. Dr. Allen's 2008 report does note that the crop reports were used in the determination of the cropping pattern used by Dr. Allen in his CIR calculations.

Page 3-1 "Using data recorded by the BIA from 1934 to 2004, along with additional data obtained for the counties of Cibola and McKinley (NASS, 2007), the cropping patterns were determined as a percentage of the total irrigated land." (also see (Allen 2008) section 3.1.1. and (Allen 2011 pages 44-45) section 4.2.2)

NRCE does not discuss why the crop reports were not used in their analysis of past and present irrigated lands. As noted above, Dr. Allen states in his report that they did not estimate the amount of acreage irrigated in any one year.

A listing of the crop reports is attached to this report as Appendix I. The report is similar to Mr. Wear's but has some differences and corrections. Mr. Wear omitted some acreage on the 1997, 1998 and 2003 listing. Those have been added and the sums for those years corrected. For the 1948 and 1949 Mr. Wear did not list the "Irrig. not cropped" acreages listed in the Zuni Project in that report, but just listed the "Net area irrigated" as listed or summed from the acreages listed in the reports. The attached table lists out the "Irrig. not cropped" acreages as a separate category.

These annual tabular crop reports are an important source of data to include in a hydrographic survey of Zuni Pueblo lands. They include information on double cropped lands,

fallow lands, dry farm lands as well as cropped and irrigated lands. The early crop reports may not be as reliable as later reports since there is no way to tell if they include the double cropped or fallow lands that are noted in some of the later reports. Dry farming is noted as far back as the 1926 crop report, but according to the 1981 crop report was still active on Zuni lands. Regardless of the definition of past and present irrigated lands that a hydrographic survey adopts, the information included in the crop reports should be included in a hydrographic survey of Zuni Pueblo Lands.

### **B. Other reports that include irrigation and farming information.**

Information about Zuni farming and irrigation is included in a number of other documents. These documents were provided to the State either through discovery or have been found by the State's expert historian during his research. They were all provided to me as Adobe Acrobat pdf digital documents. Some appear to be partial documents or compilations of documents found in files at the BIA or Zuni agency. I cite them as they appear in those pdf documents. I've listed them chronologically. I do not list all documents which may include useful data and information, but I give a good overview of those documents I feel are most relevant. The page numbers given are the page numbers of the pdf documents.

#### **"8\_Zuni Projects-Zuni, Nutria, Pescado, Tekapo, Ojo Caliente FY 1923-1935"**

This is a 126 page pdf that includes various letters and reports relating to Zuni Pueblo agricultural projects and issues. Many deal with budget, human resource or project plans. On page 22 there is a letter about transfer of irrigation administration to the superintendent at Zuni and includes a description of the various projects is given. This report includes crop information for 1935 that I have listed below.

Area	Irrigated	Maximum Area	Quotes from letter
Zuni	1296 ac	2,000 ac.	"down from 5000 ac. due to insufficient storage and run-off"
Nutria	261 ac.		"which is probably the maximum with the available water supply."
Pescado	388 ac.	400 acres.	"water is available for the irrigation of approximately 400 acres."
Tekapo	170 ac.		No Comments, no Maximum Area in Report
Ojo Caliente	286 ac.	400 ac.	"after construction approx. 400 ac. can be cultivated"

The irrigated lands sum to 2401 acres. The State does not have a crop report for 1935 to compare these numbers to. They are somewhat higher than the 2241 irrigated acres reported for 1935 listed in Table 4 of the 1956 Engineering Report (for explanation see the discussion on this report below). The maximum area is not given for Nutria and Tekapo, but using the cropped numbers for those project areas would give a total maximum area of 3,231 acres. The maximum acres reported in this 1935 report are much lower than reported in the 1981 report discussed above but compare more closely to the total irrigable acres reported in the 1982 to 2004 crop reports which is from 2800 ac. in 1987 to 2300 ac in 1992. NRCE mapped a total of 6892.7 ac. of cumulative irrigated lands (2011, page 54).

#### Water Rights Files-Southern Pueblos Agency-Irrigation Service Records 1942

This appears to be a report on expenses and budgets. On page 2 of the pdf the following acreages are reported in a table titled "Justification for Budget Estimates"

Year	Ultimate Irrigable Area	Area under Constr Works	Irrigated
1936	10,000 acres	6800 acres	2041 acres
1937	10,000 acres	7000 acres	3798 acres
1938	10,000 acres	7000 acres	2410 acres
1939	10,000 acres	6300 acres	2485 acres

We have no crop reports for these years, but acreages for these years are reported in the Engineering Study, Table 4. These acreages match the acreages given in Table 4 for 1938 and 1939. Table 4 lists a total of 2116 ac. for all of Zuni Pueblo for 1936 and 2391 ac. for all of Zuni Pueblo in 1937. The numbers given for the Area under Constructed Works in this report are much larger than the Maximum Area acreages listed in the 1923-1935 report discussed above, but the acreages listed for Area under Constructed Works are much closer to the 6892.7 ac. reported as cumulative irrigated lands by Dr. Allen.

S.D.Aberle, General Superintendent-Cost Report, Fiscal Year 1942

This is a table listing several pueblos in New Mexico the table lists data about population, irrigated lands, construction and construction costs. For Zuni it lists:

Area Under Constructed Canal	1941	6300 ac.
Total Irrigated Calendar Year	1940 *	2725 ac.
Area Under Constructed Canal Not Irrigated	1941	3575 ac.

\*(typo, based on the rest of the report it should be 1941)

I have no tabular crop report for 1941, but the total irrigated in this report matches what is listed in Table 4 of the Engineering Study. The Area Under constructed Canal is the same as given for 1939 in the report discussed directly above and is close to the 6892.7 ac. reported as cumulative irrigated lands by Dr. Allen.

Water Rights File- Southern Pueblos Agency- Texas vs. New Mexico- Lyman Tyler Report, Misc. Research- Texas vs. NM, UPA Crop Reports 1947-1951

This pdf contains several hand written tables listing crop acreages for 19 NM Pueblos including Zuni. The report gives a single number for Zuni and does not break Zuni into the 5

project areas, but does list individual crops. This report lists the following total acreages for the given years:

Year	Acres	Author's Comments
1947	2720 ac.	the 1947 tabular crop report lists a total of 2273 ac. plus 100 ac. fallow
1948	3205 ac.	the 1948 tabular crop report lists a total of 2590 ac. plus 150 ac. fallow
1949	2723 ac.	the 1949 tabular crop report lists a total of 2757.50 plus 145 ac. fallow
1950	4268 ac.	Includes 1674 ac. listed as pasture for 2594 of cropped land. This is the only year that includes pasture. The 1950 tabular report lists 3987 Total Irrigated with 1252 double cropped with net irrigated area of 2735 acres.
1951	1018 ac.	There is no other report for 1951 to compare with this acreage. This is lower than reported for 1950 or 1952 and seems more in line with the Zuni Project area acreage.

This report includes 1951 which is a year for which I do not have a tabular crop report. We have crop reports for all the other years listed in this report. At first the acreages reported in this table do not appear to match the tabular crop reports. In particular, 1950 and 1948 are higher. A closer look indicates that individual crop acreage are usually based on the crop reports, but sometimes the acreages, particularly for the pasture, are added up in a confusing manner. For 1950 the acreages listed in this report for the individual crops come directly off the summary page for the 1950 tabular crop report. Adding all the lands shown on the 1950 crop report for pasture gives 1626 ac., which is 48 acres off from the 1679 ac. of pasture noted on this report. The 1948 report is similar. Adding up all the acreages given on the individual project crop reports, plus the acreages for the pasture in all the projects except Zuni totals to 3200 acres, 5 acres less than shown in this table.

For the 1947 crop total the acreages for wheat, hay, garden and melons is the same as the tabular crop report. The acreage for alfalfa in this table incorrectly uses the Yield shown in the tabular crop report. The acreage for corn differs significantly, but it is unusual that it is equal to the sum of Corn and Wheat, the crop shown directly below it. The major differences between the acreages shown in this report and those listed on the tabular crop reports appear to be differences

or errors in how the acreages are added up or transcribed from the tabular crop reports. Enough of the acreages match to show that the tabular crop reports were the basis for the acreages shown in this table.

The crop reports were used to compile this table, though they seemed to have made several mistakes in adding up these numbers.

#### ZUNI INDIAN RESERVATION, Engineering Studies of Land and Water Resources.

In his 2011 report Dr. Allen further identifies this report as "Arizona-v-California suit (Exhibit# 36)" (2011-page 7) Based on an acreage table and statements in the report this report accompanies the 1956 BIA maps discussed by both Ben Wear (2010, page 5) and Dr. Allen (2008, page 2-1) in their reports. Mr. Wear did not have copy of the report when he prepared his report.

There are a set of maps that accompany this report. The legend on those maps states that the maps are based on a land classification survey done by plane table by the BOR in 1939. Table 4 in this report does include the 1939 crop report and lists a total of 2399 ac. for that year. Referring to these maps Dr. Allen states "These maps appear to be a composite acreage of all acres that the Zuni have irrigated in the past and up to the time of the survey, similar to the composite acreage developed by Dr. Allen." (Allen 2011 Page 59) Dr. Allen gives no explanation for this comparison.

Though Dr. Allen compares the Engineering report to his report, unlike his report the 1956 report includes a list of crop reports in Table 4 for the years 1902-1955. Some years include only an overall summary for the entire Pueblo, some years include some or all of the individual projects; only 1951 does not list any acreage either in summary or for an individual project. The report does not give any explanation of the crop report numbers. The highest acreages reported

are 5085 in 1924 and 3748 in 1926 and then 2904 in 1949. The 1924 tabular report has a note that states "3885 acres under the Zuni Project. 3596 acres cultivated outside the project. About one third under irrigation and the balance dry farming." The Table 4 acreage for 1924 appears to take 1/3 of the 3596 ac. outside the Zuni Project and add it to the 3885 ac. listed for the Zuni Project to arrive at the 5085 ac. listed in the table. The 1926 report that covers the projects other than Zuni has a hand written note that states it includes both ". . . irrigated and dry farming" and so that total can't be used to determine the amount of land that may have been irrigated.

This report includes a Table 5 subtitled "Irrigated and irrigable lands of various units." The total acreage listed in this table is 5897 ac. "Irrigated," 1855 ac. "Irrigable under constructed works", 818 ac. "Irrigable no works" and gives a total of 8570 ac. These irrigated acreage numbers are higher than any amounts given for Irrigated or cropped lands listed in any crop reports we have or are listed in Table 4 of this report. They are also higher than the Maximum Area or Area under constructed works acreages given in several of the reports listed above. The 1955 crop report was done one year before the 1956 Engineering Report and is listed in Table 4 of the 1956 Engineering Report. That 1955 report lists a total of 2475 acres irrigated and has 4575 hand written in under the category "idle, not irrigated" and 7050 acres hand written under the category "total farm area."

## **2\_Irrigation Project Case File- Ojo Caliente Irrigation rehabilitation FY 1964-69**

This document contains information about agriculture, construction and resources in the area of the Ojo Caliente Project. Page 13 of pdf document in a section of the document titled "OJO CALIENTE IRRIGATION REHABILITATION" gives the following information about agricultural land at Ojo Caliente; "1564 acres mapped as irrigable, 1349 acres are under ditch. From 1931 through 1951 400 acres were reported as farmed. The 1963 crop census acreages

given in this reported are for a year for which we have no tabular crop report. The 1963 crop census shows 150 acres in crops, 200 acres idle and 250 acres in irrigated pasture. This reports states that some or all of this irrigated pasture may have been located on a side arroyo and seasonally flood irrigated." Later on page 14 of the pdf file it states that with the present ditch loss is 60% the system can properly irrigate 230 acres and if the system was underground pipes it could irrigate all 650 acres. Dr. Allen's 2011 report claims 876.3 acres for the Ojo Caliente Project. I would like to emphasize how the report describes the farm land in the area. It describes "irrigable" acres, acres "under ditch," "farmed" acres as well as acres "in crops" and shows how much the acreage described under each category varies. Compared to the 1564 acres mapped as irrigable in this report, the 1956 Engineering Report lists 973 acres as "Irrigated" and 646 acres as "Irrig. under cons. Works" for a total of 1619 ac. Though this report lists 1349 acres are "under ditch" only 400 acres are noted as "farmed" from 1931 to 1950 and of that 150 acres were cropped for the year 1963. The tabular crop reports from 1932 to 1950 list a low of 163 acres in 1933 to a high of 490 acres in 1949 with an average of 357 ac. The first report discussed in this section listed the Ojo Caliente area as having a maximum of 400 acres in 1935; here in 1964 a report is again stating the maximum farmed area as 400 acres and the 1987-2004 tabular crop reports list the maximum acreage for Ojo Caliente as 400 acres.

## 5\_Irrigation Reports CENSUS OF IRRIGATION FY 1964-70

This is a series of tabular reports attached to a letter and instructions from the US Department of Commerce, Bureau of the Census about the Census of Irrigation Organizations. There are several tables attached to the documents that give farming and irrigation information about Indian Pueblos and Reservations. The following is the information given about Zuni.



Year	Total Assessed	Presently Irrigated	Assessed Idle	Note or Comment
1963	4727 acres	2831 acres	1896 acres	(page 124 of pdf file)
1964	4727 acres	2133 acres	2594 acres	(page 118 of pdf file)
1965	4727 acres	2745 acres	1982 acres	(page 79 of j>_df file)
1966	4727 acres	1815 acres	2912 acres	(page 86 of pdf file)
1967	4727 acres	1261 acres	3466 acres	(page 96 of pdf file)
1968		1458 acres		This is a letter that notes 4727 acres suited for IRR, adequate water for 2600 acres. The letter states these acres are based on the 1968 crop report.
None	2600	1156 acres	1444 acres	Table has no date. Probably 1969 based on title of pdf file and how it seems to follow on comments noted above. 4724 acres is listed as Ultimate Irrig. Acres, 2127 acres as Poten. acre to be Devel. and 2600 as total assess and total projects (page 106 ofpdf file)

For 1963 to 1967 this report lists 4727 ac. as the amount of "Assessed lands," while the last entry in this report (which I think represents 1969) lists 4724 ac. as the Ultimate or Potential acreage to be developed and 2600 ac, as the total project acreage. The years covered by these reports fill in a time period for which we have no annual crop reports. Another pdf file I have from the same time period titled 9\_Irrigation Project Case File, REHABILITATION & BETTERMENT, ZUNI IRRIGATION AREAS-FY 1964-68 lists 4727 acres as the Ultimate Irrigable Area and later gives lists the same 4727 acreage as "Estimated Acreage Served From Rehabilitation & Betterment" (page 2).

!\_Irrigation Project Case File- NUTRIA IRRIGATION REHABILITATION PLAN FY 1972

This appears to be a planning document written to plan improvements in all areas of agriculture in the Nutria Project Area. Parts are hand written and parts are typed. Much of the document relates to budget and personnel. Several pages address current and planned irrigation in the project. The report states (Page 18 of the pdf) "Unit consists of 700 acres of irrigable land

of which 200 acres can be served from the existing distribution system." And (Page 20 of pdf) "This system will enable the water user to irrigate approximately 200 acres with adequate carriage capacity to irrigate 700 acres in the event additional storage is provided." These statements are summarized in Table I at the end of the report which states that 113 acres cropped under present conditions (1968), 200 acres can be farmed with canal rehabilitation and 700 acres with improvements to management, canals and storage. All three columns show pasture as the largest crop by acreage in the project. According to 1956 Engineering Report Nutria dam was built in 1932 with storage noted as overnight. Dr. Allen's 2011 rebuttal report claims 833.8 acres for the Nutria Project.

If improvements are required to expand the irrigated areas to 200 ac. and then further improvements are required to expand the irrigated area to 700 ac. than it is hard to understand how more lands could be claimed to have been irrigated in the past prior to any of those improvements.

### III Mapping Issues

There are several issues with the GIS and mapping of the Zuni Pueblo places of use (POU) that have a bearing on the State's position on whether all the lands mapped by NRCE have ever been irrigated and the belief by Dr. Allen that there is no disagreement between the State's Hydrographic Survey experts and Dr. Allen on whether those lands were ever actually irrigated. Maps showing the problems discussed are provided in Appendix II of this report.

#### A. Topology problems

The GIS polygon shape file provided to the State by NRCE has several topology problems. Topology errors are the result of vertices on one polygon/tract not matching to the vertices on an adjoining polygon. In total there are 4 areas of overlapping polygons in the data.

One such area lies between Tracts 1B-4N-IRR001, 1B-4O-IRR001 and 1B-4O-IRR002 (See Figure 1). There are thin slivers of overlap and gaps between the tracts. A little farther east an unexplained gap exists between Tracts 1B-4J-IRR001 and 1B-4O-IRR002. In addition to the gaps displayed in Figure 1, there are also overlaps between Tracts 1C-4A-IRR001 and 1C-4B-IRR007 and between Tracts 5B-3A-IRR001 and 5B-3F-IRR005. There are gaps between Tracts 1C-3P-IRR001 and 1C-3Q-IRR002; Tracts 1C-4B-IRR004 and 1C-4C-IRR005; Tracts 1C-4G-IRR001 and 1C-4H-IRR002; Tracts 2C-5K-IRR005 and 2C-5L-IRR002; and Tracts 5A-3D-IRR005 and 5A-3D-IRR002.

These are small slivers and do not represent a significant amount of acreage. Nonetheless, numerous tools exist in the GIS software to avoid or correct these types of errors. The fact that these types of errors exist in the data brings into question the amount of care and quality control that was put into the mapping of these features. These errors in the data should have been fixed.

## **B. Mapping Problems**

There are also a number of larger and continuous gaps between Tracts in the data. There is nothing visible on any year of imagery that corresponds to these gaps. They appear to be errors in the data that are the result of poor interpretation or mapping. These errors in the mapping are larger than the small topology errors noted above. There is a continuous gap between Tracts 2C-3C-IRR002 and 2C-3H-IRR003 in Nutria that does not correspond to any feature visible on the imagery (See Figure 2). There is a similar gap between Tracts 2C-3H-IRR001 and 2C-3H-IRR002 (See Figure 3) and a gap with its adjoining tracts also exist along the boundary of Tract 1C-4H-IRR001 (See Figure 4). Tract 1C-4H-IRR001 also extends out into the Road along the East line. There is also a triangle of out land between Tracts 2C-3C-IRR001 and 2C-3H-IRR002 that does not correspond to anything in any year of imagery (See Figure 5). These may not be all of the

unexplained gaps that exist in the NRCE data. (also see tracts 5A-3D-IRR001 and 5A-3E-IRR005). Several of the Tracts east of the Ojo Caliente Reservoir overlap with the reservoir as mapped by NRCE. Also, Tract 5A-3J-IRR-006 does not correspond to a tract on any year of imagery (See Figure 6, 7 & 8).

There is nothing on any year of imagery that corresponds to these gaps. Again, the fact that these types of errors exist in the data brings into question the amount of care and quality control that was put into the mapping of these features and brings into question the photo interpretation that served as the basis for the mapping. These errors in the data should have been fixed.

### **C. Interpretation Issues**

Dr. Allen states in both his 2008 and 2011 reports that Aerial Photography Interpretation was their primary means of identifying lands that have been historically irrigated;

"The primary basis for NRCE's mapping is historic aerial photography and digital imagery." (Page 53-Allen 2011)

"Appendix A provides a listing of individual irrigated tracts delineated from aerial photography." and "the estimated irrigated area of each tract from the composite delineation of aerial photography" (Page A-1 Allen 2008)

As I quoted above, Mr Wear states in his report;

(page 8) – ". . . the reasoning behind some delineation in the mapping is not quite clear . .

" I would like to give some examples of what Mr. Wear was referring to.

Tract 1B-4N-IRR001 (this is one of the tracts shown in Figure 1 that has topology errors) the imagery does not seem to correspond to the way the Tract is drawn (see Fig. 9, 10, 11 and 12). In every year of imagery the tract has large areas of unirrigated land. The year of imagery

that shows the most activity appears to be 1935, yet on the year of imagery large rectangular tracts appear outside of the mapped tracts that look similar to the tracts inside the claimed area. In some cases the boundary of the NRCE mapped Tract cut right through the tracts on the imagery. Since lands outside of the NRCE mapped Tracts appear on the imagery to look very similar to tracts inside of the NRCE mapped Tracts raises the question of what the criteria were for including the tracts. The NRCE Tract is mapped adjacent to a ditch and the ditch does appear to continue into the mapped Tract, but if the tract was mapped since it lies adjacent to the ditch, can anything more than its geographic location be claimed. An area similar to this is Tract 2C-3L-IRR002 (Figures 13, 14, 15 and 16). There are tracts outside of the NRCE mapped Tract that look very similar to tracts that are included in the NRCE mapped Tract. In one area the NRCE mapped Tract boundary cuts through the tract appearing on the imagery. What criteria were used to decide to include an area inside of the mapped Tracts?

The area of tracts 2C-5K-IRR001, 2C-5K-IRR005 and 2C-5L-IRR002 is an area that shows unirrigated land included inside the NRCE mapped tracts (see Fig 17, 18, 19 and 20). In this case clearly visible drainage channels surrounded by areas of unirrigated lands exist on all three tracts in all years of the imagery.

It is not the practice of the State Engineer to rely solely on aerial photography in the mapping of irrigated lands for a Hydrographic Survey. The State Engineer uses aerial photography in conjunction with detailed field inspections and/or detailed tract by tract maps such as those provided in water rights transactions such as permits or declarations or historic surveys. Used in isolation, aerial photography can be an inconclusive means of identifying irrigated lands. Considering the technical reports and crop reports discussed in section II above as well as the mapping issues discussed here, I do not accept the claim by Dr. Allen and NRCE

that the lands mapped by NRCE are lands that have actually ever been irrigated. I think the lands NRCE mapped are more likely the lands that may have been described in those earlier reports as irrigable lands or lands under constructed works.

#### **IV. Conclusions**

Dr. Allen's statement quoted at the beginning of this report is incorrect. That statement was;

(Page 1) "... the major differences between Wear's approach and NRCE's concerns the definition of past and present irrigated lands, not the fact that the Zuni have irrigated the lands in question." (Allen 2011)

While the issue of the "cumulative" approach to describing water uses may be important, the more important issue for Dr. Allen's hydrographic survey report is the omission of important data and information about Zuni Pueblo farmed and irrigated lands. As I have explained above, there is additional information that does not appear to have been considered by Dr. Allen in his reports. Not only do these additional reports include information about irrigated acreage, but they also include information about the relationship of cropped or irrigated acreage to larger acreages defined as irrigable, under constructed works or potential farm land as well as dry farmed lands. All of this is important information and should be considered in a report on past and present irrigated acreage.

I also think that Dr. Allen is incorrect in implying that the disagreement between the State and his report does not extend to "... the fact that the Zuni have irrigated the lands in question." I do not agree that all the acreage mapped as irrigated tracts by NRCE had been irrigated at some time in the past. There are several issues with accuracy and consistency of the mapping and

photo interpretation done by NRCE that undermine the claims that the lands they mapped were irrigated at some time in the past.

As noted above in the review of the crop reports and other technical reports, several different types of acreages for the project areas have been described in previous reports. There are irrigable areas, areas under constructed works, potential areas, assessed areas as well as cropped, fallow and irrigated areas. All of these terms have been used to describe the agricultural lands on Zuni Pueblo. I would agree, as Mr. Wear did, that the lands mapped by NRCE could be the areas under constructed works or irrigable lands. These are the terms that were used to describe much of the agricultural areas on Zuni Pueblo in various technical reports over time. Based on the tabular crop reports and other reports described above I think it is also clear that smaller areas inside of those irrigable lands were actually farmed over time. Dr. Allen's claim that the smaller areas of irrigated lands could have moved around enough to have covered all of the lands is not described in any of those previous documents or reports. In many of the reports plans were made to expand or improve the irrigation infrastructure such as ditches and reservoirs to take advantage of all the lands available, but there is no indication that those improvements were ever fully carried out. It is valid to ask how so much more land could have been irrigated in these areas before those improvements were made. There is also information in the technical reports that a significant amount of land was dry farmed within those project areas and using aerial photography alone it would be difficult to determine which lands were dry farmed and which were actually irrigated from the ditches. The long periods of time since most of the land in question was farmed also makes field inspections less conclusive. All these issues combined make it very difficult to conclusively determine in detail which lands listed in the crop reports and other technical reports within the project area irrigable lands or lands under constructed

works may have ever actually been irrigated. Dr. Allen offers no additional data to support their claim other than the NRCE photo interpretation.

Dr. Allen's Hydrographic Survey is incomplete and contains too many mapping and photo interpretation errors and inconsistencies to be used to describe the historic irrigation on Zuni Pueblo lands.

Though the state has not performed a complete hydrographic survey, after reviewing the available data a Hydrographic Survey performed to Office of the State Engineer Standards would produce a delineation of an irrigable area or an area under constructed works based on the current extent of the points of diversion, the ditch system, the ditch turn outs or head gates and the tracts of land accessible from that ditch system. A complete review of all the annual crop data would determine the maximum amounts of acreage that were irrigated annually within those larger irrigable areas. The 1949 tabular crop report lists 2904 acres as the maximum amount reported in any one year that was irrigated by means of permanent works. That acreage used along with the CIR calculated by John Longworth could be used to determine the amount of water that was historically diverted from the source of water used in that project area and used for irrigation within particular project areas. Based on my review of the data available, I believe both numbers taken together would constitute the description of past and present irrigation on Zuni Pueblo.



## **Bibliography**

"ZUNI INDIAN RESERVATION REVIEW OF AND REBUTTAL TO EXPERT REPORTS FOR PAST AND PRESENT IRRIGATED LANDS SERVED BY PERMANENT IRRIGATION WORKS", by L. Niel Allen Ph.D, P.E., Natural Resources Consulting Engineers, Inc. (NRCE), November 1, 2011. (Allen 2011)

"ZUNI INDIAN RESERVATION IDENTIFICATION OF LANDS AND ESTIMATION OF WATER REQUIREMENTS FOR PAST AND PRESENT IRRIGATED LANDS SERVED BY PERMANENT IRRIGATION WORKS", by L. Niel Allen Ph.D, P.E., Natural Resources Consulting Engineers, Inc. (NRCE), November 3, 2008. (Allen 2008)

ANNUAL CROP REPORTS-ZUNI PUEBLO, by US Indian Irrigation Service and/or Bureau of Indian Affairs (BIA), U.S. Department of Interior, various years 1921-2004.

"ANALYSIS OF WATER RIGHTS SURVEYS OF THE ZUNI INDIAN TRIBE AND THE UNITED STATES ON BEHALF OF THE ZUNI INDIAN TRIBE BY THE STATE OF NEW MEXICO, OFFICE OF THE STATE ENGINEER", by Ben Wear, Hydrographic Survey & Mapping Bureau, Litigation and Adjudication Program, Office of the State Engineer (OSE), February 26, 2010 (Wear 2010)