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Transcript Exhibit(s)

Docket #(s): L-00000P-01-0117-00000

Exhibit # : A1-A9, A12, A13, Com1

EXHIBIT
A-1
admitted

2001 LAND MANAGEMENT PLAN ANNUAL REPORT

Duke Energy Maricopa, LLC

Annual Report Regarding the Land Management Plan For the Arlington Valley Energy Project

June 2001

Background

On July 25, 2000, the Arizona Corporation Commission issued Decision No. 62740 amended in Decision No. 62995, November 3, 2000 granting a Certificate of Environmental Compatibility to Duke Energy Maricopa, LLC ("Duke Energy"). This Certificate was granted with 14 specific conditions. Condition 13 was added to address concerns raised by the Power Plant and Transmission Line Siting Committee regarding the manner in which Duke Energy was to manage the property it had acquired for water rights.

Specifically, Condition 13 states:

> Applicant shall implement a Land Management Plan that includes:
> (i) Installation of a professionally designed landscape plan for the entrance of the facility and along Elliot Road.
> (ii) A comprehensive revegetation program that will restore a large portion of the property with plant communities similar to the adjacent desert lands.
> (iii) A partnership with The Arizona Game and Fish Department to provide enhanced wildlife habitat on lands that border Centennial Wash.
> (iv) An annual report (for six years) submitted to the Arizona Corporation Commission setting forth the status of the Land Management Plan.

In April 2000, Duke Energy prepared a document entitled Land Management Plan for the Arlington Valley Energy Project. This document was entered into the record, as Exhibit A-6, during Duke Energy's CEC hearing before the Power Plant and Transmission Line Siting Committee. The Land Management Plan divides the property into five distinct zones. Duke Energy and its partners in the Land Management Plan set forth unique management plans for each of the five zones. The five zones and management objectives were set forth in the Land Management Plan as follows:

Zone 1: Landscape Plan

Duke Energy will retain a professional landscaping firm to design and implement a landscape plan for the southern edge of Elliot Road in front of the facility and both sides of the entrance road to the facility to help screen the facility from view.

Zone 2: Agricultural Lands Reclamation – actively farmed

This zone will remain in active agricultural production as long as reasonable to maintain the irrigation ditches in good working order and prevent potential dust and weed problems. When it is no longer reasonable to keep the land in agriculture, the land will be folded into the active reclamation activities described under Zone 3.

Zone 3: Agricultural Lands Reclamation – fallow agricultural land

This zone includes fallow agricultural lands. In order to better understand how to effectively implement a long-term revegetation strategy, Duke Energy has contracted with the University of Arizona. Pursuant to this contract, the University will undertake a study that would investigate revegetation on arid lands. The preliminary plan for the investigation was set forth in the April 2000 Land Management Plan. A revised plan is included in the detailed discussion below.

Zone 4: Wildlife Habitat Management Area

This zone was set aside for cooperative efforts to utilize the land for a wildlife habitat area. To that end, Duke Energy has partnered with the Arizona Game and Fish Department to find appropriate uses of this property.

Zone 5: Centennial Wash

The Land Management Plan proposes to leave this area intact.

Zone 1: Elliot Road and Facility Entrance Road.
Goal: Develop a visual buffer between the facility and Elliot Road.

DENA has contracted with Todd and Associates, Inc., a landscape architectural/planning firm, to complete the landscape design and prepare landscape/irrigation construction documents for the Zone 1 area to meet the criteria as so stated.

The proposed landscape palette has been refined slightly, still utilizing arid-adapted plant species to provide a naturalistic setting along Elliot Road. The proposed plant palette is as indicated on the attached landscape plans (Tab 1).

The initial conceptual landscape plan indicated an approximate 100' wide planting area to receive trees, shrubs, and accent plants along the southern edge of Elliot Road and at the entrance road, with the goal of creating a landscape that replicates a naturally occurring environment. Also, berming was to be provided to create additional visual buffering. As indicated on the attached current plans, the subject area has increased substantially in terms of distance from Elliot Road. The area is much less linear in shape, and extends to the south as far as 350' to 800' from the roadway, thus allowing the opportunity to provide a more naturalistic appearing landscape environment as opposed to a lineal 'streetscape' appearance. This increased area allows for much larger scaled, more naturally contoured berming to be created, and provides more opportunity to plant trees and shrubs along the side slopes and at higher elevations to enhance the visual buffering objective.

The intent of the current landscape plan is to create a landscape of natural appearance. Given the location of the project, and the fact that it is not a goal to create an 'entry statement', all of the plant materials will be arranged in a freeform, random pattern. The initial concept of transitioning from a naturalized landscape to one of a more 'structured appearance' is no longer the intent. The project entry road will vary from the Elliot Road frontage only in the fact that the plant materials at the entry will be of a slightly more lush nature, with more vegetative groundcover and accent plantings to distinguish the entry roadway. Flowering shrubs for seasonal color will be utilized over the entire landscaped area.

Per instructions from the County, all landscape plantings and irrigation will be kept out of the Elliot Road right-of-way. The increase in depth of landscapable area outside of the right-of-way will help to balance the proportion of the landscaped to non-landscaped area. All landscaped areas, as well as the right-of-way area along the south side of Elliot Road will receive a decomposed granite topdressing, of a color and size to replicate the native condition, for dust and weed control

The proposed landscape palette consists of arid-adapted plant species, which are selected for their tolerance to salt and alkalinity. The water source for the irrigation will be from a replacement near the northwest corner of the project site at the Elliot Road frontage. Water from this source, as well as the existing soil conditions, are high in salinity, thus making the plant palette selection critical to the success of the landscape, as well as insuring that the materials must be of an indigenous nature.

Duke Energy has begun implementation of the landscape plan. To date, the landscaping berms have been installed along the Elliot Road corridor.

Zone 2 and 3 : Agricultural Lands.
Goal: Reestablish arid adapted vegetation that is self-sustaining and representative of adjacent plant communities.

As set forth in the April 2000 Land Management Plan, Duke Energy will revegetate a large portion of the fallow agricultural lands. In order to understand how to effectively implement a long-term revegetation strategy, Duke Energy has contracted with the University of Arizona, Office of Arid Lands Studies. Pursuant to this contract, the University will undertake a study that would investigate the best methods for large-scale revegetation on arid lands. The preliminary plan for the investigation was set forth in the April 2000 Land Management Plan. An updated report was prepared by the University of Arizona for inclusion in this document.

ARLINGTON VALLEY RETIRED FARMLAND DESERT REVEGETATION REPORT

Prepared By Travis Bean, Martin M. Karpiscak and Steve Smith
The University of Arizona, Tucson, Arizona
May 2001

I. INTRODUCTION

As part of the Land Management Plan for the Arlington Valley Energy Project, the University of Arizona has begun to study the implementation of a comprehensive revegetation program to restore a large portion of the property with self-sustaining plant communities similar to the adjacent desert lands. The primary purpose of this revegetation program is to return these former agricultural lands to beneficial use as open space that will attract wildlife and enhance the surrounding environment. The scope of this project is large: approximately 1810 acres of retired agricultural land exists on the site, having lain fallow for a period of 5 to 15 years, as well as an additional 910 acres of currently farmed agricultural lands.

An estimated 850 square miles (2,200 square kilometers) of abandoned farmland exists in the Gila and Santa Cruz River Valleys of Arizona (Jackson *et al.*, 1991). Much of this barren land is dominated by exotic annuals such as tumbleweed (*Salsola kali*) and London rocket (*Sisymbrium irio*) (Karpiscak, 1980), existing in stark contrast to native desert lands dominated by creosote bush (*Larrea tridentata*) and saltbush (*Atriplex* spp.). This land is often associated with environmental problems

such as dust pollution, a loss of wildlife habitat, soil erosion and downstream flooding caused by rapid runoff from barren surfaces, tumbleweeds blowing onto roadways and adjacent properties, and auto accidents caused by dust storms. Until recently, there has been little interest in restoring the lowland scrub that is native to this part of the Sonoran desert, most likely due to its uncharismatic nature and a general lack of knowledge about its ecology.

Few studies have been done on the lowland desert vegetation that would have dominated the areas that were developed for agricultural production in the twentieth century. One such study by Shantz and Piemeisel (1924) evaluated the potential of the soils and vegetation for their agronomic potential and encouraged the agricultural development of these areas and another by Karpiscak (1980) evaluating secondary succession on abandoned farmland.

The revegetation of former agricultural lands in Arizona is a complex process involving many challenges and often has little success. This is, in part, due to the fact that establishing arid adapted vegetation on reclaimed agricultural lands is an evolving science and there is a general lack of an established methodology. Few examples exist of attempting revegetation on retired farmland (Jackson *et al.* 1991; Munda 1986) and even fewer on a site as large as the project area (Thacker & Cox 1992). Other concerns include dust management and the management of invasive weeds. Undisturbed or long fallowed agricultural soils develop a physical crust that limits the amount of dust capable of becoming airborne. Any soil disturbing event breaks this crust, which leads to an increased potential for dust problems and provides an establishment site for invasive plant species such as salt cedar and tumbleweed. Any irrigation used to establish native species can further aid in the establishment of such undesirable plants if not managed carefully. Furthermore, new transplants or seedlings are particularly attractive to wildlife, which will already be attracted to any irrigation systems especially during the drier periods of the year.

II. METHODS AND MATERIALS

a. Inventory Of Adjacent Undisturbed Areas

A recent inventory of undisturbed desert lands to the east and west of the site was conducted by the University of Arizona to provide an estimate of local native vegetation parameters. Vegetative density on these areas was estimated at 102 plants per acre (252 plants per hectare) and vegetative cover was estimated at 4 percent using line transects and the nearest individual distance method as described by Barbour *et al.* (1998). Average plant spacings were estimated at 21 feet (6 meters) from any random point to the nearest individual plant. The most abundant species on the adjacent undisturbed lands is creosote bush, which comprises about 60 percent of all plants on the inventoried areas. White bursage (*Ambrosia dumosa*) is the second most abundant species, comprising 25 percent of all plants on the inventoried areas. Other important species occurring on the adjacent lands include velvet mesquite (*Prosopis velutina*), wolfberry (*Lycium exsertum*), desert saltbush (*Atriplex polycarpa*), diamond cholla (*Opuntia ramossissima*), caltclaw acacia (*Acacia greggi*), white ratany (*Krameria grayii*), big galleta (*Hillaria rigida*), and fluffgrass

(*Erioneuron pulchellum*), among others. Plant species were identified according to Kearny and Peebles (1960).

b. Plant Material Sources

Unfortunately, many of the native species found in the inventory are not commercially available. Of those that are, most are not available in sufficient quantities for a project of this scale. None of the available plant materials are source-identified. The most desirable plant materials for use in most restoration projects are those from the primary restoration gene pools (Booth & Jones 2001) of the local native plant species. These would be plants grown from locally collected seed, representing plants that are genetically identical to the populations of interest as a result of proximity and genetic connectivity. A compromise was made in the selection of the plant materials, for the spring 2001, so that the appropriate locally adapted native species could be used, even though the exact origins of the materials were unknown. These materials are representative of the secondary restoration gene pool, as they come from sites geographically isolated from the target population but are theoretically still adapted to the target site.

c. Location of Test Plot

The location of the first experimental plot which was planted during the last week of March 2001 was moved several times. The original location was not used because the last crop (alfalfa) continued relatively strong growth. This location was therefore not representative of the remainder of the recently farmed lands to be revegetated. However, the original location is tentatively scheduled to be planted in the second phase of the experimental plan in the fall of 2001, after the alfalfa has had sufficient time to die. The second and third locations were not utilized for the initial experimental planting either because these locations could not be readily served with irrigation water or they were needed as areas directly tied to the construction of the power generating facility.

The chosen area for the first experimental plantings permitted easy access to irrigation water because of a pre-existing well and intact irrigation canals, and is representative of much of the retired farmland in its state of vegetation and in its developed soil crust. This means that we have begun phase 1 of the revegetation plan on fallow lands representative of zone 3. In the fall of 2001 we will expand the revegetation effort to include currently irrigated lands from zone 2 as well.

d. Design of Test Plot

The test plot was designed to evaluate the effectiveness of different techniques in establishing native vegetation. The test plot measures approximately 1,200 ft by 720

ft (400 m by 240 m) (E-W by N-S), or 20 acres (8 ha). A concrete lined irrigation carry ditch runs along the west side of the plot. Rows representing different treatments were spaced 10 ft (3 m) apart and run in an east to west direction. Each row is 1100 ft long, (370 m) leaving 50 ft (16 m) at each end for equipment to maneuver. Rows are randomly arranged in four blocks of 13 rows each. Each block contains the same 13 randomly arranged treatments, which allows us to evaluate the effects of environmental variations within the field. A fence was constructed around the perimeter of the four blocks, and 15 additional rows were placed outside the fence to evaluate the effects of herbivory.

e. Techniques Implemented

The techniques attempted in the test plot are represented in the row treatments. Treatments include different combinations of watering regime, plant materials, and field preparations. The different watering regimes tested include no water, furrow irrigation, and drip irrigation. These watering regimes were tested in conjunction with mechanically transplanted liners, manually transplanted liners, manually transplanted 1-gallon plants, a native seed mix applied with a no-till grain drill at high density, a native seed mix applied with a no-till grain drill at low density, and no plant materials at all. Deep ripping and the fertigation application of a pre-emergent herbicide were then applied to certain treatment combinations. We were hoping to pre-irrigate select rows before planting, but the pump became operational only a few days before the planting and so there was not enough time to permit it.

f. Techniques of Future Interest

In the future, we will arrange for seed to be locally collected from adjacent native populations. Transplants grown with this seed to be used to produce seed for future plantings. It may also be seeded alone or in conjunction with transplants. Seed is relatively inexpensive, but establishment is slow and unreliable in an area with such a low precipitation (5-7 in/yr. (122 mm –171mm/yr)). Supplemental irrigation might be used, but then invasive weeds may become a problem. Therefore dryland seeding is an option that will probably be considered for only some of the long-retired areas where an irrigation infrastructure is no longer operational. Elsewhere, transplants may be emphasized. A drip system with pumps and filtering equipment mounted on a movable trailer may be the irrigation method of choice. This might help to offset some of the high costs associated with drip as most of the system will be relocated after irrigation is phased out in each area. Drip will cut down on water usage and help to prevent the establishment of weeds. Pre-irrigation will be a must for all transplants.

Currently, the plan is to expand phase 1 of the revegetation to an additional 60 acres of fallow farmland directly adjacent to the south and west of the test plot. Another 40 acres of recently irrigated land located directly across the Winter's wash

to the east will also be included. This planting will take place sometime between November 2001 and January 2002. The techniques to be implemented on these lands will include the use of transplants and drip irrigation. The transplants will be hand planted using farm labor. A pre-emergent herbicide will be used. Fencing will not be used. Ripping will not be used.

III. PRELIMINARY OBSERVATIONS*

The most obvious problems were those associated with the mechanical transplanter. The transplanter was designed to transplant tobacco, and so was not designed to plant into ground that had not been tilled and prepared as in conventional agriculture. The randomization of treatments was also a problem for the transplanter, as it was designed to plant in paired rows. The net result is that the majority of the transplants were not placed firmly into the ground by the transplanter, but rather just placed onto the soil surface, where they had to be handled a second time by farm laborers to actually plant them in the ground. Mechanically planted liners into dry soil have approximately 30% initial establishment. Mechanically planted liners did not withstand deep furrow flood irrigation and did poorly under drip as well. In contrast, hand-planting of small liners was >90% successful when soil was pre-irrigated and then plants were individually irrigated immediately after.

In general, the inability to pre-irrigate was very detrimental to the survival of the transplants. However, this did not seem to have as great of an effect on the 1-gallon plants as on the liners. This may be due in part to the fact that the pre-dug 1-gallon holes were filled with water just prior to planting. They were also individually watered immediately after planting. Other factors that might be involved are the older age and more developed root structure of the 1-gallon plants. Another benefit of the 1-gallon plants is that they handled the deep furrow flood irrigation extremely well. Greater than 90% success was achieved using 1-gallon plants placed into a dry field with a watered hole.

The drip system experienced many problems as well. The initial setup was delayed, preventing the timely application of the initial irrigation. Also, the east end of the drip lines do not appear to receive as much water as the west end of the lines. The drip system continues to drip for many days after being turned off, resulting in standing water. This is detrimental to both transplants and seeds due to oxygen deprivation and salt buildup. In addition, the continuously moist surface is likely to facilitate the re-establishment of salt cedar.

Seed germination is occurring in both drip and flooded plots, but seems to be less abundant and diverse in flooded plots. The aerial application of Roundup appears to have been very effective in killing off the developing tumbleweed population. The irrigation application of Prowl has been reasonably effective in inhibiting the initial development of weeds. Thus far, no significant herbivory has been observed outside the fence.

*These are preliminary observations subject to change based on additional observation and data collection

IV. LITERATURE CITED

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Jackson, L.L., J.R. McAuliffe, and B.A. Roundy. 1991. Desert restoration: revegetation trials on abandoned farmlands. *Restoration & Management Notes* 9:71-80.

Karpiscak, M.M. 1980. Secondary succession of abandoned field vegetation in southern Arizona. Ph. D. dissertation, University of Arizona, 219 pp.

Kearney, T.H., and R.H. Peebles. 1960. Arizona Flora. University of California Press, Berkeley, California.

Munda, B. 1985. USDA-NRCS Tucson Plant Materials Center. Vegetative treatment of abandoned cropland in the Sonoran Desert to reduce soil erosion. Plant Materials Technical Note No. 4.

Thacker, G.W., and J.R. Cox. How to establish a permanent vegetation cover on farmland. Pima County Cooperative Extension, University of Arizona, Tucson, Arizona.

Zone 4: Wildlife Habitat Management Area
Goal: Provide enhanced wildlife habitat in the project area.

Representatives of Duke Energy and the Arizona Game and Fish Department have had excellent discussions over recent months to determine how best to accomplish improvements to existing habitat. These discussions have frequently included both the Arizona Game and Fish Department and University of Arizona to gain as much synergy from the two efforts; the goal is to encourage both game and non-game species. Most recently, site visits have been made with the Arizona Game and Fish Department and with a regional representative of Ducks Unlimited. The next step is to develop a habitat plan. That plan will include recommendations on the various options that might be considered in the development of a wildlife habitat program.

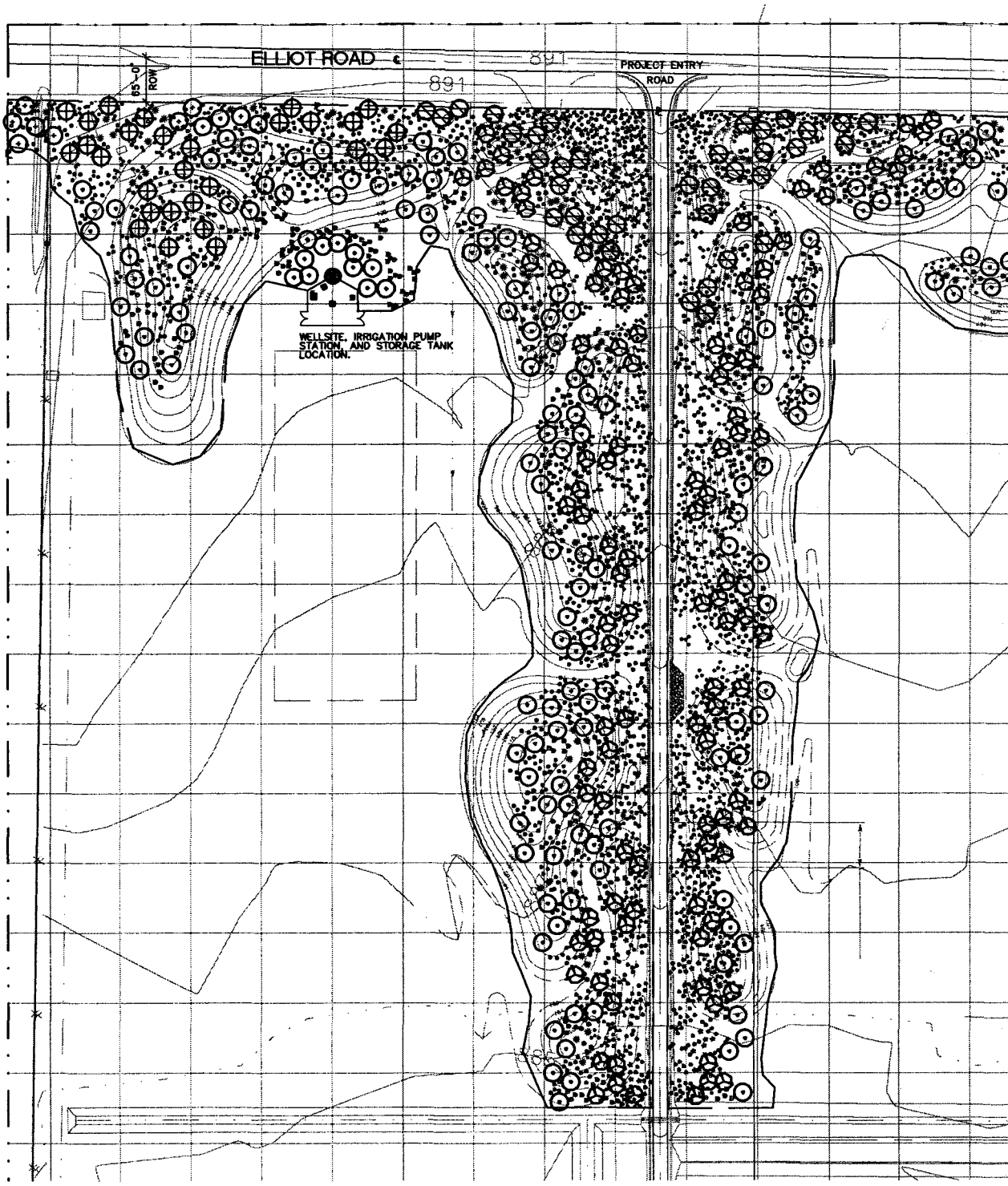
Zone 5: Centennial Wash
Goal: Protect existing riparian vegetation

The project contains only a small portion of land that has not been extensively managed for agricultural production. This area located in the southeastern portion of

the site is in Centennial Wash and contains a functioning riparian ecosystem. Duke Energy continues to maintain the area in its current state.

Conclusion

The Land Management Plan for the Arlington Valley Energy Project is progressing well. Duke Energy continues to work with its outside contractors including a professional landscaping firm, the University of Arizona, and the Arizona Game and Fish Department. These efforts have resulted in the implementation of the landscape plan, a comprehensive test plot by the University of Arizona to study the best methods for large-scale revegetation and conceptual meetings with the Arizona Game and Fish Department regarding enhanced wildlife habitats.



PLANT LEGEND

	COMMON NAME	BOTANICAL NAME	QUANTITY	SIZE	NOTES
TREES	SWEET ACACIA	ACACIA SMALLII	37	36" BOX	
	BLUE PALO VERDE	CERCIDIUM FLORIDUM	57/51	24"/36"BOX	36" BOX NOTED ON PLAN
	FOOTHILL PALO VERDE	CERCIDIUM MICROPHYLLUM	100	24" BOX	
	CHILEAN MESQUITE	PROSOPIS CHILENSIS	251/13	15 G./24" BOX	24" BOX NOTED ON PLAN
	VELVET MESQUITE	PROSOPIS VELUTINA	34	24" BOX	
	DESERT HACKBERRY	CELTIS PALLIDA	11	36" BOX	
SHRUBS	LITTLELEAF CORDIA	CORDIA PARVIFOLIA	507	5 GAL.	
	BLACK DALEA	DALEA FRUTESCENS 'SIERRA NEGRA'	345	5 GAL.	
	BRITTLE BUSH	ENCELIA FARINOSA	1548	5 GAL.	
	CHUPAROSA	JUSTICIA CALIFORNICA	434	5 GAL.	
	CREOSOTE BUSH	LARREA TRIDENTATA	804	5 GAL.	

ACCENTS/CACTI	PULQUE AGAVE	A
	SAGUARO	C
	OCOTILLO	F
	SACAHUISTA	N
GROUNDCOVERS	AUSTRALLIAN SALTBUSH	A
	DWARF DESERT BROOM	B
	SANDPAPER VERBENA	V
SEE SHEETS	DECOMPOSED GRANITE	D

*P

SCALE: 1"=100'-0"

0" 50' 100' 200' 300'

NORTH

GAVE SALMIANA	157	5 GAL.
ARNEGIEA GIGANTEA	28	8' SPEAR
OUQUIERIA SPENDENS	189	8' TO 10', 10 CANE
OLINA MICROCARPA	146	5 GAL.
TRIPLEX SEMIBACCATA	260	5 GAL.
ACCHARIS 'CENTENNIAL'	240	5 GAL.
ERBENA RIGIDA	323	1 GAL.
ESERT TAN*	1,579,000 SF.	3/4" MINUS, 1" DEPTH. RANDOM COVER OF 1"-3" D.G. COBBLE*

ER SPECIFICATIONS

ARLINGTON VALLEY ENERGY FACILITY
387th AVE. & ELLIOT ROAD
ARLINGTON, AZ.

DUKE ENERGY MARICOPA, LLC.
26405 W. MC85
BUCKEYE, AZ. 85326

Todd & Associates, Inc.
Architecture/Planning/Landscape Architecture
4019 North 44th Street · Phoenix, Arizona 85018 · (602) 952-8280 · FAX (602) 952-8695

Job# 00-0028-00 Date: 01-22-00 Revision: - Preliminary Not For Construction or Recording

3

EXHIBIT
A-2
admitted

COMMUNITY INFORMATION

A

NOTICES AND ANNOUNCEMENTS

Buckeye Valley News

BUCKEYE MARICOPA COUNTY ARIZONA 40 CENTS

August 30, 2001 Buckeye's News Source Since 1912 Volume 77 Number 35

Duke Energy®

Arlington Valley Energy

We would like to thank all those in Buckeye and the Westside communities that have made us feel so welcome.

Our experience here has been very positive and we now have plans to expand the capacity of the Arlington Valley facility.

We would like to invite any interested residents to a community meeting to hear about our plans and answer any questions that you may have.

September 5 - Ruth Fisher School
September 6 - Arlington Elementary School
6 to 8 p.m.

We would also like you to know that the Arizona Corporation Commission has scheduled hearings before the Arizona Power Plant and Transmission Line Siting Committee on Duke Energy Maricopa's Application for a Certificate of Environmental Compatibility to build Arlington Valley energy Facility II

Case No. 117

Those hearings will be held September 18, 19 at the Quality Hotel
3600 North 2nd Avenue, Phoenix, Arizona
Hearings begin at 9:00 a.m.
Interested parties are invited to attend.

Duke Energy®
Arlington Valley Energy

May, 2001

Dear Neighbor,

First of all, we would like to thank the many area residents who participated in our groundbreaking events earlier this spring. It was a great opportunity for us at Duke Energy to see a lot of friends and to meet many more. On a personal note, my wife Kathy and I have been made to feel very welcome as we settle in to the community and the wonderful "Arizona Lifestyle." We would like to thank those of you that we have met and made us feel so welcome. Over time, we look forward to getting to know many more you who live in the area.

As you know, there has been a lot of activity on and around the plant site the last several weeks and I thought this would be a good opportunity to up-date everyone on our progress towards our planned completion next summer.

First, we have moved the project office from Buckeye out to the plant site. Our phone numbers and mailing address however remain the same. We now have nearly 100 workers on-site and we are in the process of continuing with our underground piping; earth moving work, and pouring the first foundations for the turbine generators and the heat recovery boilers. It is our ability to capture the waste heat from the gas turbines and use it to drive the steam generator that makes this type of plant 40% more efficient than other existing technologies.

With the good progress we are experiencing, we expect to have 600 workers employed on site by early fall.

Additionally, please know that we are working hard to mitigate the traffic impacts on Elliot Road. This includes working with the other construction in the area and Maricopa County to accomplish needed road repairs.

We are very proud to say that in a much smaller groundbreaking ceremony in late March, we also put the first plantings and water in the field for the Phase 1 test plot of our joint re-vegetation project with the University of Arizona. Over the next few years we will be able to return over 2000 acres to a state of natural desert vegetation. Duke regards its reputation as an "Environmental Steward" to be one of the most important attributes of the company. Our commitment to that goal is unwavering.

Similarly, our joint effort with the Arizona Dept of Game and Fish will begin later this year on the south end of our property near Centennial Wash. The establishment of bird and game habitat on the site will continue over the next few years.

We should also finalize our schedule for the transmission and gas lines over the next few weeks. I'll keep you informed as we go along.

As always, I am available for any questions or comments regarding our facility, so please call me at 623-327-1314. Otherwise, it is also likely that we will see one another at various community events.

Sincerely,

Rufus Kellam
Director, Arlington Valley Energy Project.

Duke Energy®
Arlington Valley Energy

June, 2001

Dear Neighbor,

Let me begin with saying that with each passing month Duke Energy North America and the Kellam family in particular, are reminded how pleased we are that we chose to locate in Arizona. The community has been very supportive and we hope that you feel we have responded in kind.

Since the last letter to the community, we have had several positive developments regarding the progress of our Arlington Valley Energy project.

First of all, construction continues on schedule and activity has increased recently. We now have approximately 150 workers on site, and the number will continue to grow to a peak of 600 this fall. Two construction milestones are coming up shortly. In the next few weeks you will be able to see vertical construction as the plant begins to go up from the foundation work we have been doing. Also, specialized transport will begin to deliver the heavy components for the plant. These include the gas and steam turbines and the steam boiler.

Secondly, our very positive experience in Arizona has prompted us to commit to an expansion of the capacity of the Arlington facility. The critical power needs of metropolitan Phoenix, and the west in general will remain for some time. Duke has the ability to construct and deliver additional power quickly. For those reasons and others, expanding the capacity of Arlington Energy seems to be the right thing to do. Our current construction will be able to provide 570 MW of power in the summer of 2002. The expansion will double the overall output and we intend to have it all on-line by the summer of 2003. This additional construction, we believe, will further enhance the economy in Arizona with additional jobs and investment and at the same time, insure that there is sufficient power produced in Arizona for future needs.

Finally, we are pleased to announce that Arlington Valley Energy now has its own website dedicated to providing the community with up-to-date news and information about Duke Energy and Arlington in particular. We invite you to visit the site and check it in the future for progress reports and photos of construction and our re-vegetation project with the University of Arizona.

The address is: http://dena.duke-energy.com/arlington/

In closing, let me just restate that my wife Kathy and I are proud to be your neighbors and I hope that you will contact me with any questions or comments you may have regarding the Arlington Energy project. Positive comments are especially welcome, by the way.

Sincerely,

Rufus Kellam
Project Director

Duke Energy®
Arlington Valley Energy

August, 2001

Re: Duke Energy AVEF II

Dear Neighbor,

As you may recall from my last letter in June, Duke Energy North America has decided to proceed with an expansion of the Arlington Valley Energy facility. Last week an application was filed with the Maricopa County Planning and Development Department requesting a Special Use Permit to expand the facility. With the first 570 mw due to go online the summer of 2002, our expansion will double our capacity and is scheduled for completion the summer of 2003. We are pleased to report that process is moving forward with the necessary applications for permits to the Arizona Corporation Commission and Maricopa County.

At this time we would like to invite you to attend meetings that have been scheduled and to ask for your feedback on how we have been doing with the planned expansion. First of all, we will have two community meetings in early September. Both meetings start at 6:00pm and will be held at:

- September 5th – Ruth Fisher School
- September 6th – Arlington Elementary School

We hope you will plan to attend one or both of them and we look forward to visiting with you about our project and answer whatever questions you may have concerning the expansion or the current construction.

Secondly, the Corporation Commission has also scheduled a hearing for the 18th and 19th of September regarding our application there. The official notice is as follows:

- *Hearing before the Arizona Power Plant and Transmission Line Siting Committee on Duke Energy Maricopa's Application for a Certificate of Environmental Compatibility to build Arlington Valley Energy Facility II Case No. 117*

The hearings are scheduled to begin at 9:00am both days and will be held at the Quality Hotel 3600 N. 2nd Avenue Phoenix, Arizona.

In the way of construction updates, we are very proud that we now have had 200,000 work hours without a lost time accident. The permanent administration building is well under way and both of the large boilers are under construction. One of the gas turbines is now on site, as well.

Finally, much has been learned this summer with the University of Arizona re-vegetation test plots and we plan to expand the plantings this fall.

In closing, let me once again thank everyone in the Community for the cooperation and support we have seen since our arrival in Arizona. It is a pleasure for us to be living and working here. Please plan to attend any and all of the above scheduled meetings that may be of interest. If you have any questions in the meantime, please do not hesitate to contact me at 623-327-1314.

Sincerely,

Rufus Kellam
Director

[This plan was extracted from the addendum to the Special Use Permit submitted to Maricopa County Planning and Development, August 16, 2001. The exhibits A-D referred to herein are contained elsewhere in this exhibit book.]

ARLINGTON VALLEY ENERGY FACILITY II
SWC of 387th Avenue and Elliot Road
Arlington Valley, Arizona

PUBLIC INVOLVEMENT
And
CITIZEN PARTICIPATION PLAN

CITIZEN PARTICIPATION PLAN

Introduction:

This application for addendum to the Special Use Permit for Arlington Valley Energy Facility ("AVEF") deals with the expansion (the expansion referred to here as AVEF II) of a natural gas-fired electrical generating plant that is currently under construction (the current plant referred to herein as AVEF I). As such, the Public Involvement and Citizen Participation Plan for this addendum are actually already mature and ongoing components of a regular communication and feedback process that was begun prior to the initial permitting of AVEF I and extends back to 1999.

This exhibit outlines the process up to this application and stipulates the activities that will be done to fully comply with:

- Requirement to Notice
- Requirement to Post
- Requirement to Complete a Citizen Participation Plan Results Report

As part of the AVEF I permitting process, multiple community meetings were held both at Arlington (Arlington Elementary School) and Tonopah (Ruth Fisher School) and also included meetings with the Tonopah Community Council.

At those meetings, information was provided regarding Duke Energy and the plant in particular. That information included maps, photos, renderings, and information regarding air quality, water, noise, economic impacts and the company, The public was afforded the opportunity to ask questions and to answer surveys related to the plant and its construction.

All residents (approximately 1300) of Arlington and Tonopah were notified of the meetings by mail and flyers distributed at the schools. Spanish language translation was done in writing and provided in verbal form at the earlier community meetings.

Additionally, ads were taken out in the newspapers *El Sol* and *Buckeye Valley News* and flyers were distributed by the Buckeye Chamber of Commerce to their members.

All of this was part of the initial AVEF I submittal for the Special Use Permit and Area Plan Amendment.

Since the granting of the permits for AVEF I, Duke Energy has sent letters to all residents of Arlington and Tonopah providing information on the construction status and the re-vegetation program on an ongoing basis. Specifically, all residents of Arlington and Tonopah were notified by letter in June 2001 of Duke Energy's decision to move ahead with an expansion of the plant. Those letters and related press releases are all included in this Exhibit at **Tab A**.

Furthermore, Duke Energy / Arlington Valley Energy has established an AVEF specific website that includes information on:

- Plant size and description
- Environmental Protection
- Economic benefits
- Outreach activities
- Press Releases
- Arizona Contacts
- Updated photos on construction progress posted every 30 days
- At this web address: http://www.dena.duke-energy.com/arlington

Printed material as well as the letters to the community include the information about the website.

Duke Energy also hosted a Groundbreaking Ceremony in February of 2001 on the construction site and invited all community members, schools and various elected officials. The event was attended by over 200 guests and included school children from Ruth Fisher School, local elected officials, residents and community leaders.

As a result of the notifications regarding AVEF II expansion, various letters from the community have been written and copies of those we have seen are included here at **Tab B.**

Additionally, at the time that Duke Energy first engaged with the community and made applications for AVEF I, the company expressed its commitment to partner and participate with the area residents in worthwhile projects and activities. To date, Arlington Valley Energy has expended $300,000 in that effort. Local schools and civic organizations have been the primary beneficiaries and include the donation and construction of a computer lab for Arlington School, providing van transportation for Ruth Fisher School and funding the construction of a new track and field facility for Buckeye Union High School. A listing of recipient organizations is included with this Exhibit **Tab C.**

Finally, as part of Duke Energy's commitments under AVEF I, a partnership has been formed with the University of Arizona to undertake (with funding from Duke Energy) a re-vegetation program for all the land designated as "open space" as part of the AVEF I permit process. That program is well under way, with test plots currently planted and under irrigation.

Parties Affected by the Application:

The location of AVEF I and AVEF II is in a very rural area of western Maricopa County. The plant is specifically located in the area known as Arlington Valley. The community of Tonopah and the incorporated Town of Buckeye, while over 10 miles from the site, are other communities that could be affected by this application and the construction of the plant.

Notification and Information Procedures:

Notice to the community regarding this application and its substance has or will consist of the following:

- Letter to all residents (approximately 1300) of Arlington and Tonopah that Arlington Valley Energy has decided and plans to expand the capacity of the plant currently under construction on Elliot Road. **Completed – June 2001**

- Personal contact with community leaders and elected officials including Arlington, Tonopah, Buckeye, Goodyear, Avondale, Tolleson and Maricopa County informing them that Duke Energy desires to expand the capacity of AVEF I. **Completed – June-July, 2001**

- Letter to the residents (approximately 1300) of Arlington and Tonopah informing them that application has been made to the Arizona Corporation Commission and to Maricopa County for the necessary permits to expand AVEF I. Specifically regarding the ACC, the letter will notice hearing dates of September 18-19, 2001 including time and place. This letter will also invite area residents to two community meetings scheduled for September 5th at Ruth Fisher School and September 6th at Arlington Elementary School to present and discuss the scope of AVEF II including all relevant environmental, transportation and economic components of the planned expansion. A copy of the letter is included at **Tab D. To be mailed the week of August 20, 2001**

- Quarter-page advertisement in the *Buckeye Valley News* informing readers of the ACC and Maricopa County applications, noticing the ACC hearings of Sept. 18-19 and inviting readers to the two community meetings Sept. 5 and 6 mentioned above. **To run Aug 30, 2001**

- The letter at Tab D also will go to all real property owners within 300' of the proposed SUP request within 30 days of submitting the Special Use Permit

application. There are no homeowners associations within the 300' boundary. A copy of the 300' property owners list is included at **Tab E. To be mailed the week of August 20, 2001**

- Required postings on the Elliot Road property will be erected within 30 days of submitting the Special Use Permit application.

Response Procedures:

Issues and concerns expressed by residents and interested parties with be noted at the planned community meetings and each person attending will additionally be provided with a survey questionnaire to complete regarding Duke Energy and AVEF II. Duke Energy / Arlington Valley Energy will attempt to address issues that are raised. Outcomes of all of the above will be part of the Citizens Participation Results Report.

Schedule for Completion:

Communication to and with area residents and community leaders will continue on a regular basis from the time the Special Use Permit application is filed throughout the construction phase in particular and beyond. The AVEF website will be maintained and updated continually throughout the S.U.P. application, construction, and operational phases.

Status Procedure:

Duke Energy/Arlington Valley Energy will keep the Planning and Zoning Department informed of the status of our citizen participation efforts through written and verbal communication and timely submittals of required affidavits and Results Reports.
Issues brought to the County and not directly to Arlington Valley Energy will be addressed with the Planning and Zoning Department and where it is appropriate, with the originator of the question or issue as well.

ARIZONA CAPITOL TIMES

CLASSIFIED ADVERTISING

Notice of Hearing

NOTICE OF HEARING/THE ARLINGTON VALLEY ENERGY PROJECT

BEFORE THE ARIZONA POWER PLANT AND TRANSMISSION LINE SITING COMMITTEE

IN THE MATTER OF THE APPLICATION OF DUKE ENERGY MARICOPA, L.L.C., IN CONFORMANCE WITH THE REQUIREMENTS OF ARIZONA REVISED STATUTES § 40-360.03 AND § 40-360.06 FOR A CERTIFICATE OF ENVIRONMENTAL COMPATIBILITY AUTHORIZING THE CONSTRUCTION OF A NATURAL GAS-FIRED, COMBINED CYCLE GENERATING FACILITY (ARLINGTON VALLEY ENERGY FACILITY II) NEAR ARLINGTON IN MARICOPA COUNTY, ARIZONA.

Docket No. L-00000P-01-0117

CASE NO. 117

NOTICE OF HEARING

A public hearing will be held before the Power Plant and Transmission Line Siting Committee ("Committee") at the **Quality Hotel & Resort, 3600 North 2nd Avenue, Phoenix, Arizona 85013, on September 18 @ 9:00 a.m., and continuing September 19 @ 9:00 a.m. (hotel phone number: [602] 248-0222)** or as soon as the matter can be heard, regarding the application of Duke Energy Maricopa, L.L.C. or their assignee(s) ("Duke") for a Certificate of Environmental Compatibility authorizing the Arlington Valley Energy Facility II in Maricopa County, Arizona. The Arlington Valley Energy Facility II includes a 600-megawatt (MW) (nominal) gas turbine/steam turbine combined-cycle merchant power plant. This is an expansion of Duke's approved Arlington Valley Energy Facility I. The proposed site of the project is a 65 acre site approximately 50 miles west-southwest of Phoenix, in Maricopa County, Arizona. The project site is situated approximately 1.5 miles southwest of the Palo Verde Nuclear Generating Station property and 5 miles west of the town of Arlington. The site is located on the south side of Elliott Road between 387th Avenue and 391st Avenue, 112° 53' 34" longitude and 33° 20' 54" latitude, Section 17, Township 1 South, Range 6 West, Gila and Salt River Base and Meridian.

The Application, including detailed maps of the proposed Arlington Valley Energy Facility II, is on file with Docket Control Center of the Arizona Corporation Commission, 1200 West Washington Street, Suite 108, Phoenix, Arizona, 85007, and the Commission's Tucson Office at 400 West Congress, Suite 218, Tucson, Arizona 85701.

Depending on the issues raised and the number of intervenors appearing during the hearing, the Committee may deem it appropriate at some point to recess the hearing to a time and place to be announced during the hearing. At the discretion of the Committee, such resumed hearing may be held at a date, time and place designed by the Committee or its Chairman.

NOTE: Notice of such resumed hearing will be given. Published notice of such resumed hearing is not required.

Each county and municipal government and state agency interested in the proposed facilities and desiring to become a party to the certificate proceeding shall, not less than ten (10) days before the date set for hearing, file with the Director of Utilities, Arizona Corporation Commission, 1200 West Washington, Phoenix, Arizona 85007, a notice of its intent to be a party.

Any domestic, non-profit corporation or association, formed in whole or in part to promote conservation of natural beauty, to protect the environment, personal health or other biological values, or to promote the orderly development of the area in which the facilities are to be located and desiring to become party to the certification proceeding, shall, not less than ten (10) days before the date set for hearing, file with the Director of Utilities, Arizona Corporation Commission, 1200 West Washington, Phoenix, Arizona 85007, a notice of its intent to be a party.

The Committee or hearing officer, at any time deemed appropriate, may make other persons parties to the proceedings.

Any person may make a limited appearance at the hearing by filing a statement in writing with the Director of Utilities, Arizona Corporation Commission, 1200 West Washington, Phoenix, Arizona 85007, not less than five (5) days before the date set for hearing. A person making a limited appearance shall not be a party or have the right to present testimony or cross-examine witnesses.

This proceeding is governed by A.R.S. § 40-360.03 to 40-360.13 and Arizona Administrative Code, Rules R14-3-201 to R14-3-219. The written decision of the Committee shall be submitted to the Arizona Corporation Commission pursuant to Arizona Revised Statutes Section 40-360.07. Any person intending to be a party before the Arizona Corporation Commission must be a party to the certification proceedings.

ORDERED this 25th day of July, 2001.

/s/ Laurie A. Woodall, Chairman
Arizona Power Plant & Transmission Line Siting Committee
Published 7/27 and 8/3/01 editions ARIZONA CAPITOL TIMES.

B

PUBLIC RESPONSES

ROBERT BLENDU
1700 WEST WASHINGTON STREET
PHOENIX, ARIZONA 85007-2844
CAPITOL PHONE: (602) 542-5894
CAPITOL FAX: (602) 542-4030
TOLL FREE: 1-800-352-8404
rblendu@azleg.state.az.us

DISTRICT 15

COMMITTEES:
APPROPRIATIONS, VICE CHAIRMAN
RULES

APPROPRIATIONS SUBCOMMITTEE ON HEALTH AND WELFARE

JOINT LEGISLATIVE AUDIT COMMITTEE

Arizona House of Representatives
Phoenix, Arizona 85007

July 5, 2001

Ms. Laurie Woodall, Chairman
Arizona Power Plant & Transmission Line Siting Committee
1200 W. Washington Street
Phoenix, AZ 85007

Dear Ms. Woodall:

I am writing in support of the application for a Certificate of Environmental Compatibility submitted by Duke Energy North America for an energy facility planned in Arlington Valley, Arizona. I urge the Arizona Power Plant & Transmission Line Siting Committee to approve the application.

The application is based on a planned expansion of a clean-burning 570-megawatt combined-cycle natural gas plant located in Arlington Valley that has already completed the required permitting process and is currently under construction.

The expansion of the Arlington Valley facility will help to provide critically needed electrical generation capacity, add to our local economy by employing hundreds of skilled workers during construction and pay millions of dollars in taxes that will go to support local schools.

Thank you for you consideration of my support.

Sincerely,

Representative Robert Blendu

EDWARD J. CIRILLO
DISTRICT 15

STATE SENATOR
FORTY-FIFTH LEGISLATURE

CAPITOL COMPLEX, SENATE BUILDING
PHOENIX, ARIZONA 85007-2890
PHONE (602) 542-4173
TOLL FREE 1-800-352-8404, X4173
FAX (602) 542-3429
E-MAIL ecirillo@azleg.state.az.us

COMMITTEES:

APPROPRIATIONS
BANKING & INSURANCE, Chair
FINANCE
HEALTH

ETHICS COMMITTEE
JOINT COMMITTEE ON CAPITAL REVIEW
JOINT LEGISLATIVE BUDGET COMMITTEE

Arizona State Senate

July 5, 2001

Ms. Laurie Woodall
Chairman
Arizona Power Plant & Transmission Line Siting Committee
1200 W. Washington Street
Phoenix, AZ 85007

Dear Ms. Woodall:

I am writing in support of the application for a Certificate of Environmental Compatibility submitted by Duke Energy North America for an energy facility planned in Arlington Valley, Arizona. I urge the Arizona Power Plant & Transmission Line Siting Committee to approve the application.

The application is based on a planned expansion of a clean-burning 570-megawatt combined-cycle natural gas plant located in Arlington Valley that has already completed the required permitting process and is currently under construction.

The expansion of the Arlington Valley facility will help to provide critically needed electrical generation capacity, add to our local economy by employing hundreds of skilled workers during construction and pay millions of dollars in taxes that will go to support local schools.

Thank you for your consideration of my support.

Sincerely,

Edward J. Cirillo

Edward J. Cirillo

MIKE GLEASON
1700 WEST WASHINGTON STREET
PHOENIX, ARIZONA 85007-2844
CAPITOL PHONE: (602) 542-5409
CAPITOL FAX: (602) 542-3689
TOLL FREE: 1-800-352-8404
lgleason@azleg.state.az.us

DISTRICT 15

COMMITTEES:
NATURAL RESOURCES AND AGRICULTURE, CHAIRMAN
RULES
TRANSPORTATION

Arizona House of Representatives
Phoenix, Arizona 85007

July 6, 2001

Ms Laurie Woodall, Chairman
AZ Power Plant & Transmission Line
Siting Committee
1200 West Washington Street
Phoenix, AZ 85007

Dear Ms Woodall:

I support the application for a Certificate of Environmental Compatibility submitted by Duke Energy North America for an energy facility planned in Arlington Valley, Arizona. I urge the Arizona Power Plant & Transmission Line Siting Committee to approve the application.

The expansion of the Arlington Valley facility will help to provide critically needed electrical generation capacity, add to our local economy by employing hundreds of skilled workers during construction and pay millions of dollars in taxes that will go to support local schools.

In view of the current electrical problems, this expansion is a must for the West Valley.

Thank you for your consideration of my support.

Sincerely,

Mike

MIKE GLEASON
State Representative

MG/ga

Ruth Fisher School District #90

38201 West Indian School Road
Tonopah, AZ 85354

Phone 623-386-5688
Fax 623-386-3364

June 20, 2001

Honorable, Mary Rose Wilcox
301 W. Jefferson 10th floor
Phoenix, Arizona 85003

Dear Supervisor Wilcox:

Let me begin by thanking you for the representation and support you have given the Tonopah Community as a member of the Board of Supervisors. Your commitment to the entire district is greatly appreciated.

It is my understanding that Duke Energy of the Arlington Valley is applying for expansion of their electrical generating plant. To that end, I feel that Duke's track record in support of Ruth Fisher School and the Tonopah Community should be noted. I find it very refreshing to work with a company who is committed to the formation of a lasting partnership. As you are aware, rural Western Maricopa County has not had the luxury of many opportunities to establish working partnerships with industry. Duke has "Stepped up to the plate". Our school has, in a short time , reaped the benefits of a good neighbor.

Duke has contributed in excess of $15,000 over two years in funding a teacher vanpool, which has made the recruitment and retention of teachers much easier. They have also provided several pieces of equipment to assist us in exposing our students to new technology.

Sincerely,

Ruben S. Jimenez
Superintendent

cc:Rip Wilson, SRW Consulting

Buckeye Union High School District No. 201

902 Eason Avenue
Buckeye, Arizona 85326
Phone 623-386-4423 Fax 623-386-9705

Mr. Marty Arambel
Governing Board Member

Mr. Phillip Echeverria
Governing Board Member

Mrs. Jeanine Guy
Governing Board Member

Mr. Jerry Kerr
Governing Board Member

Mr. Gary Mayfield
Governing Board Member

June 21, 2001

Mary Rose Wilcox
Maricopa County Board of Supervisors
301 W. Jefferson
Phoenix, AZ 85003

Dear Supervisor Wilcox,

It is my understanding that Duke Energy is seeking approval from Maricopa County to expand their generating facility in Western Maricopa County, i.e., Arlington, Arizona.

Buckeye Union High School District receives students from the three Elementary School Districts surrounding the Duke plant. Serving a composite community as we do, we have a partnership interest in a good neighbor policy for the whole of Buckeye Valley.

When Duke Energy first arrived, they confidently announced that they would be good neighbors, keep us informed, and try to respond to our concerns and community needs. Even before they had even filed a permit application, company personnel made a genuine and credible effort to communicate with and support our communities. They also said they would be "straight" with us. Well, not all of us believed them.

It is my pleasure to report that this company has been true to its word. In particular, Rufus Kellam, the Project Director for Duke, has been very active in the communities.

While their first phase is still under construction, based on their record so far, I would like to voice support for their expansion. I believe the power plant and its employees are, and will continue to be, an asset to the Buckeye Valley.

Sincerely,

Dr. Henry E. Schmitt

Dr. Henry E. Schmitt
Superintendent

HES/ph

Dr. Henry Schmitt
Superintendent

Dr. Danny Hernandez
Principal

Ms Mary Ann Sphar
Assistant Principal

Mrs. Marquel L. Wheeler
Business Manager

Buckeye Water Conservation & Drainage District

205 ROOSEVELT AVENUE
P.O. BOX 1726
BUCKEYE, ARIZONA 85326-0160
PH: (623) 386-2196
FAX (623) 386-7789

July 10, 2001

House of Representatives
Honorable Mike Gleason
District 15
1700 West Washington
Phoenix, Arizona 85007-2844

Re' Duke Energy-Arlington Facility
Arlington, Arizona

Mike

Dear Honorable Mike Gleason:

We have been notified that Duke Energy is planning on expanding their Arlington Plant. This letter is in complete support of Duke's planned expansion. Since Duke has arrived in this community, they have joined in community affairs both as individuals and as financial Corporate sponsors. They have made every effort to keep our communities informed as to their plans and have bent over backwards in order to be a "good neighbor."

They are very conscience of the environment and their technology is state of the art. They are in the process of planting the 2000 acres of prior farmland back into its original desert landscape.

Again we are in complete support of Duke Energy, Max Shilstone and Rufus Kellam. I stand ready to stand up and speak on behalf of my community.

Sincerely,

Jackie A. Meck, General Manager

Buckeye Water Conservation & Drainage District

205 ROOSEVELT AVENUE
P.O. BOX 1726
BUCKEYE, ARIZONA 85326-0160
PH: (623) 386-2196
FAX (623) 386-7789

July 10, 2001

Arizona Corporation Commission
Commissioner Jim Irvin
1200 West Washington
Phoenix, Arizona 85007

Re' Duke Energy-Arlington Facility
Arlington, Arizona

Jim

Dear Commissioner Irvin:

We have been notified that Duke Energy is planning on expanding their Arlington Plant. This letter is in complete support of Duke's planned expansion. Since Duke has arrived in this community, they have joined in community affairs both as individuals and as financial Corporate sponsors. They have made every effort to keep our communities informed as to their plans and have bent over backwards in order to be a "good neighbor."

They are very conscience of the environment and their technology is state of the art. They are in the process of planting the 2000 acres of prior farmland back into its original desert landscape.

Again we are in complete support of Duke Energy, Max Shilstone and Rufus Kellam. I stand ready to stand up and speak on behalf of my community.

Sincerely,

Jackie A. Meck, General Manager

DUKE ENERGY NORTH AMERICA OPEN HOUSE

Arlington Valley Energy Facility II – September 5, 2001

NAME	MAILING ADDRESS	CITY	ZIP CODE	PHONE
DORIS HEISLER	3002 N. 423 AVE.	TONOPAH, AZ.	85354-7324	623.386-5154
Sonja Hammock Ginger HAMMOCK	HCR3, Box 113	Arlington, AZ	85322	623-386-4785
DONNA STAGGS	P.O BOX 57	ARLINGTON	AZ 85322	602-242-2631
NEIL PETERS	PO BOX 57	ARLINGTON	AZ 85322	602-242-2631
Chris Larson	P.O. Box 194	Arlington	AZ 85322	623-386-6253
Joseph & CAROL MELVIN	34814 W Buckeye Rd ~~Tonopah~~	TONOPAH	A 85354	
CARLO LONGO	POB 147	TONOPAH	85354-0147	

DUKE ENERGY NORTH AMERICA OPEN HOUSE

Arlington Valley Energy Facility II – September 5, 2001

NAME	MAILING ADDRESS	CITY	ZIP CODE	PHONE
Mark & Marita Lonner	36515 Sarome Hwy	Tonopah. Az	85354	(623) 393-0107
Jack and Karen Arend	325 50 403 AVE	Tonopah Az	85354	
Carter Gable	PO Box 150	ARLINGTON AZ	85322	928-587-1154
Les Meredith	Box 69	Arlington Az	85322	623-386-2138
Allan Gustavson	PO B207	Tonopah Az	85354	623 386 2190
Kelly & Patricia Reed	PO Box 509	Tonopah Az	85354	386-3839 w
Cheryl Dunbar	P.O. Box 896	Tonopah AZ	85354	3869653
				386-9339

DUKE ENERGY NORTH AMERICA OPEN HOUSE

Arlington Valley Energy Facility II – September ~~5~~ 6, 2001

NAME	MAILING ADDRESS	CITY	ZIP CODE	PHONE
JACK AREND	P.O. BOX 874	TONOPAH	85354	520-587-1154
Lloyd Rogers	P.O. Box 523	Tonopah	85354	623-393-0076
JIM GARNER	P.O. BOX 87	ARLINGTON	85322	623-386-2059
JOE HARRIOT	P.O. BOX 699	AVONDALE AZ	85323	
Ed Bull	702 E. Osborn	PHX	85014	602/234-9913
Dianna L. Workman	16601 W. Old Hwy 80	Arl. AZ	85322	623-386-2578
Debbie Hightower	P.O. Box 182	Arlington	85322	623-386-4304

DUKE ENERGY NORTH AMERICA OPEN HOUSE

Arlington Valley Energy Facility II – September ~~5~~ 6, 2001

NAME	MAILING ADDRESS	CITY	ZIP CODE	PHONE
Joan Meredith	P.O. Box 69	Arlington	85322	623-386-2190
Judy Richardson	34401 W. Desert Rose RD	Arlington	85322	386-7243
Heidi Richardson	34401 W. Desert Rose RD	Arlington	85322	386-7243
Ana + Nelo Soto	P.O. Box 54	Arlington AZ	85322	386-1229
Ron Fletcher	Po Box 122	ARLINGTON AZ	85322	623.386.2021

We Want Your Feedback...

Duke Energy®
Arlington Valley Energy

Thank you for visiting with us this evening. Please take a few minutes to give us your feedback.

1) How useful was the information we shared with you about Duke Energy and our project Arlington Valley Energy in terms of

(0 – not useful, 5 – somewhat useful, 10 – very useful)

a. Learning more about Duke Energy. 10

b. Learning more about Arlington Valley Energy. 10

c. Having your interests and concerns addressed. 10

d. Hearing the interests and concerns of others. 5

2) Were your interests about Arlington Valley Energy satisfactorily addressed?

☒ Yes ☐ No (If no, please specify and indicate what Duke Energy could do to address them.)

3) What is your opinion of the Arlington Valley Energy project? (please describe why)

☒ Very desirable ☐ OK ☐ Undesirable ☐ Undecided

4) How would you like to receive information about the modernization project in the future? (please rank 1-4)

In group presentations 4

In letters to the community 1

On the Internet 2

In the newspaper 3

5) What groups do you think we should keep well informed about Arlington Valley Energy?

Would you like to be in our mailing list? If so, please let us know your name and address.

Name: AL Ready on list

Address:

Phone: **Email:**

ok

We Want Your Feedback...

Duke Energy.
Arlington Valley Energy

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In group presentations 4

In letters to the community 2

On the Internet 2

In the newspaper 3

5) What groups do you think we should keep well informed about Arlington Valley Energy?

Would you like to be in our mailing list? If so, please let us know your name and address.

Name: Jack Arend

Address: P.O. Box 874

Phone: 928-587-1154 **Email:** aaaavn@cybertrails.com

9/5/01

We Want Your Feedback...

Duke Energy.
Arlington Valley Energy

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In group presentations _____

In letters to the community _____

On the Internet _____

In the newspaper _____

5) What groups do you think we should keep well informed about Arlington Valley Energy?

Neighbors on Elliot Road

Would you like to be in our mailing list? If so, please let us know your name and address.

Name: Ginger Hammock

Address: HCR 3, Box 113, Arlington, AZ 85322

Phone: 623-386-4785 **Email:** _____

We Want Your Feedback...

Duke Energy®
Arlington Valley Energy

Thank you for visiting with us this evening. Please take a few minutes to give us your feedback.

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3) What is your opinion of the Arlington Valley Energy project? (please describe why)

☒ ~~Very~~ desirable ☐ OK ☐ Undesirable ☐ Undecided

The way it is planned, less use of ground water than what agriculture would do

4) How would you like to receive information about the modernization project in the future? (please rank 1-4)

In group presentations 2

In letters to the community 3

On the Internet 4

In the newspaper 1

5) What groups do you think we should keep well informed about Arlington Valley Energy?

ALL

Would you like to be in our mailing list? If so, please let us know your name and address.

Name: Joseph Harriot

Address: P.O. Box 699 Avondale AZ

Phone: _____ **Email:** Joebacca@webtv.net

We Want Your Feedback...

Duke Energy®
Arlington Valley Energy

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In group presentations ✓

In letters to the community ✓

On the Internet ✓

In the newspaper ✓

5) What groups do you think we should keep well informed about Arlington Valley Energy?

Entire Buckeye Valley and probably all of Az

Would you like to be in our mailing list? If so, please let us know your name and address.

Name: Debbie Hightower

Address: PO Box 182 Arlington AZ 85322

Phone: 623-386-4304 **Email:** ~~Debbie~~ debbiemhightower@yahoo.com

We Want Your Feedback...

Duke Energy.
Arlington Valley Energy

Thank you for visiting with us this evening. Please take a few minutes to give us your feedback.

1) How useful was the information we shared with you about Duke Energy and our project Arlington Valley Energy in terms of

(0 – not useful, 5 – somewhat useful, 10 – very useful)

a. Learning more about Duke Energy. 10

b. Learning more about Arlington Valley Energy. 10

c. Having your interests and concerns addressed. 10

d. Hearing the interests and concerns of others. 4

2) Were your interests about Arlington Valley Energy satisfactorily addressed?

☒ Yes ☐ No (If no, please specify and indicate what Duke Energy could do to address them.)

3) What is your opinion of the Arlington Valley Energy project? (please describe why)

☒ Very desirable ☐ OK ☐ Undesirable ☐ Undecided

4) How would you like to receive information about the modernization project in the future? (please rank 1-4)

In group presentations ✓

In letters to the community ✓

On the Internet ✓

In the newspaper

5) What groups do you think we should keep well informed about Arlington Valley Energy?

New School For Arlington Committee

Would you like to be in our mailing list? If so, please let us know your name and address.

Name: Chris Larson

Address: P.O. Box 194 Arlington, AZ 85322

Phone: 623-386-6253 **Email:** shlazmataz@aol.com

9/5/

We Want Your Feedback...

Duke Energy.
Arlington Valley Energy

Thank you for visiting with us this evening. Please take a few minutes to give us your feedback.

1) How useful was the information we shared with you about Duke Energy and our project Arlington Valley Energy in terms of

(0 – not useful, 5 – somewhat useful, 10 – very useful)

a. Learning more about Duke Energy. 10

b. Learning more about Arlington Valley Energy. 10

c. Having your interests and concerns addressed. 10

d. Hearing the interests and concerns of others. 10

2) Were your interests about Arlington Valley Energy satisfactorily addressed?

☒ Yes ☐ No (If no, please specify and indicate what Duke Energy could do to address them.)

It was good to be able to attend & see first hand after mining earlier meeting & prospects

3) What is your opinion of the Arlington Valley Energy project? (please describe why)

☒ Very desirable ☐ OK ☐ Undesirable ☐ Undecided

The project is very favorable with our family & for the future

4) How would you like to receive information about the modernization project in the future?
(please rank 1-4)

In group presentations 4

In letters to the community 4

On the Internet 1

In the newspaper 3

Please Note - That we have not received all your mailings Please keep us informed Thank You

5) What groups do you think we should keep well informed about Arlington Valley Energy?

Residents & all Businesses - in general all people

Would you like to be in our mailing list? If so, please let us know your name and address.

Name: CARLO & MARIA LONGO

Address: 423 SOUTH 348 AVE - TONOPAH - POB 147 - 85354-0147

Phone: 623-386 9145 **Email:**

We Want Your Feedback...

Duke Energy®
Arlington Valley Energy

Thank you for visiting with us this evening. Please take a few minutes to give us your feedback.

1) How useful was the information we shared with you about Duke Energy and our project Arlington Valley Energy in terms of

(0 – not useful, 5 – somewhat useful, 10 – very useful)

a. Learning more about Duke Energy. 8

b. Learning more about Arlington Valley Energy. 8

c. Having your interests and concerns addressed. 9

d. Hearing the interests and concerns of others. 5

2) Were your interests about Arlington Valley Energy satisfactorily addressed?

☒ Yes ☐ No (If no, please specify and indicate what Duke Energy could do to address them.)

3) What is your opinion of the Arlington Valley Energy project? (please describe why)

☒ Very desirable ☐ OK ☐ Undesirable ☐ Undecided

4) How would you like to receive information about the modernization project in the future? (please rank 1-4)

In group presentations _____

In letters to the community ✓

On the Internet _____

In the newspaper _____

5) What groups do you think we should keep well informed about Arlington Valley Energy?

TVCC

Would you like to be in our mailing list? If so, please let us know your name and address.

Name: Percival M "Mark" Lowell Jr

Address: 36515 Salome Hwy Tonopah AZ 85354

Phone: 623 393 0107 **Email:** Marita Mark @ AOL.Comm

We Want Your Feedback...

Duke Energy®
Arlington Valley Energy

Thank you for visiting with us this evening. Please take a few minutes to give us your feedback.

1) How useful was the information we shared with you about Duke Energy and our project Arlington Valley Energy in terms of

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a. Learning more about Duke Energy. 10

b. Learning more about Arlington Valley Energy. 10

c. Having your interests and concerns addressed. 10

d. Hearing the interests and concerns of others. 10

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☐ Very desirable ☑ OK ☐ Undesirable ☐ Undecided

4) How would you like to receive information about the modernization project in the future? (please rank 1-4)

In group presentations 4

In letters to the community 4

On the Internet

In the newspaper

5) What groups do you think we should keep well informed about Arlington Valley Energy?

Would you like to be in our mailing list? If so, please let us know your name and address.

Name: Joseph Melvin

Address: 34814 W. Buckeye Rd Tonopah, Az 85354

Phone: **Email:**

9/5/01

We Want Your Feedback...

Duke Energy®
Arlington Valley Energy

Thank you for visiting with us this evening. Please take a few minutes to give us your feedback.

1) How useful was the information we shared with you about Duke Energy and our project Arlington Valley Energy in terms of

(0 – not useful, 5 – somewhat useful, 10 – very useful)

a. Learning more about Duke Energy. 10

b. Learning more about Arlington Valley Energy. 10

c. Having your interests and concerns addressed. _____

d. Hearing the interests and concerns of others. _____

2) Were your interests about Arlington Valley Energy satisfactorily addressed?

☐ Yes ☐ No (If no, please specify and indicate what Duke Energy could do to address them.)

_____

_____

3) What is your opinion of the Arlington Valley Energy project? (please describe why)

☒ Very desirable ☐ OK ☐ Undesirable ☐ Undecided

_____

_____

4) How would you like to receive information about the modernization project in the future? (please rank 1-4)

In group presentations 3

In letters to the community 4

On the Internet _____

In the newspaper 3

5) What groups do you think we should keep well informed about Arlington Valley Energy?

We are on your mailing list

Would you like to be in our mailing list? If so, please let us know your name and address.

Name: Les Meredith

Address: _____

Phone: _____ **Email:** _____

We Want Your Feedback...

Duke Energy.
Arlington Valley Energy

Thank you for visiting with us this evening. Please take a few minutes to give us your feedback.
Hoping for permanent employment.

1) How useful was the information we shared with you about Duke Energy and our project Arlington Valley Energy in terms of

(0 – not useful, 5 – somewhat useful, 10 – very useful)

a. Learning more about Duke Energy. 5

b. Learning more about Arlington Valley Energy. 5

c. Having your interests and concerns addressed. 5

d. Hearing the interests and concerns of others. 5

2) Were your interests about Arlington Valley Energy satisfactorily addressed?

☒ Yes ☐ No (If no, please specify and indicate what Duke Energy could do to address them.)

3) What is your opinion of the Arlington Valley Energy project? (please describe why)

☐ Very desirable ☐ OK ☐ Undesirable ☒ Undecided

4) How would you like to receive information about the modernization project in the future? (please rank 1-4)

In group presentations ____

In letters to the community ✓

On the Internet ____

In the newspaper ____

5) What groups do you think we should keep well informed about Arlington Valley Energy?

Town Council

Would you like to be in our mailing list? If so, please let us know your name and address.

Name: Kelly + Patricia Reed

Address: PO Box 509 Tonopah AZ 85354

Phone: 623-386-9653 **Email:** pjreed0227@aol.com

9/5/01

We Want Your Feedback...

Duke Energy®
Arlington Valley Energy

Thank you for visiting with us this evening. Please take a few minutes to give us your feedback.

1) How useful was the information we shared with you about Duke Energy and our project Arlington Valley Energy in terms of

(0 – not useful, 5 – somewhat useful, 10 – very useful)

a. Learning more about Duke Energy. 9

b. Learning more about Arlington Valley Energy. 9

c. Having your interests and concerns addressed. 9

d. Hearing the interests and concerns of others. 9

2) Were your interests about Arlington Valley Energy satisfactorily addressed?

☒ Yes ☐ No (If no, please specify and indicate what Duke Energy could do to address them.)

3) What is your opinion of the Arlington Valley Energy project? (please describe why)

☒ Very desirable ☐ OK ☐ Undesirable ☐ Undecided

4) How would you like to receive information about the modernization project in the future? (please rank 1-4)

In group presentations X

In letters to the community X

On the Internet

In the newspaper X

5) What groups do you think we should keep well informed about Arlington Valley Energy?

school

Would you like to be in our mailing list? If so, please let us know your name and address.

Name: Kevin & Judy Richardson

Address: 34401 W. Desert Rose RD Arlington AZ. 85322

Phone: 386-7243 **Email:**

We Want Your Feedback...

Duke Energy®
Arlington Valley Energy

Thank you for visiting with us this evening. Please take a few minutes to give us your feedback.

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3) What is your opinion of the Arlington Valley Energy project? (please describe why)

☐ Very desirable ☒ OK ☐ Undesirable ☐ Undecided

4) How would you like to receive information about the modernization project in the future? (please rank 1-4)

In group presentations 1

In letters to the community 2

On the Internet 4

In the newspaper 3

5) What groups do you think we should keep well informed about Arlington Valley Energy?

Would you like to be in our mailing list? If so, please let us know your name and address.

Name: Ana Soto

Address: P.O. Box 54 Arlington Az 85322

Phone: 623-386-1229 **Email:** ~~FAMGH~~

We Want Your Feedback...

Duke Energy®
Arlington Valley Energy

Thank you for visiting with us this evening. Please take a few minutes to give us your feedback.

1) How useful was the information we shared with you about Duke Energy and our project Arlington Valley Energy in terms of

(0 – not useful, 5 – somewhat useful, 10 – very useful)

a. Learning more about Duke Energy. 10

b. Learning more about Arlington Valley Energy. 10

c. Having your interests and concerns addressed. 10

d. Hearing the interests and concerns of others. 10

2) Were your interests about Arlington Valley Energy satisfactorily addressed?

☑ Yes ☐ No (If no, please specify and indicate what Duke Energy could do to address them.)

3) What is your opinion of the Arlington Valley Energy project? (please describe why)

☑ Very desirable ☐ OK ☐ Undesirable ☐ Undecided

4) How would you like to receive information about the modernization project in the future? (please rank 1-4)

In group presentations 3

In letters to the community 4

On the Internet 2

In the newspaper 1

5) What groups do you think we should keep well informed about Arlington Valley Energy?

Would you like to be in our mailing list? If so, please let us know your name and address.

Name: Dianna L. Workman

Address: 16601 W. Old Hwy 80 Arlington, AZ 85322

Phone: (623) 386-2578 **Email:** dlworkman@yahoo.com

C

DUKE ENERGY AS CORPORATE CITIZEN

Duke Energy®

Arlington Valley Energy

COMMUNITY CONTRIBUTION REPORT

CIVIC and CHAMBERS OF COMMERCE			
ARIZONA CHAMBER OF COMMERCE	EVENT SPONSORSHIP	01/23/01	
ARIZONA CHAMBER OF COMMERCE	SENATORIAL SPONSORSHIP	01/23/01	
ARIZONA CHAMBER OF COMMERCE	ANNUAL MEMBERSHIP DUES	08/31/00	
ARIZONA HISPANIC CHAMBER OF COMMERCE	EVENT SPONSORSHIP	04/18/01	
BUCKEYE VALLEY CHAMBER OF COMMERCE	RODEO TICKET SPONSORSHIP	03/01/01	
BUCKEYE VALLEY CHAMBER OF COMMERCE	BLUEGRASS SPONSORSHIP	03/02/01	
BUCKEYE VALLEY CHAMBER OF COMMERCE	DEMOLITION DERBY SPONSORSHIP	05/04/01	
BUCKEYE VALLEY CHAMBER OF COMMERCE	CHAMBER LUNCHEON DUES	12/01/00	
PHOENIX CHAMBER OF COMMERCE	FUNDRAISING EVENT SPONSORSHIP	04/01/01	
GREATER PHOENIX CHAMBER OF COMMERCE	ANNUAL MEMBERSHIP DUES	11/15/00	
BUCKEYE VALLEY CHAMBER OF COMMERCE	ANNUAL SWEAT GOLF TOURNAMENT	06/15/01	
ARIZONA CHAMBER OF COMMERCE	THE CLASSIC GOLF TOURNAMENT	04/05/01	
ARIZONA ASSOCIATION OF INDUSTRIES	ENVIRONMENTAL SUMMIT SPONSORSHIP	08/15/01	
ARIZONA HISPANIC CHAMBER OF COMMERCE	ANNUAL MEMBERSHIP DUES	07/15/01	
TONOPAH VALLEY ASSOCIATION	COMMUNITY FIREWORKS DISPLAY	05/29/01	
		TOTAL	
SCHOOLS			
BUCKEYE UNION HIGH SCHOOL	MUSIC PROGRAM DONATION	05/23/01	
BUCKEYE UNION HIGH SCHOOL	STUDENT EYE GLASS FUNDRAISER	11/01/00	
RUTH FISHER ELEMENTARY SCHOOL	VAN POOL PROJECT	05/15/00	
RUTH FISHER ELEMENTARY SCHOOL	VAN POOL PROJECT	04/26/01	
ARLINGTON ELEMENTARY SCHOOL	DESKS AND CHAIRS	12/15/00	
ARLINGTON ELEMENTARY SCHOOL	NEW COMPUTER LAB	09/01/00	
BUCKEYE UNION HIGH SCHOOL	BAND BOOSTERS - UNIFORMS	06/05/01	
		TOTAL	

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FIRE AND POLICE DEPARTMENTS			
AVONDALE PROFESSIONAL FIREFIGHTERS	SPONSORSHIP 2001 WORLD POLICE AND FIRE GAMES	04/19/01	
BUCKEYE VALLEY FIRE DISTRICT	FIRE SUPPRESSION AGREEMENT	11/10/00	
BUCKEYE VALLEY FIRE DISTRICT	BUCKEYE PIONEER DAYS - PARADE CANDY	03/29/01	
BUCKEYE VALLEY FIRE DISTRICT	PARADE CANDY	02/07/01	
BUCKEYE VALLEY POLICE DEPARTMENT	COMPUTER UPGRADES FOR NEW SOFTWARE FOR DISPATCH	04/17/01	
TONOPAH VALLEY FIRE DISTRICT	CONTRIBUTION	11/29/00	
		TOTAL	
COMMUNITY			
ARIZONA ORDER OF WOMEN'S LEGISLATORS	EVENT SPONSORSHIP	04/06/01	
AVONDALE GOODYEAR HISPANIC FORUM	SCHOLARSHIP SPONSORSHIP	03/05/01	
AYSO REGION 225 FAR WEST CLASSIC	FIELD SPONSORSHIP	03/01/01	
BUCKEYE LIONS CLUB	FAMILY CRISIS CENTER	02/01/01	
ST HENRYS CHURCH	NEEDY FAMILIES	11/15/00	
UNITED WE WIN	UNITED WE WIN GOLF TOURNAMENT	03/01/01	
BUCKEYE ELKS LODGE	GOLF SPONSORSHIP	09/01/00	
BUCKEYE VALLEY PUBLIC LIBRARY	FRIENDS OF THE LIBRARY SPONSORSHIP	02/19/01	
THE NATURE CONSERVANCY ARIZONA CHAPTER	CORPORATE COUNCIL MEMBERSHIP DUES	04/18/01	
VALLEY CITIZENS LEAGUE	CALIFORNIA ELECTRICAL CRISIS PANEL	04/01/01	
GOODYEAR/AVONDALE HISPANIC FORUM	CONTRIBUTION	10/15/00	
SOCIETY OF ST. VINCENT DE PAUL	SCHOOL CLOTHES FOR ARLINGTON SCHOOL CHILDREN	06/05/01	
		TOTAL	
MAJOR GIFTS			
BUCKEYE UNION HIGH SCHOOL	CONSTRUCTION OF ALL WEATHER TRACK	07/02/01	
		TOTAL	
		GRAND TOTAL	**$297,332.25**

8/14/2001 Duke Energy Arlington Valley, LLC. Confidential

Buckeye Union High School District No. 201

902 Eason Avenue
Buckeye, Arizona 85326
Phone 623-386-4423 Fax 623-386-9705

Mr. Marty Arambel
Governing Board Member

Mr. Phillip R. Echeverria
Governing Board Member

Mrs. Jeanine Guy
Governing Board Member

Mr. Jerry Kerr
Governing Board Member

Mr. Gary Mayfield
Governing Board Member

July 2, 2001

Rufus D. Kellam, Director
Duke Energy
Arlington Valley Project
Duke Energy Maricopa, LLD
P.O. Box 26
Arlington, AZ 85322

Dear Mr. Kellam:

Your call to confirm Duke Energy's generous donation of $170,000.00 for the all-weather track at Buckeye Union High School represents a hallmark contribution in the storied history of the District. Indeed, Duke Energy is a gold metal Corporate Neighbor!

This bountiful contribution will make it possible for the District to immediately commence on the construction of the all-weather track. With the collection of $89,000.00 from various prior donors, the additional $170,000.00 will ensure a state-of-the-art track for our high school scholar/athletes coupled with use by our feeder schools, public agencies and our community. It is extremely timely as the District is rebuilding 75 percent of Buckeye Union High School with an anticipated completion date of June 2003.

Consistent with our earlier conversation, this letter will serve as an invoice for receipt of the $170,00.00 which will be made in two payments of $85,000.00. The first installment will be received by the District on July 15, 2001, and the second installment will be received by the District on December 15, 2001. Please issue the checks to: Buckeye Union High School District No. 201 with a memo (i.e., notation) for the BUHS All-Weather Track. Upon receipt of the first installment the District will commence immediately on the architectural, civil engineering and invitation to bid for the track. Our critical path way is to have the track completed for the 2001- 02 season. This is a very aggressive timeline.

Under your leadership Rufus, Duke Energy, has established a bonafide school/corporate partnership that will impact the Buckeye Valley for generations to come. You have been true to your word. You are the shining star!

Respectfully,

Dr. Henry E. Schmitt
Superintendent of Education

cc: Buckeye Union High School Governing Board

RECEIVED
JUL 0 2 2001
Duke Energy Maricopa, LLC

Dr. Henry Schmitt
Superintendent

Mr. Danny Hernandez
Principal

Ms Mary Ann Sphar
Assistant Principal

Mrs. Marquel L. Wheeler
Business Manager

Duke Energy®
Arlington Valley Energy

August, 2000

Dear Neighbor,

As you may know, Duke Energy is seeking to develop and build a new combined cycle gas-fired electric generating plant called Arlington Valley Energy Project. I was recently appointed as director of the project and therefore, as we move forward I will be responsible for overseeing the construction of the facility.

Over the past year or so I know many of you have met and talked with Max Shilstone, Duke's project developer for Arlington. Max has led the team to get the project off the ground and ready for construction. Now that we are nearing completion of the permitting process, it will be my responsibility to work with you, our neighbors, as we undertake the actual construction of the plant. Most recently, I worked with a great team of people in Veazie, Maine completing the construction and commissioning of a similar plant, the Maine Independence Station.

My wife, Kathy, and I are excited about moving to Arizona and have recently purchased a home in western Maricopa County not far from our plant site. Over the next few months, it is my intention to get to know as many of the area residents as possible.

Additionally, we plan to provide as much information as possible about the construction status and what you, as a resident, can expect regarding our activities. Letters like this will be one way we will try to keep you informed. You can expect community meetings and we will occasionally publish an Arlington Energy newsletter that should help you get to know the company and the project people even better.

In the way of an update, Duke Energy hopes to complete all of the permitting for the Arlington project by September and plans for a groundbreaking early in 2001. An aggressive construction timetable calls for Arlington Valley Energy to go online in the summer of 2002. Combined cycle gas-fired facilities are among the cleanest thermal electric generation technologies at work today. Furthermore, the energy from the facility will help meet the rapidly growing demand for electric energy in the Southwest and help hold down costs for everyone.

We are confident that you, as an area resident, will be pleased with our plans for the actual plant site; our re-vegetation program for much of the surrounding land; and the positive results of the water studies for our planned groundwater use. For those of you who have not yet seen them, details about these issues and more will be part of our ongoing communication process.

I look forward to working with you through this next phase and please note that I can be reached through the above address. Please call me at 602-258-0822 with any comments or concerns. When we can relocate to offices closer to the job site, I'll send out another letter with the new phone numbers.

Sincerely,

Rufus D Kellam
Director, Arlington Valley Energy Project

January 17, 2001

Duke Energy®
Arlington Valley Energy

Dear Neighbor,

Thanks in large part to the input and support of area residents, I'm happy to report that we have our permits and have started dust suppression and earth work at our site on Elliot Road. We are proud to be coming to Arlington Valley and to commemorate the beginning of construction, we're inviting you to join us for a **Groundbreaking Celebration on February 22nd at 11:00 am** at our plant site. The site is south of Palo Verde Nuclear Station and west of Wintersburg Road. We'll have signs that will direct you to the precise location. If you plan to attend, please take the time to return the enclosed RSVP card no later than February 16th.

My wife, Kathy, and I have completed our move to the west valley. We have been getting out in the community meeting people and look forward to meeting more of you at the groundbreaking ceremony and in the coming months.

To keep you up to date, here's our status and our expectations over the next several weeks: Site preparation has begun with watering for dust suppression. Ames Construction will begin significant earth moving the week of January 22nd. Klondike Construction has begun temporary electric and telephone installation. We expect that construction trailers will move to the site immediately

Duke-Fluor Daniel (D-FD) is the General Contractor for the power plant construction. Their plans are to have the new access road in service by March. This will lessen traffic impact as we begin receiving equipment deliveries on site.

Since D-FD will be using sub contractors, we expect most of the workers to come from the metropolitan area. We expect to have 50 people on site by the end of Jan; 100 by April; 300 by June and 500 by mid-summer.

In addition, we are working with the Game and Fish Department and with the University of Arizona to accomplish our re-vegetation plan for over 2,000 acres. I'll provide more detail after the test plot is begun.

Duke Energy has an excellent safety record on our projects and we are totally committed to our safety program here in Arizona.

If you have any questions or comments about our event, or construction, please call me at our temporary offices in Buckeye at 623-327-1314. I look forward to seeing you February 22nd.

Sincerely,

Rufus Kellam
Director, Arlington Valley Energy Project

Feb. 22nd, 2001

Duke Energy®

Arlington Valley Energy

Groundbreaking Ceremony

11:00am – 1:00 pm

39027 W. Elliot Rd.

(West of Wintersburg Rd. – Follow the Signs)

We Invite All Members of the
Buckeye Chamber of Commerce
To
Join Us As We Celebrate
The Start of Construction
Of The Arlington Gas-Fired
Generating Facility

Food and Refreshments Will Be Served

Duke Energy and the Communities of the West Valley
A Powerful Partnership

Duke Energy®

Arlington Valley Energy

February 22, 2001

CONTACT: Richard A. Fernandez
Office: 713/627-5984
Mobile: 713/516-8592
24-hour: 888/487-5557

DUKE ENERGY NORTH AMERICA BREAKS GROUND ON NEW MERCHANT POWER GENERATION FACILITY IN MARICOPA COUNTY

Arlington Valley, AZ -- Today, Duke Energy North America (DENA) celebrates the ground breaking of their new $250 million electric power generating facility in Arlington Valley. Known as the Arlington Valley Energy Facility, this 570-megawatt merchant power plant will supply clean power to the wholesale market by summer of 2002. This state-of-the-art facility will supply enough power to light and heat about 570,000 households, which will significantly add to the availability of reliable power in Arizona and the Southwest.

The Arlington Valley Energy Facility has successfully completed the required permitting process and has the approval of Maricopa County and the Arizona Corporation Commission. It also received broad community support throughout the permitting process.

This facility's combined-cycle natural gas technology is environmentally superior to the technology used in older plants. About two-thirds of its electricity is generated by two combustion turbine generators that are fueled exclusively by natural gas. The exhaust heat from these turbines is captured and recycled to create high-pressure steam, which drives an additional steam turbine generator, producing the balance of the plant's electric output. This recycling process will allow the plant to be 40 percent more efficient than older technology and will help to conserve valuable resources. The Arlington Valley Energy Facility's production is the type of safe, clean and efficient energy elected officials, community leaders, and citizens want.

-more-

"It is with great pleasure that I congratulate Duke Energy North America on the occasion of the groundbreaking of the Arlington Valley Energy Facility, and welcome you [Duke Energy North America] to our great state of Arizona," said Governor Hull. "As Governor it is critically important to me that Arizona's electricity consumers have confidence in our electric generation system, and knowledge that the energy they desire will be available as needed. That is why I am grateful for the investment Duke Energy North America is making here in Western Maricopa County.

"The Arlington Valley Energy Facility will provide critically needed electrical generation capacity, add to our local economy by employing hundreds of skilled workers during construction, and pay millions of dollars in taxes that will go to support local schools," added Governor Hull.

County supervisors support Duke Energy's Arlington Valley Energy Facility. This project has met and exceeded environmental and community requirements.

"Part of our task as County supervisors is not simply to deal with current issues, but to plan for the future of the citizens in Maricopa County. Duke Energy's Arlington Valley Energy Facility will help us provide the electricity generation we need to ensure an excellent future for our citizens," said Supervisor Mary Rose Wilcox. "While we address the need for new power generation, we must never forget the impact that development has on our community. We must make sure that air quality, groundwater, and every environmental concern is satisfied by the companies that locate in our community. Duke Energy Arlington Valley Energy has met and exceeded our standard on every level. This facility will be a great addition to our community."

-more-

"As Supervisors, we must balance citizen and business objectives. In order to encourage economic development in our county, we must encourage the production of reliable, affordable electricity without compromising the needs of our citizens," said Supervisor Jan Brewer. "Duke Energy Arlington Valley is exactly what we need. Duke Energy has been open and responsive to citizen concerns and input. We look forward to a great relationship throughout the next phase of this project."

"The construction of this technologically advanced power plant represents a significant investment by our company in the West Valley's economic future," said Jim Donnell, president and chief executive officer of DENA. "We are proud to be a part of this community and look forward to providing reliable energy for all Arizonans.

"I cannot overemphasize the importance of the excellent support we received from the community and state and local officials to make this day a reality," added Donnell. "The process that got us here today was an excellent example of private industry, government and community leaders working together to bring a valuable economic asset to Maricopa County."

The Arlington Valley Energy Facility also offers a unique opportunity for the West Valley's ecology. A joint project between Duke Energy and a team of University of Arizona students and faculty will return 2,000 acres of currently fallow farmland to its former natural state. This land will be set aside and will not be developed.

"Duke Energy has given us an incredible research opportunity and donated land, plants, and all the materials necessary to begin a massive re-vegetation project at the site," said Dr. Martin Karpiscak, professor of plant ecology at the University of Arizona. "We will design, implement and monitor this large-scale desert re-vegetation program. And by summer 2001, we will make significant progress toward returning this land to a desert ecology. For the next several years, we will continue to monitor this project and learn from our research. Without Duke Energy's generous contribution, a project of this scale would not be possible."

-more-

The general contractor for this project is Duke/Fluor Daniel, a joint venture company of Duke Energy and Fluor Daniel. During the 18-month construction period, the project will generate approximately 500 construction-related jobs. Upon commercial operation a permanent staff of approximately 25 employees will operate and maintain the plant.

DENA is Duke Energy's Houston-based merchant energy company. Currently, DENA's merchant portfolio includes 6,200 megawatts of generation located in the western, midwestern and eastern regions of the United States. By summer 2001, DENA will deliver six new merchant facilities totaling 3,400 megawatts. DENA also has more than 13,500 megawatts in advanced development and expand its merchant portfolio to more than 23,000 megawatts by 2003.

Duke Energy, a diversified multinational energy company, creates value for customers and shareholders through an integrated network of energy assets and expertise. Duke Energy manages a dynamic portfolio of natural gas and electric supply, delivery and trading businesses -- generating revenues of more than $49 billion in 2000. Duke Energy, headquartered in Charlotte, N.C., is a Fortune 100 company traded on the New York Stock Exchange under the symbol DUK.

More information about the company is available on the Internet at: www.duke-energy.com.

###

FOR IMMEDIATE RELEASE

April 6, 2001

CONTACT:
Megan Ross, (703) 438-6068

DUKE ENERGY HONORED FOR NATIONAL CONSERVATION ACHIEVEMENT

Washington, D.C. -- The nation's largest conservation organization honored Duke Energy with its prestigious National Conservation Achievement Award at its 65th Annual Meeting today in Washington, D.C. The National Wildlife Federation (NWF) recognized Duke Energy's outstanding contributions to the Jocassee Gorges project, which led to the protection of tens of thousands of wilderness acres in the states of North and South Carolina.

"Duke Energy is demonstrating that large, multi-national companies can give back to the community and its wildlife in a meaningful way," said NWF President Mark Van Putten. "The company's efforts to conserve these spectacular lands reflect a commitment to the environment and to sound resource management. Their example proves that successful business and land stewardship can -- and must -- go hand in hand."

Through the recent Jocassee Gorges project, which local leaders have called "the most significant conservation project in the Southern Appalachians in the past 50 years," Duke Energy transferred 50,000 acres of land to the people of the Carolinas and to the USDA Forest Service, land that offers outstanding wildlife habitat, tremendous natural beauty and valuable recreational opportunities. The land was sold to the states, while Duke Energy made a contribution to facilitate the sale.

This spectacular mountain landscape is a precious resource for people and wildlife alike. With its rugged gorges, spectacular waterfalls, and rivers fed by plentiful rains, the area is home to eagles, peregrine falcons, black bears, trout and rare plant species, and offers a welcome escape for hikers, anglers and other outdoor enthusiasts. A nationally significant natural resource in its own right, this parcel also ties together other existing conservation lands to create a major preserve along the Southeastern Blue Ridge Escarpment.

Even while Duke Energy owned this property, the company proved an excellent land steward, keeping the area undeveloped and carefully managed. By turning over this land to the

states of North and South Carolina and the Forest Service, Duke Energy has ensured that it will be protected in the long term. As a result of the company's efforts, South Carolina now has a new state-owned 33,000 acre tract of gamelands and heritage preserves, while its northern neighbor has its newest and westernmost state park. The company is also maintaining an adjacent 10,000 acres of its own land as a conservation easement.

Since 1965, NWF's National Conservation Achievement Awards have been presented each year to individuals and organizations who provide leadership in spreading the conservation message and protecting natural resources. For 2000, awards were presented in the following categories: NWF Affiliate of the Year, Communications, Corporate Leadership, Education, Government, International, Legal/Legislative, Organization, Philanthropy, Science, Youth, and Special Achievement. Duke Energy was honored in the Corporate Leadership category.

The nation's largest member-supported conservation advocacy and education group, the National Wildlife Federation unites people from all walks of life to protect nature, wildlife, and the world we all share. The Federation has educated and inspired families to uphold America's conservation tradition since 1936. Its common-sense approach to environmental protection brings individuals, organizations, and governments together to ensure a brighter future for people and wildlife.

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Merchant Power Plant

FACT SHEET

Duke Energy North America

A Duke Energy Company

Who is Duke Energy?

Duke Energy Corporation (NYSE:DUK) is a global energy company with more than $26 billion in assets. Headquartered in Charlotte, N.C., the company reaches into more than 50 countries, producing energy, transporting energy, marketing energy and providing energy services. In the United States, Duke Energy companies provide electric service to approximately two million customers in North Carolina and South Carolina; operate interstate pipelines that deliver natural gas to various regions of the country; and are leading marketers of electricity, natural gas and natural gas liquids.

The company's business units have long been recognized for building and operating plants in the most efficient, cost-effective manner while maintaining safety and reliability. Additional company information is available on the World Wide Web at http://www.duke-energy.com.

Who is Duke Energy North America?

Duke Energy North America is a wholly owned affiliate of Duke Energy. DENA develops, owns and operates electric generation across the United States, Canada and Mexico.

What is a merchant plant?

DENA develops, owns and operates what are referred to as "merchant" plants. A merchant power plant is an electric generating facility that produces power for the express purpose of selling electricity into the wholesale electricity market. This wholesale electricity market comprises municipalities, cooperatives, investor-owned utilities and power marketers that need low-cost power to meet the needs of their retail customers. DENA makes the capital investment and takes the economic risks for these projects. In order for a merchant plant to be successful, it must produce electricity at or below the market price for wholesale electricity.

How can Duke Energy do this in another utility's territory?

A federal law, the Energy Policy Act of 1992, opened the national wholesale electricity market to competition. This wholesale market – which involves the buying and selling of electricity at high voltage on a bulk basis – is the market Duke Energy has entered or proposes to enter in several states.

Are other companies operating merchant plants?

Merchant plants are proliferating throughout the U.S. Many companies are building new state-of-the-art power plants or are buying existing power plants formerly owned by utility companies. These activities underscore the fact that a number of players in the power industry are routinely moving outside of their historical operating areas into the open wholesale power market across North America.

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Produced by Duke Energy Creative Services

A "Good Neighbor" Tradition

Operational Excellence

- 1999: *Most admired Gas and Electric Utility Company* – Fortune Magazine
- 1998: *Utility of the Year* – Electric Power and Light Magazine
- 1998: *World's Most Respected Utility* – England's Financial Times Newspaper
- 1998 and 1997: *Leading the Electrical Utility Industry in Customer Satisfaction* – National Quality Research Center Survey
- 1995: *Edison Award* for operating the nation's best utility – Edison Electric Institute

Duke Energy.
Arlington Valley Energy

Duke Energy SM

Arlington Valley Energy

Dec. 6, 1999

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DUKE ENERGY NAMED CORPORATE LEADERSHIP WINNER BY TOP INDUSTRY PUBLICATION

CHARLOTTE, N.C. – Citing the company's overall excellence, Duke Energy was honored with the Corporate Leadership Award from industry publication *Energy Daily* in ceremonies last Thursday night in Williamsburg, Va.

Duke Energy Chairman Richard B. Priory accepted the award on behalf on the company. The award was part of *Energy Daily's* 27th Annual Conference and Awards banquet. Also honored by the publication were former Energy Secretary Dr. James Schlesinger, Senator Pete Domenici and Sempra Energy Chairman Richard Farman.

"Duke Energy's stellar reputation has been earned over the years by tens of thousands of dedicated employees," said Priory. "I'm pleased that the efforts of my teammates worldwide have again been recognized."

In acknowledging Duke Energy as an award recipient, *Energy Daily* Publisher Llewellyn King said, "This reflects and recognizes that for many years Duke has been outstanding in its organization, leadership and especially the depth and excellence of its engineering."

- more-

Duke Energy has garnered a number of awards in 1999. Among the more prominent, the company was named "Most Admired Electric and Gas Utility" in *Fortune* magazine's "Most Admired Companies" roster. It was named "Best Electricity Company" at the *Financial Times* Energy Awards last month.

Washington, D.C.-based King Publishing produces *Energy Daily*. Since 1973, it has been the leading publication reporting on the energy industry.

Duke Energy (NYSE:DUK) is a global energy company with more than $29 billion in assets. Headquartered in Charlotte, N.C., the company reaches into more than 50 countries, producing energy, transporting energy, marketing energy and providing energy services. In the United States, Duke Energy companies provide electric service to approximately two million customers in North Carolina and South Carolina; operate interstate pipelines that deliver natural gas to various regions of the country; and are leading marketers of electricity, natural gas and natural gas liquids. Additional information about the company is available on the Internet at: www.duke-energy.com

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A "Good Neighbor" Tradition

Leader in Environmental Stewardship

- 1999, 1994: *Land Stewardship Award* – National Wild Turkey Federation
- 1998: *Conservationist of the Year* – South Carolina Wildlife Federation
- 1997: *Conservation Leadership Award* – Nature Conservancy of Texas
- 1996: *Significant Contribution to Improving Small Game Population and Habitat* – North Carolina Wildlife Resource Commission
- 1995: *Environmental Achievement Award* – International Erosion Control Association
- 1995: *Governor's Award for Pollution Prevention and Waste Reduction Programs* – South Carolina

Duke Energy: A Leader In Environmental Stewardship

In January 1998, the South Carolina Wildlife Federation recognized Duke Energy's commitment to the environment by presenting the company with its annual **Conservationist Of The Year Award**. Duke was honored for its key role in making possible the public acquisition of 41,000 acres of land in the Jocassee Gorges. South Carolina governor David Beasley said the effort to protect the area was "the most significant conservation project in the Southern Appalachian mountains in the later half of the twentieth century."

In November 1997, the Nature Conservancy of Texas named Duke Energy the winner of its 1997 **Conservation Leadership Award**. The award was given for four special programs that illustrate the company's commitment to environmental awareness. The company's historical commitment to conservation is also reflected by Duke Power's 1990 Corporate Conservation Award presented by the North Carolina Nature Conservancy.

In 1996, Duke Power's 2,200 megawatt Belews Creek Steam Station was recognized by the North Carol ina Wildlife Resources Commission as the winner of its **Dr. William H. McCall Small Game Award**. The award was given in recognition of significant contributions to improve small game populations and habitats.

In 1995, Duke Electric Transmission received the **Environmental Achievement Award** from the International Erosion Control Association – the group's highest award – for the environmentally-sensitive practices used during the construction of a 27-mile 161 kilovolt transmission line through the North Carolina mountains.

In 1995, Duke Power received the **South Carolina Governor's Large Category Pollution Prevention Award**, which recognized the company's pollution prevention and waste reduction efforts.

In 1994, Duke Power was the first utility ever to win the prestigious **Land Stewardship Award from the National Wild Turkey Federation**. The federation recognized the company for overall excellence in natural resource protection around power plants, transmission lines and support of conservation education programs.

In December 1998, Duke Energy was named as the **Utility Of The Year** by *Electric Power & Light* magazine. The magazine said that Duke Energy is one of the global energy industry's most diversified companies. It also noted investment analysts' comments about the company, which refer to Duke Energy as an "energy-services giant," "powerhouse," "strong and tough competitor," and "bellweather."

In a *Fortune* magazine survey published in February 1998, Duke Power, the largest subsidiary of Duke Energy, **led the electric utility industry in customer satisfaction**. The survey was conducted by the National Quality Research Center and involved more than 50,000 consumers. Duke Power also led the electric utility industry in the same survey published by *Fortune* in 1997.

In 1995, Duke Power received the coveted **Edison Award** from the Edison Electric Institute for operating the nation's best utility. Duke is the only utility in the nation to have received the award three times.

ELECTRIC LIGHT & POWER

INDUSTRY REPORT

ON UTILITY OF THE YEAR

Utility of the Year: Duke Energy

Michael T. Burr, Managing Editor

Duke Energy's June 1997 merger with midstream gas major PanEnergy created one of the global energy industry's most broadly diversified companies. Analysts raved about the combination, using terms like "energy-services giant," "powerhouse," "strong and tough competitor," and "bellwether."

A forward-thinking approach puts Duke in a strong competitive position

Duke is wasting no time putting its new capabilities to use. After merging with PanEnergy, the company has set sights on an ambitious goal: add $2 billion a year to its revenues.

Duke's strategy depends on an integrated approach to developing fuel and electricity infrastructure around the world, a strong energy trading organization to support merchant plants in the United States, and a regulated utility focused on system efficiency and world-class customer care.

This forward-thinking approach promises to put Duke in a good position to compete in the deregulated electricity marketplace. This is the main reason *Electric Light & Power* magazine selected Duke for the 1998 Utility of the Year award. The company's industry-leading plant efficiencies and customer satisfaction ratings, as well as its consistently strong stock performance, affirmed the selection.

In terms of heat rates, Duke's Belews Creek and Marshall coal-fired plants have consistently led *EL&P's* ranking of U.S. steam-electric plants, with 1997 figures of 8,962 Btu/kWh and 9,009 Btu/kWh, respectively. Its Catawba nuclear facility also leads the pack with a 10,069 Btu/kWh performance.

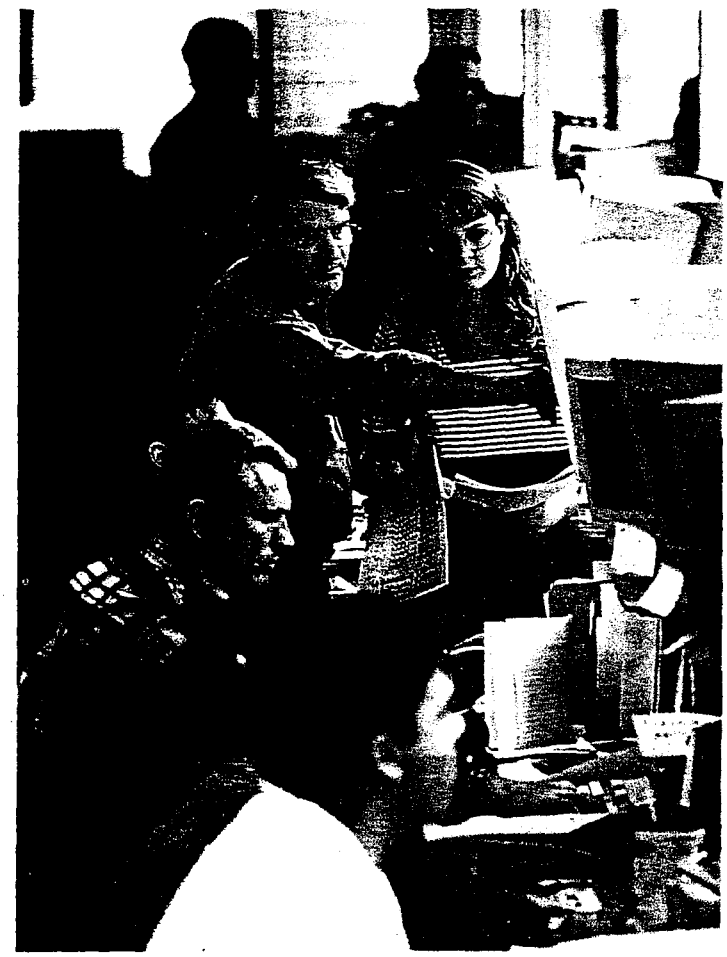
EL&P's most recent report on the top 99 U.S. ties' 1997 financial performance ranked Duke second to Enron Corp. in total revenue generated, with $16.3 billion. The company came in 11th in electric revenue, with about $6 billion, and 18th for its 13.7 percent return on common equity. So far in 1998, the company's performance is even better, with earnings per share up by 33.8 percent, to $2.81, for the first three quarters of the year.

Unregulated muscle

In the unregulated energy project development business, Duke Energy's $24 billion asset base gives the company a distinct advantage over smaller companies. With these deep resources, Duke can issue corporate bonds to finance new projects, at a significant cost savings compared to project finance loans. Further, its engineering and construction expertise, through subsidiary Duke/Fluor Daniel, minimizes construction costs. And perhaps most importantly, Duke is leveraging commercial trading expertise gained from PanEnergy to maximize its profits in wholesale energy markets.

These unregulated businesses provide the muscle for Duke's aggressive growth strategy. "We are targeting 8 percent to 10 percent growth per year for the next five years," said David Hauser, Duke's senior vice president and treasurer. To put that in perspective, in Duke's historically regulated business, the company expected to grow from 2 percent to 4 percent a year.

The company's sights are set on downstream merchant electric capacity and international energy markets. To achieve its goals, Duke's unregulated development groups have been adding staff quickly, bringing in people from electric, pipeline and development businesses. "We're pulling people up internally and hiring



Playing the margins: Duke Energy Trading & Marketing, with trading floors in Houston and several other cities, provides the foundation for Duke's integrated merchant energy strategy. The company leverages the former PanEnergy's gas resources and Duke's electric resources for commodities risk management. Ranked third in 1997 U.S. sales, the group sold nearly 92 MWh during the year, according to the Edison Electric Institute.

Reprinted from the December 1998 edition of ELECTRIC LIGHT & POWER
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from outside." Hauser said. "We've doubled our development staff since June 1997."

While working to establish a global presence, Duke is taking a selective approach. The company is staying out of China and India, and instead is focusing its efforts elsewhere in Asia, Latin America and Europe. Although last year Duke sold $87 million worth of trading and marketing operations and other investments in the United Kingdom, the company's plans include expanding its trading presence into Europe. In each case, Duke is taking an integrated approach, seeking a larger share of the energy stream than just a power plant or a pipeline.

In the United States, Duke is developing merchant power plants, relying on Duke Energy Trading & Marketing for support at the fuel and energy marketing ends of the business. So far, Duke has acquired 2,600 MW of capacity from Southern California Edison, and is developing new capacity in a number of areas, including Connecticut, Maine, Florida, Missouri and Texas.

At the helm of the new Duke Energy is Richard Priory, president, chairman and CEO. *EL&P* interviewed Priory in his office in mid-November.

EL&P: We selected Duke Power as our Utility of the Year in 1977. This is the first time in 29 years that a company has won the award twice. Much has changed since then, for the industry and for Duke. What do you think have been the key changes for Duke?

Priory: ***I came to the company in 1976. Thinking back to 1977, we had almost no non-regulated activities.*** We still needed additional capacity in the Carolinas, so we were building like crazy. All of our company was focused on building.

After the late '70s, when we got our nuclear generation into place, it was a matter of reshaping our company into one which focuses on the efficient operation of facilities and serving our customers the best.

We built a series of non-regulated businesses starting in 1981. We started with an engineering company, because we had thousands of engineers for the nuclear program. I was the chairman of that company, and at the same time I was running the project management division.

Our engineering business today is 3,000 people strong, with $500 million in revenue. It also has been the root of a number of other businesses.

> **"We can't perfectly see the horizon, but we have a sense of what it will look like when it's done. This gives us an opportunity to grab the right positions and get some margins."**
>
> ***—Richard Priory, Duke Energy***

In 1989, we took the coal portion of our engineering business, which represented about half of it, and spun it off into a joint venture with Fluor Daniel.

Then came the cogeneration years. We selected some people from the engineering group and formed our asset development group, which is now Duke Energy Global Asset Development. In the late '80s, the world started breaking loose in the energy area. By then we were very well equipped, with a lot of talent that had been developed in the non-regulated area, so it was very commercially sensitive talent. This gave us a great deal of flexibility that many utilities never had, because they were pretty much fixed on their regulated mode.

When the Energy Policy Act of 1992 passed we realized the wholesale market would open up in a way it never had before. So we formed a trading and marketing company.

In 1996, we felt one of the major gaps in our strategy, given the way the energy future was going, was that we didn't have a lot of experience with gas. We started looking at midstream gas players—not E&P [exploration and production] or local distribution, but everything in-between. We were interested in gathering and processing, storage, transportation, and trading and marketing.

We decided the best fit for us was PanEnergy. We closed that deal on June 18, 1997, and the rest is history. We worked hard to integrate the teams together. We were very focused on making sure we created the value we expected.

Since then, it's been a blur of projects and opportunities. The synergy of putting together

Duke's vital statistics

Second largest IOU	$16.3 million (1997 total revenues) $23 billion market capitalization
11th largest electric revenue	$6 billion
18th best return on equity	13.7 percent
23rd best earnings per share	$2.51 (1997); $2.81/share for Q. 1-3, 1998
Fifth largest generator	76.2 TWh (1997 generation), 17,857 MW capacity owned
Industry-leading heat rate	9,338 Btu/kWh
Third largest power marketer	91.9 million MWh
Second largest interstate pipeline	37,000 miles
Largest natural gas liquids producer*	200,000 bl/d
Third largest gas gatherer	
Fourth largest EPC** firm	

*After acquisition of UPFuels, announced Nov. 1998
**Engineering, procurement and construction

Sources: *EL&P*, EEI and Duke Energy

the gas skills and knowing the infrastructure, along with power skills, was remarkable.

EL&P: How has PanEnergy helped Duke so far?

Priory: ***It was astonishing what it opened up. The first thing the gas people would say, for example, is that if you have this plant in Bridgeport, you need four or five different transportation paths to fuel it.*** You need to come out of a series of supply basins, so if there's a hurricane in one, you can supply it from another. You've got to be able to take advantage of the price arbitrage to be successful in this business on the fuel side.

We also believe on the plant output side, you must likewise be able to do similar things. We took our trading and marketing company, and put it with PanEnergy trading and marketing, and it became a very significant part of our efforts going forward. The integration and synergies we hoped to get by putting them together began to flourish in all ·ctions. We are really pleased with that.

ok at our Maine Independence project, for example. Duke Engineering & Services went after the permits and was the engineering consultant. Duke Energy Trading & Marketing manages the fuel and takes the output to market. Global Asset Development's domestic side, Duke Energy Power Services, is the asset developer, and will be the owner. Duke Fluor/Daniel, one of our O&M operators as well as the turnkey construction company, will operate the plant. It will be fueled by a pipeline we're building from Sable Island to the Northeast.

Integrated development: "Unless we can get some chunk of the energy value chain and create a real business, we're not interested."
—Richard Priory, President, Chairman & CEO, Duke Energy Corp.

All integrated together—to us, that's what convergence looks like in this business. Anyone who competes with us must have the same kinds of people in the game. But if they don't have those capabilities in-house, they will hire separate companies, all with various interests. They all have to maintain their margin. Having our companies all under one umbrella, and having control over all the margins, gives us flexibility in terms of pricing.

EL&P: Is the market forcing this integra-ed approach? Can other, non-integrated companies compete?

Priory: ***The winners left standing will be those who execute the fundamentals well, not those with the greatest press releases, or who spend the most money and get the most attention.*** It will be those who make plants more efficient.

Obviously it takes a good strategy. You have to pick the right location, with a confluence of gas supply and optionality to be successful. Other people will pick the right places, and when all is said and done, you will have to beat them on the fundamentals. That gets back to core competencies.

A bank can compete with us in a New York minute. An investment banker could hire people to do everything we're doing, but we believe in the end they won't be able to exercise the fundamentals of the business as solid as we can, because of our core competency.

EL&P: You're clearly focused on the unregulated wholesale business. What about retail, including your core regulated utility, Duke Power?

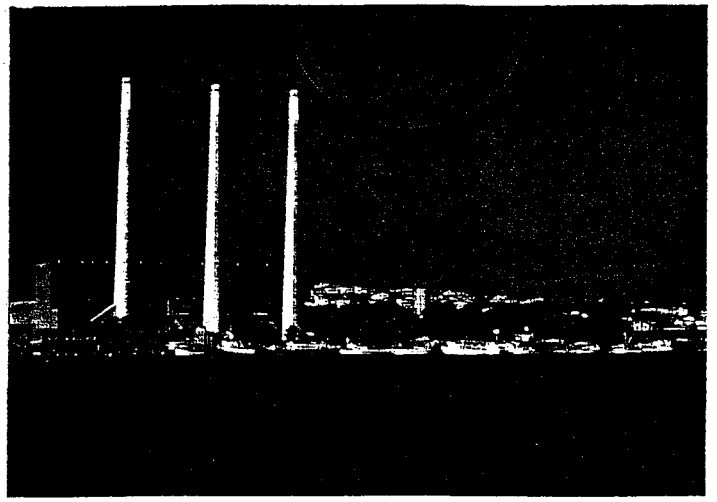
Priory: ***Things have accelerated in the last few years.*** It took a couple of years after EPAct in 1992 for everyone to shake the cobwebs out of their heads and realize we were moving into a competitive wholesale marketplace. Then all the talk regarding customer choice has energized the customers, the regulators, the legislators and the energy companies. Now, there is so much disruption taking place in the energy industry, you can't stand still. If you do, you'll be eroded away.

Legislators want to deregulate the industry and create an open marketplace. You're the monopoly supplier now, but retail choice will introduce a free market with a low threshold of entry for people to come in and take away your customers. Regulators are taking actions to deliberately ensure there's a competitive market that will take away a significant portion of your business—purposely and for the betterment of all of us.

There's nothing wrong with the free enterprise system. We think it's the right way and the most efficient. But if you're a regulated electric utility and you sit still as they tie your arms behind your back, your business will erode. You have to position yourself to be a winner in this changing marketplace.

That's exactly what we've done. We don't know when restructuring will happen, so there's a huge timing issue. You have to restructure yourself in a way to create value without depending on a specific timing for restructuring. We've stayed away from things like the big retail play, because of the huge timing issue.

We may be spoiled because fortunately we have excellent relationships with our customers, and therefore we might not have a good view of the [rest of the retail] world. Fortune magazine listed us number one last year in customer satisfaction. A number of research organizations have talked to our customers about supply and reliability, and in all cases we rank in the top three. This makes us



Duke Energy bought the Morro Bay power plant as part of a three-plant, 2,633 MW acquisition from PG&E Corp. Duke installed selective catalytic reduction systems at the plant to reduce nitrogen oxide emissions.

believe we have tremendous holding power with our customers.

We expect legal attempts to break that holding power—to get the regulators to prevent us from taking advantage of the long-term relationships we've established. We, of course, will fight that, because our shareholders have invested in those relationships and they're important to us.

But we do think we'll have considerable incumbent power as a result of our good performance. We intend to take advantage of that. As you go around the country, electric utilities in general will have strong incumbent power. Our belief is that if you're going to be a retail player and go into markets where they don't know you, customers will likely stay with their incumbent.

We decided to stay out of that. We have a great laboratory in the Carolinas, where we will attempt to hold our customers and capture other customers where we have brand equity. If we can find products and services that prove to give us a competitive advantage here, then we might take the investment risk of going to Wyoming or Oklahoma to see if we can succeed.

If we can't find that competitive advantage, and commodity pricing drives everything, then there won't be any real margin. We won't be interested in that retail business.

L&P: Many players are buying into electric distributors overseas. What about Duke?

Priory: ***We're not going to bid on distribution in Argentina, the U.K. or anywhere else where the prime play is distribution.*** If there are substantial generating assets we can use to create value, and distribution happens to be wrapped with it, we might bid on the whole thing and later try to spin off distribution.

When the big fad of buying into British RECs [regional electricity companies] came along, we ran the numbers. Using American metrics to analyze a British firm, they looked very strong. But it didn't show the whole picture. Distribution is political.

We decided not to participate in the U.K. because of a decision we made in Argentina, on the Buenos Aires distribution system. There was a tremendous amount of power stealing taking place. Many teams saw that as the value-creation opportunity. But we said you can't possibly do that unless you have a set of laws on the books to support you, a police force to support you, and most importantly, a political system that will support you in stopping the stealing. Stopping stealing creates its own social dynamic.

Globally, if you try to evaluate everything with your U.S. eyeglasses on, you may miss some of that stuff. You have to be careful about the political and social issues.

We have stayed out of that game, and we have been rewarded. A lot of people decided to play, and while some have done just fine, others have tried to get out. In the U.K., they've all had a windfall profits tax imposed on them, and there's another wave of this coming. British RECs owned by U.S. companies now can be beat up pretty badly without any negative political fallout. In some cases the more they get beat up, the better it is for the politicians. We don't want to be in that situation, and we see some others don't want to be beat up any more either.

EL&P: How is your strategy evolving?

Priory: ***We put together a strategy for our company several years ago, and so far we remain very much on that strategy.*** That's become very well recognized on Wall Street and elsewhere. Duke hasn't lost a lot of momentum by doing other things that didn't work. Now we see all these companies reshaping their strategies to fit exactly what Duke has done.

The problem that creates for us is that it refocuses all the energies of some other companies right down the same strategy that we're following. So we're busy now, re-thinking our strategy. We've got to find some competitive advantage. One way is in the fundamentals, as I mentioned earlier—do it better than everyone else—but there's more to it than that. Strategically, we have to be very sharp about what we're doing. We're going as fast as our feet can carry us.

The shareholders seem to have a great deal of confidence in our strategy, as witnessed by the share price and how well it's done, and earnings continue to flow effectively. We've been happy so far, but we know it won't be without ups and downs.

EL&P: Duke seems to be becoming more active as an investor in independent power producers around the world.

Priory: ***Our approach internationally has changed dramatically. Our initial ventures I would characterize as portfolio participation, although we were active developers.***

We had criteria about the kinds of partners we needed. We needed local partners to keep our risk within the profile we thought was rational for starting out. We crafted our deals so that we had control of the project even though we were minority owners. We had a good enough name, and a lot of investors didn't mind having Duke run the thing.

That's how we cut our teeth, got our understanding of how to operate in international markets, and proved to ourselves we could do it effectively.

As with any other investment, there's a business rule that says your economic interests should line up with your control. We found in these portfolios the other partners would begin to want more control. We knew that would happen, and we said all along we'd do good business, not bad business. Bad business is when one party has a big advantage over the other.

So we restructured the deals, because that was the right thing to do to get our control

Watching the skies: Duke Power's customer service center includes a meteorology center to watch developing climate and weather patterns. This information is used to anticipate customer service needs, plus to inform the operations of Duke's trading and marketing unit.

ter lined up with our percentage of interest in these plants. On the other hand, we now have become very comfortable with our abilities in this regard. And thus we've moved to the point where we want our control lined up with our economic interests as before, but we want control of the project because that appears to be where we can be most successful. That means we'll take a big position in these projects, if not 100 percent, we'll take sufficient economic interest to ensure we'll have control of the project.

We're in Latin America, Australia, Asia. We're looking very hard at Europe, because of the European community and its new agreements to trade energy across borders. It is creating an opportunity for greater efficiency, and we're looking for a way to effectively get in and use our skills to create value for those customers.

The other switch we've done is that although we used to invest in a power plant asset, internationally we never looked at the fuel infrastructure because it wasn't our forte. Now, after our merger, we're interested in the entire energy value chain. It can include gathering and processing of gas out of the wellhead, production and sale of natural gas liquids, providing dry gas into the pipeline, transportation, storage, delivery of the gas to the electric generation facility, building the facility, transmission out of the facility, and even building distribution if we have to—although we don't really want to own it.

We have a plant in Peru that is like that. We take gas out of the south Amazon, gather it, process it with a plant we've built in the Amazon, and take gas liquids to make jet fuels and things of that sort. We built a pipeline to deliver the gas liquids to the market, a pipeline to deliver dry gas to a power plant we built on the edge of the Amazon, and a transmission line across the Andes to connect to the Peruvian national grid.

Going forward, we'll never have a stand-alone power plant investment. Unless we can get some chunk of the energy value chain and create a real business, we're not interested. We've had examples where we've bought stand-alone power plants because we know there's a gas field next door, and we're working with the owner of the gas field.

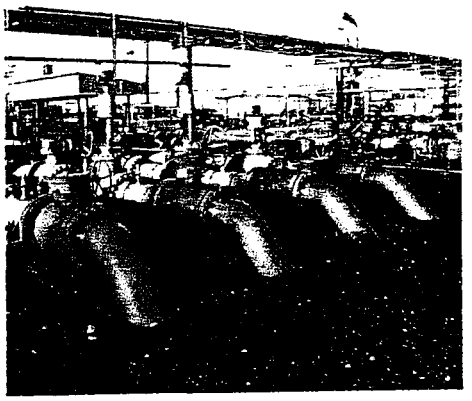
We bought a pipeline in Queensland, Australia, and you'll probably see us building some pipeline in Queensland because it is critically needed to get a good trading and marketing system going. Then, when we get the infrastructure in place, you'll see us with an interest in building selected electric generators to convert molecules to electrons, and for delivering gas. Those are our core competencies.

We have a lot of trading and marketing skill. Our marketing operation in Charlotte trades out of our regulated assets, and trading and marketing operations in Houston, Salt Lake City and Calgary trade in the marketplace. We have about 450 people in that business. They're quite good, and as other companies are closing up shop after the downturns in the business during the summer, we've done very well. Our guys are reporting the margins are improving because there are fewer players. Also, the tightness in people supply has been eased because everyone is looking for jobs.

"The synergy of putting together the gas skills and knowing the infrastructure along with power skills, was remarkable. All integrated together—to us, that's what convergence looks like in this business."

—Richard Priory, Duke Energy, on Duke's merger with PanEnergy

We think we can transfer that trading and marketing capability to Europe, which is just starting to open up. To be able to take those



About 12 percent of the natural gas consumed in the United States travels through Duke infrastructure. Duke's Texas Eastern pipeline moves gas from Texas and the Gulf of Mexico to the populous northeastern United States, where gas metering facilities such as the Staten Island installation shown here regulate and measure gas for delivery to wholesale customers.

experiences and skills to a brand new market is an exciting proposition. We can't perfectly see the horizon, but we have a sense of what it will look like when it's done. This gives us an opportunity to grab the right positions and get some margins.

EL&P: Where do you think deregulation is headed? Will retail choice happen nationally in the United States?

Priory: ***We think, given experiences in telecom and gas, that choice and opening the markets will continue on the electric side.*** It will speed up and slow down depending on events that occur. But it will never abate, and it will eventually be completed with a deregulated industry.

An image will begin to emerge from a series of actions taken by the states and by FERC that will allow states to deregulate more easily. Eventually everyone will become confident it will work well. We'll arrive at a sensible code of conduct for the industry, so regulated and non-regulated elements can work together. Incumbent suppliers will not be precluded from participating. Some people want this, but it is annoying to the customer.

The new entrants will have an opportunity to gnaw away at the incumbent at every angle. It's not unlike the situation with AT&T, where they had the lion's share of the business, and the MCIs and Sprints and others have clearly gnawed away at their position. This has forced AT&T to do things they never dreamed they could do, but it's all for the betterment of the customer in the end.

When the final chapter is written [on telecom deregulation] it will be painfully clear that there have been dramatic improvements in quality and availability of innovative products; that prices have gone down dramatically; that competition has stimulated all the right things for the customer. The same will be true when the final chapter is written in electric industry deregulation.

It will be painful, confusing and chaotic to get from here to that point. The free market in California is the most regulated system we've ever been involved in. It makes the regulated utility industry look like children's sport by comparison. My feeling is that will sort out, to the benefit of the customers. Right now the transition is very difficult. California is courageous in taking it on. They're the laboratory for the United States. With a lot of people's help, California will get a system that works. It will provide a good example for other states.

Here in the Carolinas, deregulation will continue down a very deliberate path. These folks are pretty smart, and they know prices are pretty low here. North Carolina was ranked number one last year in terms of attracting economic development. Although deregulation is like Mom and apple pie in terms of using the free enterprise system in our country, we'll head down that path deliberately, watching what works and what doesn't in states like California, Massachusetts and New York. This will probably create the greatest value for the customer. ■

D

ECONOMIC IMPACT

Economic and Real Estate Consulting

JUL 5 2001

June 25, 2001

Mr. H. Max Shilstone
Duke Energy
5400 Westheimer
Houston, TX 77056

Re: Economic Impact of Arlington Valley Generating Facility Expansion

Dear Mr. Shilstone:

This firm prepared an economic and fiscal impact report for Duke Energy in December 1999 concerning the proposed construction of an electrical generating facility in the Arlington Valley area of Maricopa County. We understand Duke Energy intends to expand that generating facility by doubling its size, i.e. constructing a second plant that is similar to the first. The purpose of this letter is to outline the expected additional economic and fiscal impacts that may result due to the expansion. Our original report has been used as the basis for estimating the expected impact of a second generating facility.

If the assumptions of our original report still apply, the second generating facility would be expected to create approximately the same impact as the original generating plant. The economic impact of a particular facility or land use is typically proportional to the spending and employment associated with that facility or use. In other words, if Duke Energy's investment in a generating facility doubles, the economic impact would be expected to double as well.

In our December 1999 report, we assumed that the initial investment by Duke Energy would be $250 million, with local construction spending estimated at $67 million. The operation of the facility was expected to generate 25 full-time jobs.

We understand that the expansion of the site will require a similar investment by Duke Energy of $250 million and that the local construction cost occurring in Maricopa County will be similar to the original $67 million. The total investment in the generating plant is important since it establishes the market value for the site for property tax purposes. The plant is then depreciated over 30 years, straight-line. The only difference between the impact of the original plant and the second, additional facility is that number of full-time jobs required to operate second plant is 10, making a total of 35 jobs for the entire expanded generating site. The economic impact of the second facility's operations is, therefore, only 40% as large as the operation of the original generating plant.

Elliott D. Pollack & company

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www.arizonaeconomy.com

Given the above assumptions, the additional generating facility would yield approximately $62 million annually in economic activity in Maricopa County over its two-year construction schedule and an average of $2.1 million annually in economic activity over the first eight years of its operation. The following table summarizes those impacts.

Average Annual Economic Impact
Duke Energy Electric Generating Facility Addition
(in Inflated Dollars)

	Construction[1]	Operations[2]
Local Economic Output		
Direct output	$33,500,000	$1,551,000
Indirect output	$28,225,000	$598,000
Total output	$61,725,000	$2,149,000
Employment		
Direct jobs	298	10
Indirect jobs	345	17
Total jobs	643	27
Wages	$22,718,000	$739,800
Population		
Population supported by project	1,512	63
Households supported by project	577	24

[1]Annual total for each year of two year construction period.
[2]Average annual impact from 2003 - 2010.

Sources: IMPLAN; Duke Energy; Elliott D. Pollack & Co.

The impact of the combined operations of the original and second generating facility is shown on the following table. The site will create an average of $7.5 million in economic activity annually in Maricopa County over the first eight years of combined operations. A total of 94 jobs (35 direct and 59 indirect jobs) will be created by the generating site with wages of nearly $2.6 million. The construction of both generating facilities results in the injection of $134 million in direct spending in the Maricopa County economy over the four years required to construct the two plants, resulting in $247 million in total direct and indirect economic activity.

Average Annual Operations Economic Impact
Duke Energy Expanded Electric Generating Site
(in Inflated Dollars)

	Operations[1]
Local Economic Output	
Direct output	$5,428,000
Indirect output	$2,094,000
Total output	$7,522,000
Employment	
Direct jobs	35
Indirect jobs	59
Total jobs	94
Wages	$2,589,300
Population	
Population supported by project	222
Households supported by project	85

[1]Average annual impact over first eight years of operation.

Sources: IMPLAN; Duke Energy; Elliott D. Pollack & Co.

The fiscal impact of the second generating facility on city, county and state taxing authorities will only be slightly smaller than the original. Most of the fiscal impact of the generating facility is associated with property taxes levied on the capital investment in the facility and sales taxes levied on fuel consumption. The fiscal impact of the additional facility will be essentially the same as the original, if it has the same value and consumes similar amounts of natural gas. The annual operating impact of the second facility is projected to be about 2% lower than the original plant due to the lower employment level at the second facility.

As noted in the earlier impact report, Duke Energy's investment will have a significant impact on the assessed value and property tax rates of local school districts. The expanded site with the two generating facilities will have an assessed value greater than the current value of the entire Buckeye Union High School District. This should lead to significant reductions in property tax rates for local property owners once the facilities are added to the tax rolls.

If you should have any questions or comments about the information contained in the letter, please do not hesitate to contact us. We appreciate the opportunity to consult with you on your expansion plans.

Sincerely,

Richard C. Merritt

Richard C. Merritt, AICP
Senior Vice President

cc: Tom Campbell
Ed Bull

ECONOMIC AND FISCAL IMPACT OF DUKE ENERGY'S ELECTRIC GENERATING STATION ARLINGTON, ARIZONA

Prepared for:

Duke Energy

Prepared by:

Elliott D. Pollack and Company
7505 East Sixth Avenue, Suite 100
Scottsdale, AZ 85251

December 15, 1999

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Economic and Fiscal Impact
of
Duke Energy's Electric Generating Station
Arlington, Arizona

1.0 Executive Summary

Elliott D. Pollack and Company has been retained by Duke Energy to analyze the economic and fiscal impact of a proposed $250 million electric generating station to be located in a rural area southwest of the Town of Buckeye known as Arlington Valley. The plant will use natural gas as its primary fuel and will require a substantial quantity of water to generate steam. Approximately 2,800 acres of land will be purchased to provide a site for the plant and the water rights necessary to operate the facility. Construction is expected to start in February 2001, with completion slated for July 2002. The operation of the plant will generate 25 jobs.

While the investment by Duke Energy is estimated at $250 million, the local construction cost is estimated at about $67 million. Most of the cost of the generating station is associated with the purchase of gas and steam turbines that will be manufactured out of state.

The proposed Duke Energy electric generating station will be located in the Arlington Elementary and Buckeye Union High School Districts. Arlington Elementary (kindergarten through eighth grade) is a small district of approximately 155 students who are fed to the Buckeye Union District for secondary education. Buckeye Union has slightly over 1,000 students and serves a wide rural area of southwest Maricopa County.

This report will evaluate both the economic and fiscal effects of the proposed generating station. Economic impact analysis examines the regional implications of an activity in terms of three basic measures: sales or output, earnings and job creation. Fiscal impact analysis, on the other hand, evaluates the public revenues and costs created by a particular activity. In fiscal impact analysis, the primary revenue sources of a city, county or state are analyzed to determine how the activity may financially affect them. In addition, this report will evaluate the impact of the generating station on the Arlington Elementary and Buckeye Union High School Districts.

1.1 Economic Impact Summary

The economic impact of the Duke Energy generating station is substantial, resulting in the creation of nearly 643 total direct and indirect jobs annually during the two year construction period and 67 total direct and indirect jobs yearly during its operation. Local economic output during construction is $61.7 million annually and about $5

million per year thereafter. The project supports 577 households during construction and 60 households while in operation.

Table 1
Average Annual Economic Impact
Duke Energy Electric Generating Station
(in Inflated Dollars)

	Construction[1]	Operations[2]
Local Economic Output		
Direct output	$33,500,000	$3,877,000
Indirect output	$28,225,000	$1,496,000
Total output	$61,725,000	$5,373,000
Employment		
Direct jobs	298	25
Indirect jobs	345	42
Total jobs	643	67
Wages	$22,718,000	$1,849,500
Population		
Population supported by project	1,512	158
Households supported by project	577	60

[1]Annual total for each year of two year construction period.
[2]Average annual impact from 2003 - 2010.

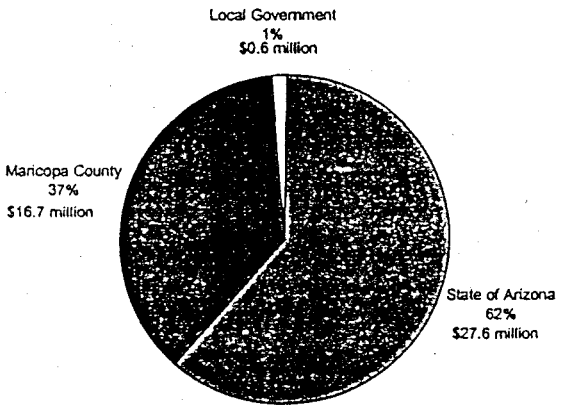
Sources: IMPLAN; Duke Energy; Elliott D. Pollack & Co.

1.2 Fiscal Impact Summary

One of the major benefits of the generating station is the increase in the assessed value of the County and other taxing districts within which the plant is located. The projected assessed value of the generating station and land, when first placed in operation and before deducting depreciation, is $62 million. This represents approximately 0.3% of the total $18 billion 1999 assessed value of the County, a fairly significant figure given the size of the metro area. A project of this magnitude is equivalent to a new regional shopping mall or large manufacturing plant from the standpoint of property tax revenue, even though the plant's value will slowly decline over the years as it is depreciated.

The electric generating station produces significant positive effects for the State of Arizona and Maricopa County totaling nearly $45 million dollars between 2001 and 2010. The majority of the revenue, 62%, accrues to the State, but Maricopa County and its taxing districts also receive $16.7 million. The taxation of real property, construction contracts and natural gas consumption accounts for about 90% of the revenue. Impacts resulting from the spending of workers supported by the plant contribute another $4.5 million over the 10 years. During construction of the plant, approximately $5.8 million accrues to governmental entities. After completion of the generating station, total revenues reach $5 million annually.

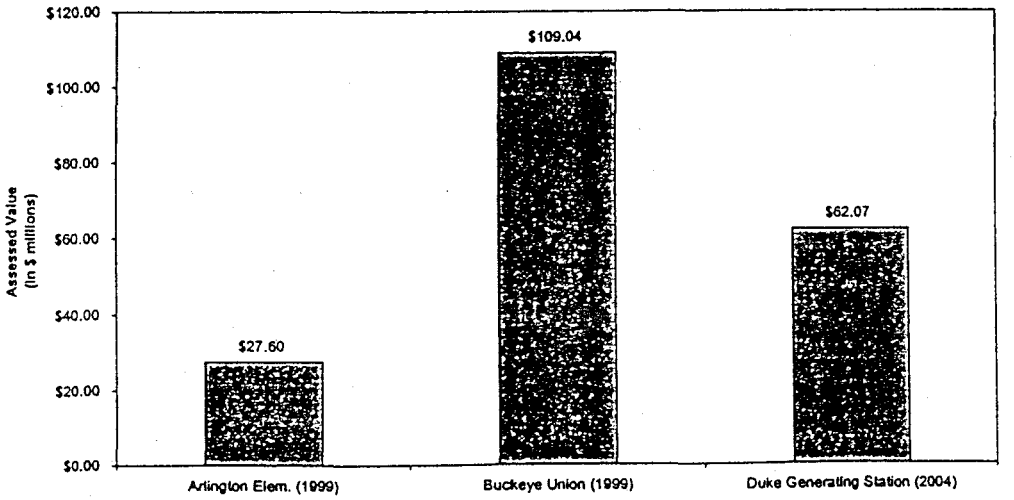
Chart 1
Distribution of Revenues
From Duke Energy Electric Generating Station
2001 - 2010
Sources: Duke Energy, IMPLAN, AZ Dept. of Revenue, Maricopa County Assessor, Elliott D. Pollack & Co.



1.3 Impact on School Districts

A large capital investment such as that proposed by Duke Energy will have a significant impact on the assessed value and tax rates of a school district. With the high assessment ratio of 25% for utility companies, the financing of schools is transferred in many respects from local residents to private business. When the plant is completed and added to the tax rolls in 2004, its estimated assessed value will be $62 million. Comparatively, this represents 125% of Arlington Elementary's 1999 primary assessed value and 57% of Buckeye Union's 1999 value.

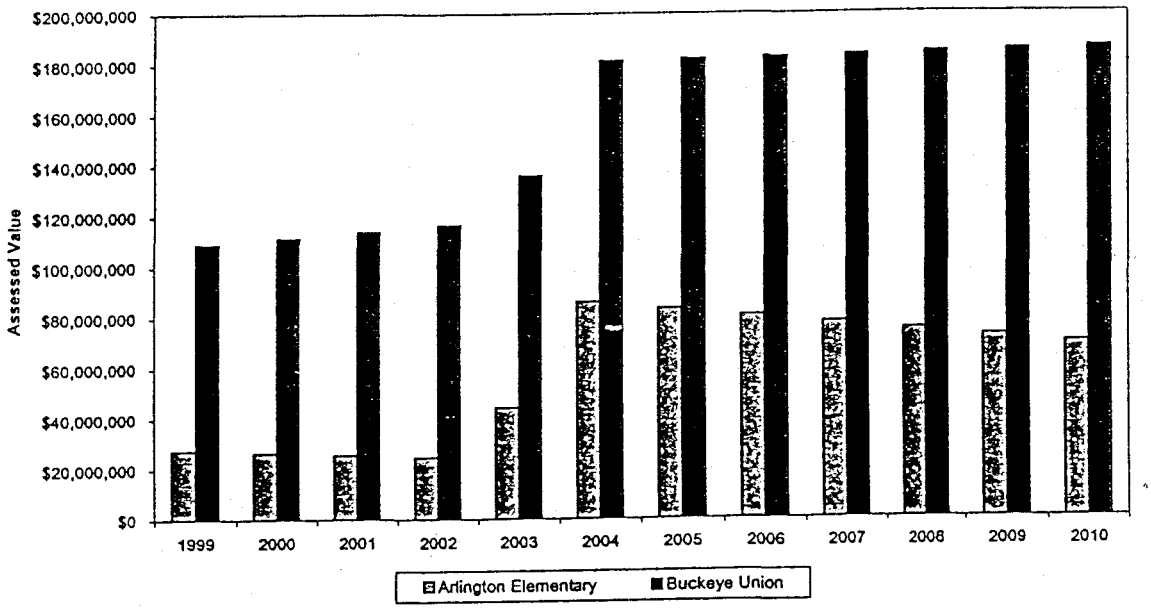
Chart 2
Comparison of Primary Assessed Values
Arlington Elementary District, Buckeye Union H. S. District, Duke Generating Station
Sources: AZ Dept. of Revenue, Maricopa County Assessor, Elliott D. Pollack & Co.



Duke Energy's investment in the generating station produces a large boost in the assessed valuation of both the Arlington Elementary and Buckeye Union Districts. The projected primary assessed value begins to climb in 2003 with the construction of the plant (there's a two year time lag between construction and the recording of the generating station on the tax rolls). By 2004, the full effect of the plant on assessed values is realized.

Chart 3

Projected Primary Assessed Values
Arlington Elementary and Buckeye Union School Districts
Sources: AZ Dept. of Revenue, Maricopa County Assessor, Elliott D. Pollack & Co.



As a result, the primary and secondary tax rate for both Arlington Elementary and Buckeye Union should experience significant decreases. For instance, Arlington Elementary's primary rate should drop by about 63% between 1999 and 2004 when the plant is completed. The rate is projected to decline from the current $2.2040 to $0.8187, assuming that the school district's revenues needs increase at 3% per year from their current level.

Likewise, Buckeye Union's primary rate is projected to decline by 30% between 1999 and 2004 if revenue needs grow by 3% per year. The primary tax rate falls from $2.1337 in 1999 to a projected $1.4880 in 2004. Similar decreases in the secondary tax rate will also occur.

Individual property owners should see a 46% decline in school district property taxes between 1999 and 2004 as a result of the construction of the electric generating station. The typical annual savings range from $95 for a 40 acre vacant parcel to $421 for a 160 acre agricultural parcel. While these savings seem small for each property owner, the effect across both the Arlington Elementary and Buckeye Union Districts is substantial. Based on the projected future assessed values for the plant and expected property tax

rates, Duke Energy will be absorbing over $1.8 million in school district property taxes each year, once the plant is in service. These are expenses that previously accrued to all other property owners located within the school districts.

Table 2

Estimated Annual School District Property Tax Savings Resulting From Duke Energy Electric Generating Station

Property type	Residence on 1 acre lot	40 acre vacant parcel	160 acre parcel in agriculture
Market value	$70,000	$23,280	$103,200
Assessed value	$7,000	$3,725	$16,512
1999 combined school property tax[1]	$282	$206	$914
Projected 2004 combined school property tax[2]	$153	$111	$493
Tax savings	**$129**	**$95**	**$421**
Percentage tax decrease	**45.7%**	**46.0%**	**46.0%**

[1]Combined Arlington Elementary and Buckeye Union tax rate of $5.5364; reduced homeowner rate of $4.0341.

[2]Projected combined rate of $2.9887; reduced homeowner rate of $2.1899.

Note: Tax calculations do not include County or special district property taxes.

Sources: AZ Dept. of Revenue; Maricopa County Assessor; Elliott D. Pollack & Co.

2.0 Methodology and Sources

This report will describe the projected economic and fiscal impact of the construction and operation of a privately-owned electric generating station on metro Phoenix. Economic impact analysis examines the regional implications of an activity in terms of three basic measures: sales or output, earnings and job creation. Fiscal impact analysis, on the other hand, evaluates the public revenues and costs created by a particular activity. In fiscal impact analysis, the primary revenue sources of a city, county or state are analyzed to determine how the activity may financially affect them.

This study will focus on the benefits that would accrue to the State of Arizona, Maricopa County, and the Arlington Elementary and Buckeye Union High School Districts from the construction of the Duke Energy electrical generating station. The site of the plant is not located within an incorporated area, so the effect on local municipalities will be negligible. The analysis assumes that the current tax structure of the State and County would continue at current rates into the future. The impact on the school districts will be evaluated from the standpoint of increased assessed valuation and potential effect on property tax rates.

The fiscal impact figures cited in this report have been generated from information provided by a variety of sources including:

- Arizona Department of Education;
- Arizona Department of Economic Security;
- Arizona Department of Revenue;
- Duke Energy;
- Maricopa County Assessor's office;
- U.S. Consumer Expenditure Survey.

On of the most important effects of the power plant is the impact on assessed values and property taxes. The Arizona Department of Revenue controls the valuation of electric utility company property for property tax purposes. Utility companies, mines, and railroads are known as "centrally assessed" property and are subject to different standards than other types of real property. The plant is placed on the tax rolls at the book cost of investment and then depreciated over the life of the investment. In this case, depreciation is calculated based on a 30 year straight-line plant life. Pollution control equipment receives a 50% market value exemption under state law. Electric utility company property is assessed at 25% of its full cash value.

During construction of the plant, property taxes are calculated based on 50% of the actual cost expended for the year ending December 31st. A two-year time lag occurs between actual construction of the plant and placing it on the tax rolls. For instance, if the plant were started in 2001 as anticipated, the value of the first year's construction activity would not reach the tax rolls until the 2003 tax year. The full value of the

plant will not be recorded for tax purposes until 2004, based on the projected completion in 2002.

Elliott D. Pollack and Company has relied upon Duke Energy for construction cost estimates, employment projections and operating expenditures. This firm has not provided any estimate of the projected governmental costs to provide services to the generating station. Such analysis is beyond the scope of this study. Unless otherwise stated, all dollar values are expressed in current, inflated dollars using a 3% annual inflation rate.

This report is organized to provide an overview of economic and fiscal impact analysis and the results attributed to this particular project. The following section describes the proposed generating station and the primary assumptions that will drive the impact analysis. Section 4.0 summarizes the economic impact of the generating station on the metro Phoenix area. The fiscal impact of the plant is outlined in Section 5.0. Lastly, the impact of the generating station on the local school districts is described in the final part of the study.

3.0 Description of Project

Duke Energy is proposing to construct a $250 million electric generating plant in a rural area southwest of the Town of Buckeye known as Arlington Valley. Approximately 2,800 acres valued at $5 million will be purchased to provide a site for the plant and the water rights necessary to operate the facility. The plant will use natural gas as its primary fuel, but will also require a substantial quantity of water to generate steam. Duke Energy expects to purchase approximately $50 million of natural gas per year to operate the plant. Construction is expected to start in February 2001, with completion slated for July 2002.

For property tax analysis, it is necessary to differentiate between various parts of the plant and the company's investment. Of the $250 million cost, approximately $10 million will be spent on pollution control equipment, which is the subject of a 50% property tax exemption.

The land parcels that are subject to purchase are all contiguous and located within the Arlington Elementary and Buckeye Union High School Districts. The property is located within Township Six West, Range 1 South, which will provide rail access to the site.

While the investment by Duke Energy is estimated at $250 million, the local construction cost is estimated at about $67 million. Most of the cost of the generating station is associated with the purchase of gas and steam turbines that will be manufactured out of state. The operation of the plant will generate 25 jobs.

4.0 Economic Impact of Generating Station

This portion of the report will outline the economic impacts of both the construction of the generating station as well as its operations. Analysis of the fiscal impacts of the project is provided in the Section 5.0. All dollar figures, unless otherwise stated, are expressed in current, inflated dollars.

An extensive spreadsheet model was developed to evaluate and calculate the fiscal and economic impacts of the Duke Energy generating station from 2001 to 2010. The first subsection describes the economic impact methodology while subsection 4.2 summarizes the total benefits.

4.1 Economic Impact Analysis Methodology

Economic impact analysis examines the economic implications of an activity in terms of sales or output, earnings, and employment. For this study, the following two economic activities associated with the generating station were evaluated:

- the construction of the plant and
- the operations of the plant once completed.

Construction phase economic impacts are generally short-term effects related to onsite and offsite construction employment and other industries that support the construction. The long-term consequences of a project are the operational phase impacts. These include employment, earnings and expenditures that recur over the long-term.

The different types of economic impacts are known as direct, indirect, and induced, according to the manner in which the impacts are generated. For instance, direct employment consists of permanent jobs held by the project employees. Indirect employment is those jobs created by businesses that provide goods and services essential to the operation or construction of the project. These businesses range from manufacturers (who make goods) to wholesalers (who deliver goods) to janitorial firms who clean the buildings. Finally, the spending of the wages and salaries of the direct and indirect employees on items such as food, housing, transportation and medical services creates induced employment in all sectors of the economy.

Economists have developed multipliers that are used to estimate the indirect and induced impacts of various economic activities. These indirect and induced ripple effects occur as the wages of direct employees are respent in local businesses on retail goods and services. In response to this spending, local businesses hire more staff and expand their operations, creating additional jobs in retailing, wholesaling, manufacturing, transportation and other service sectors. These secondary effects are captured in the analysis conducted in this study.

Multipliers have been developed by both public and private organizations for each state and county in the country. The Minnesota IMPLAN Group developed the multipliers

used in this study. The IMPLAN multipliers are used to estimate the impacts of project expenditures on a region (gross receipt or sales), earnings (the sum of wages and salaries, proprietors income, and other labor income), and employment (number of jobs).

4.2 Economic Impact of Duke Energy Electric Generating Station

As noted previously, the local economic impact of the construction of the generating station is significantly less than its full cost since most of the major components are manufactured out-of-state. The local construction contract is estimated at approximately $67 million, spent during 2001 and 2002. Duke Energy projects that 25 direct jobs will be permanently created for the operation of the plant. Plant operators are expected to earn the typical wage for public utility employees in Maricopa County of about $39,000 annually. From this data, the IMPLAN economic multipliers are used to calculate the total impact of the project.

The economic impact of the Duke Energy generating station is substantial, resulting in the creation of nearly 643 total direct and indirect jobs annually during the two year construction period and 67 total direct and indirect jobs yearly during its operation (see Table 3). Local economic output during construction is $61.7 million annually and about $5 million per year thereafter. The project supports 577 households during construction and 60 households while in operation.

The impacts described above are regional in nature and will affect cities throughout the metro Phoenix area. For instance, construction materials will be purchased from local vendors and construction employees might commute long distances to work on the plant. Most likely, these workers and their families will purchase their daily needs at stores close to their place of residence, helping to disperse the Duke Energy generating station's impact throughout many local cities. Full-time workers who operate the plant after construction will most likely live on the west side of Maricopa County, once again distributing the impact among a number of communities.

Table 3

Economic Impact on Maricopa County
Duke Energy Electrical Generating Station
(In Inflated Dollars)

Inflation rate: 3.0%

	Construction		Operations							
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Local Economic Output										
Direct output	$33,500,000	$33,500,000	$3,488,000	$3,592,000	$3,700,000	$3,811,000	$3,926,000	$4,043,000	$4,165,000	$4,290,000
Indirect output	$28,225,000	$28,225,000	$1,346,000	$1,386,000	$1,428,000	$1,471,000	$1,515,000	$1,560,000	$1,607,000	$1,655,000
Total output	$61,725,000	$61,725,000	$4,834,000	$4,979,000	$5,128,000	$5,282,000	$5,440,000	$5,604,000	$5,772,000	$5,945,000
Employment										
Direct jobs	298	298	25	25	25	25	25	25	25	25
Indirect jobs	345	345	42	42	42	42	42	42	42	42
Total jobs	643	643	67	67	67	67	67	67	67	67
Wages	$22,718,000	$22,718,000	$1,664,000	$1,714,000	$1,765,000	$1,818,000	$1,873,000	$1,929,000	$1,987,000	$2,046,000
Population										
Population supported by project	1,512	1,512	158	158	158	158	158	158	158	158
Households supported by project	577	577	60	60	60	60	60	60	60	60

Sources: IMPLAN; Duke Energy; Elliott D. Pollack & Co.

5.0 Fiscal Impact of Generating Station

5.1 Background

Fiscal impact analysis studies the public revenues associated with a particular economic activity. The primary revenue sources of local, county, and state governments (i.e. taxes) are analyzed to determine how an activity may affect the various jurisdictions. This section will only evaluate the impact on the governmental entities. The impact on local school districts will be analyzed in Section 6.0.

Fiscal impacts are categorized by type in this study, similar to economic impact analysis. Construction impacts relate to the revenues generated from construction of the power plant. The primary sources of revenue are the state, county, and local sales taxes levied on the value of construction activity. In this particular case, the project is not located in a municipality, so local sales taxes will not be applicable. Operation phase fiscal impacts result from payment of employee wages and expenditures related to operating the generating station. One of the most important on-going revenues are the property taxes that will be paid by Duke Energy.

In addition to the direct revenues described above, secondary fiscal effects also occur as a result of spending by construction and operations employees. For instance, employees of the plant will live in all parts of Maricopa County, benefiting those communities from their spending on housing, retail goods and services. Indirect and induced employment supported by the plant will also create fiscal impacts resulting from the spending of their wages. Examples of the types of secondary fiscal impacts that will be generated include State income taxes paid on wages and sales taxes paid on retail sales.

5.2 Revenue Sources

This section outlines the applicable tax rates of the various jurisdictions and the types of taxes that will be collected from construction and operation of the Duke Energy electric generating station.

- <u>Tax On Construction Materials</u>
  The State and County levies a sales tax on materials used in the construction of land or building improvements. That tax is calculated by State law under the assumption that 65% of the construction cost of the facility and its land improvements are related to construction materials with the remaining 35% devoted to labor. The sales tax rate is then applied to the 65% materials figure. The sales tax on construction materials is a one-time collection by the governmental entity.

  The State currently levies a 5.0% sales tax on construction activity. Maricopa County levies two sales taxes totaling 0.7%. The freeway tax, which is used to fund the County's freeway program, is levied at a 0.5% rate until 2006 when it

expires. In November 1998, the electorate approved a 0.2% levy for the construction of prison facilities that is schedule to expire at the end of 2007.

- Property Taxes

  Real estate taxes are typically based on the assessed value of real property as determined by County Assessor. In the case of an electrical generating station, however, the Arizona Department of Revenue conducts the valuation in accordance with State Statute. The market value of the power plant is established as the original cost less accumulated depreciation. For this report, the plant was depreciated over 30 years, straight-line. Pollution control equipment is provided a 50% exemption from taxation.

  The assessed value of the plant is calculated by multiplying the assessment ratio, determined by the property's use, by its full cash value. The assessment ratio for an electric utility plant is 25%; vacant land is assessed at 16%. Assessed value is expressed by the following equation:

  market value X assessment ratio = assessed value

  The property tax rate, expressed in dollars per $100 of assessed value, is then applied to the assessed value to determine the amount of property tax. There are two types of property taxes – primary taxes used to finance general government operations, and secondary taxes used to finance general obligation bonded debt, budget overrides and special districts. The primary tax is based on what is known as the limited property value, calculated under a formula spelled out in State law. Secondary taxes are based on full cash value of property. The limited value cannot exceed full cash value. For an electrical utility, the limited and full cash values are the same.

  The combined Maricopa County property tax rate (primary and secondary) for 1999 is $3.4250 per $100 of assessed value comprised of the following taxing entities or districts:

  - general County tax,
  - Community College tax,
  - Flood Control District tax,
  - Fire District Assistance tax,
  - County Free Library tax,
  - Central Arizona Water Conservation tax.

  In addition, direct and indirect employees supported by the construction and operation of the plant will also pay city property taxes on homes they occupy. The tax rate used for this analysis is the weighted average rate of the eight largest cities in the metro area or $1.4380 per $100 of assessed value. The value of a typical Maricopa County housing unit has been calculated at approximately $105,000. This value assumes that employees will occupy units in a pattern similar to the current inventory of housing in the Valley. Today,

single family homes account for 66.1% of the housing stock, townhouses 8.1%, and apartments 25.8%. The current average sale price of these units is $131,000, $85,000, and $43,800 respectively, with the weighted average of all units at $104,776.

- Sales/Use Tax.
  The electric generating station will consume a large quantity of natural gas, estimated at $50 million per year. The State and County will charge a use or sales tax on this consumption at the 5.0% rate for the State and 0.7% rate for the County.

  Fiscal impacts also result from the spending by direct and indirect employees supported by the construction and operation of generating station. Most of the employees supported by the project will reside within one of Maricopa County's cities or, at the very least, purchase goods from retailers located within a local municipality. Based on data from the U. S. Consumer Expenditure Survey, the projected extent of retail spending and resulting sales tax receipts was calculated.

  State and County sales tax rates for employee spending are the same as cited previously (5.0% for State and 0.7% for County). The retail sales tax receipts for local cities are based on the weighted average tax rate for all cities in Maricopa County or 1.38%.

- State Income Tax
  The State of Arizona collects taxes on personal income. The tax rate used in the analysis averages about 1.7% of gross income for construction-related wages and 1.3% for operations-related earnings. These percentages are based on the most recently available income tax data from the State and the projected wage levels of jobs created by the project. This tax will apply to the wages and earnings of direct and indirect employment resulting from construction and operation of the generating station. Portions of this tax are redistributed through revenue sharing to cities throughout Arizona based on population.

- State Unemployment Tax
  Unemployment insurance tax for employees is 2.7% on the first $7,000 of earned income. This factor is applied to the projected wages and earnings of direct and indirect employees involved in construction and operation of the project.

- Gas Tax
  The State of Arizona collects a motor vehicle fuel tax of $0.18 per gallon. The tax revenue is calculated based on a vehicle traveling 12,000 miles per year at 20 miles per gallon. Portions of this tax are distributed to cities and counties throughout Arizona based on a formula that includes population and the origin of gasoline sales.

- Vehicle License Tax
  The vehicle license tax is a personal property tax placed on vehicles at the time of annual registration. The average tax in Maricopa County is $148 and funds are shared between the cities, county and state in accordance with population based formulas.

The above tax categories represent the largest sources of revenues that will be generated to city, county and state governments.

5.3 Fiscal Impact of Duke Energy Electric Generating Station

One of the major benefits of the generating station is the increase in the assessed value of the County and other taxing districts within which the plant is located. The projected assessed value of the generating station and land, when first placed in operation and before deducting depreciation, is $62 million (see Table 4). This represents approximately 0.3% of the total $18 billion 1999 assessed value of the County, a fairly significant figure given the size of the metro area. A project of this magnitude is equivalent to a new regional shopping mall or manufacturing plant from the standpoint of property tax revenue, even though the generating station's value will slowly decline over the years as it is depreciated.

Table 4
Projected Market and Assessed Values
Duke Energy Electric Generating Station
(in Inflated Dollars)

	Projected Market Value				
	Plant Value	P.C.E.*	Land	Total Value	Assessed Value
2001	$0	$0	$1,680,000	$1,680,000	$268,800
2002	$0	$0	$1,680,000	$1,680,000	$268,800
2003	$73,333,333	$1,527,778	$5,000,000	$79,861,111	$19,515,278
2004	$240,000,000	$5,000,000	$5,150,000	$250,150,000	$62,074,000
2005	$232,000,000	$4,833,333	$5,304,500	$242,137,833	$60,057,053
2006	$224,000,000	$4,666,667	$5,463,635	$234,130,302	$58,040,848
2007	$216,000,000	$4,500,000	$5,627,544	$226,127,544	$56,025,407
2008	$208,000,000	$4,333,333	$5,796,370	$218,129,704	$54,010,753
2009	$200,000,000	$4,166,667	$5,970,261	$210,136,928	$51,996,909
2010	$192,000,000	$4,000,000	$6,149,369	$202,149,369	$49,983,899

*Pollution Control Equipment

Sources: AZ Dept. of Revenue; Maricopa County Assessor; Elliott D. Pollack & Co.

Table 4 shows the projected depreciated value of the plant over time. The analysis assumes there will be no additional capital improvements to the site in the future. The value of the land to be acquired by Duke Energy has been inflated at a 3.0% rate given historical land appreciation trends in the area.

As shown on Table 5 on page 17, the electric generating station will produce significant positive effects for the State of Arizona and Maricopa County totaling nearly $45 million

dollars between 2001 and 2010. About 90% of the revenue is derived from taxation of real property, construction contracts and natural gas consumption. Impacts resulting from employment spending and wages contribute another $4.5 million over the 10 years. During construction of the plant, approximately $5.8 million per year accrues to governmental entities. After completion of the generating station, total revenues reach $5 million annually.

The State of Arizona reaps most of the rewards of the plant, accounting for $27.4 million in revenue or 62% of the total. Maricopa County also gains about $16.7 million in tax revenue, primarily from property taxes. It should be noted that most of these revenues do not flow directly to the County's general fund, but rather to county-wide taxing jurisdictions such as the Community College District and Flood Control District. Cities in the county gain the least because the plant is located in a rural area. Any impact on local cities is the result of spending of wages by persons supported by the generating station.

It needs to be emphasized that the above revenue figures are based on the current tax structure of the State and County. Any increase in sales or income tax rates would produce even greater benefits. The high tax valuation of the plant also provides a significant boost to the assessed valuation of the County, helping to stabilize or even reduce County property tax rates. In addition, the figures do not include corporate income taxes that may be paid to the State by Duke Energy.

Table 5

Fiscal Impact on Arizona and Maricopa County
Duke Energy Electrical Generating Station
(In Inflated Dollars)

Inflation rate: 3.0%

Fiscal Impact of Project	Construction 2001	Construction 2002	Operations 2003	2004	2005	2006	2007	2008	2009	2010	Total
State of Arizona											
Construction sales tax	$1,089,000	$1,089,000									$2,178,000
Sales tax on fuel consumption			$2,500,000	$2,575,000	$2,652,000	$2,732,000	$2,814,000	$2,898,000	$2,985,000	$3,075,000	$22,231,000
Maricopa County											
Construction sales tax	$152,000	$152,000									$304,000
Sales tax on fuel consumption			$350,000	$361,000	$371,000	$382,000	$113,000	$0	$0	$0	$1,577,000
Property tax	$9,000	$9,000	$668,000	$2,126,000	$2,057,000	$1,988,000	$1,919,000	$1,850,000	$1,781,000	$1,712,000	$14,119,000
Fiscal Impacts of Employees											
State of Arizona											
Retail sales tax[1]	$483,000	$483,000	$44,000	$45,000	$47,000	$48,000	$49,000	$51,000	$52,000	$54,000	$1,356,000
Income tax[1]	$393,000	$393,000	$22,000	$23,000	$23,000	$24,000	$25,000	$26,000	$26,000	$27,000	$982,000
Unemployment tax	$122,000	$122,000	$13,000	$13,000	$14,000	$14,000	$14,000	$15,000	$15,000	$16,000	$358,000
Gas tax[1]	$69,000	$69,000	$7,000	$7,000	$8,000	$8,000	$8,000	$8,000	$9,000	$9,000	$202,000
Vehicle license tax[1]	$95,000	$95,000	$10,000	$10,000	$11,000	$11,000	$11,000	$12,000	$12,000	$12,000	$279,000
Maricopa County											
Retail sales tax	$80,000	$80,000	$7,000	$8,000	$8,000	$8,000	$2,000	$0	$0	$0	$193,000
Property tax	$166,000	$166,000	$17,000	$18,000	$18,000	$19,000	$20,000	$20,000	$21,000	$21,000	$486,000
Local Government											
Retail sales tax	$158,000	$158,000	$14,000	$15,000	$15,000	$16,000	$16,000	$17,000	$17,000	$18,000	$444,000
Property tax	$70,000	$70,000	$7,000	$8,000	$8,000	$8,000	$8,000	$8,000	$9,000	$9,000	$205,000
Total Impact											
State of Arizona	$2,251,000	$2,251,000	$2,596,000	$2,673,000	$2,755,000	$2,837,000	$2,921,000	$3,010,000	$3,099,000	$3,193,000	$27,586,000
Maricopa County	$407,000	$407,000	$1,042,000	$2,513,000	$2,454,000	$2,397,000	$2,054,000	$1,870,000	$1,802,000	$1,733,000	$16,679,000
Local Government	$228,000	$228,000	$21,000	$23,000	$23,000	$24,000	$24,000	$25,000	$26,000	$27,000	$649,000
Total All Impacts	$2,886,000	$2,886,000	$3,659,000	$5,209,000	$5,232,000	$5,258,000	$4,999,000	$4,905,000	$4,927,000	$4,953,000	$44,914,000

[1] A portion of these taxes are shared with cities, towns and counties under revenue sharing.

Sources: IMPLAN; Duke Energy; Arizona Department of Revenue; Maricopa County Assessor's Office; Elliott D. Pollack & Co.

6.0 Impact of Generating Station on School Districts

6.1 Background

The Duke Energy electric generating station is located in the Arlington Elementary and Buckeye Union High School Districts. Arlington Elementary (kindergarten through eighth grade) is a small district of approximately 155 students who are fed to the Buckeye Union District for secondary eduation. Buckeye Union has slightly over 1,000 students and serves a wide rural area of southwest Maricopa County.

The history of assessed values of the two districts is shown on Table 6. Arlington's assessed value has been declining since 1991 as a result of the large percentage of utility company investments within the District. For 1999, over 50% of the District's assessed value is attributable to utility and pipeline company improvements. Since these properties depreciate over time, the assessed value declines as well. Buckeye Union's assessed value has been growing since the end of the local real estate depression in 1995. Utilities account for about 31% of Buckeye Union's assessed value.

Table 6
Assessed Valuation History
Arlington Elementary and Buckeye Union High School Districts

Arlington Elementary #47	Primary Property Tax		Secondary Property Tax		Property Tax Revenue	
	Valuation	Tax rate	Valuation	Tax rate	Primary	Secondary
1991	$34,673,905	$2.2854	$37,110,165	$0.0000	$792,437	$0
1992	$33,854,336	$2.4430	$35,455,605	$0.0000	$827,061	$0
1993	$32,074,642	$2.3907	$32,670,713	$0.0000	$766,808	$0
1994	$31,496,043	$2.2549	$32,099,408	$0.1973	$710,204	$63,332
1995	$32,562,122	$1.9804	$33,388,798	$0.3933	$644,860	$131,318
1996	$30,589,918	$2.3780	$31,139,091	$0.2090	$727,428	$65,081
1997	$30,271,539	$2.2309	$31,006,780	$0.4229	$675,328	$131,128
1998	$29,622,791	$2.3097	$30,632,190	$0.4192	$684,198	$128,410
1999	$27,601,070	$2.2040	$28,536,546	$0.4816	$608,328	$137,432
Compound annual change 1996-99	-3.37%		-2.87%			

Buckeye Union High School #201	Primary Property Tax		Secondary Property Tax		Property Tax Revenue	
	Valuation	Tax rate	Valuation	Tax rate	Primary	Secondary
1991	$115,410,114	$2.5579	$129,471,406	$0.7654	$2,952,075	$990,974
1992	$119,897,053	$2.1808	$127,640,825	$0.5166	$2,614,715	$659,393
1993	$109,944,995	$2.5032	$113,431,370	$0.5817	$2,752,143	$659,830
1994	$107,249,347	$2.6897	$109,847,874	$0.6343	$2,884,686	$696,765
1995	$105,322,499	$2.0479	$109,517,107	$0.5521	$2,156,899	$604,644
1996	$101,996,864	$2.3267	$104,597,699	$0.7058	$2,373,161	$738,251
1997	$102,860,395	$2.5973	$106,842,353	$0.6617	$2,671,593	$706,976
1998	$104,992,419	$2.5043	$109,689,634	$0.7414	$2,629,325	$813,239
1999	$109,037,307	$2.1337	$114,684,129	$0.7171	$2,326,529	$822,400
Compound annual change 1996-99	2.25%		3.12%			

Sources: Maricopa County Assessor; Elliott D. Pollack & Co.

The financing of public education in Arizona is a complex matter. Funding comes from a variety of local, state, and federal sources based on complicated formulas. For fiscal year

1997-98, local property taxes provided 47% of total public school funding within Maricopa County while the State contributed 45%. Federal and County sources contributed the remaining revenue. Two types of property taxes accomplish funding at the local level:

- Primary taxes used to finance school operations; and
- Secondary taxes used to finance general obligation bonded debt and budget overrides.

According to the Arizona Department of Education, local property taxes provided about 86% and 62%, respectively, of the Arlington and Buckeye Union Districts' total budgets during fiscal year 1997-98. The proposed Duke Energy electric generating station will increase the assessed value of the school districts and provide two primary benefits:

- Funding for schools can be increased without raising tax rates or, alternatively, current funding levels can be maintained while reducing the tax rate; and
- The districts' bonding capacities will be increased to support new capital improvements.

Both of the above benefits are subject to spending and debt limitations provided in State law. In addition, the financing of public school capital facilities and the future of the secondary property tax is currently in a state of flux due to the passing of the Students FIRST bill by the State Legislature in July 1998. A discussion of the implications of Students FIRST is included in the last part of this section.

6.2 Impact of Duke Energy Generating Station on School Districts

A large capital investment such as that proposed by Duke Energy will have a significant impact on the assessed value and tax rates of a school district. With the high assessment ratio of 25% for utility companies, the financing of schools is transferred in many respects from local residents to private business. The analysis contain in this section will illustrate the potential impact of the power plant on local school property taxes.

When the plant is completed and added to the tax rolls in 2004, its estimated assessed value will be $62 million. Comparatively, this represents 125% of Arlington Elementary's 1999 primary assessed value and 57% of Buckeye Union's 1999 value. Clearly, the generating station should have an immediate positive effect, resulting in lower school tax rates.

Chart 4

Comparison of Assessed Values
Arlington Elementary District, Buckeye Union H. S. District, Duke Generating Station

Sources: AZ Dept. of Revenue, Maricopa County Assessor, Elliott D. Pollack & Co.

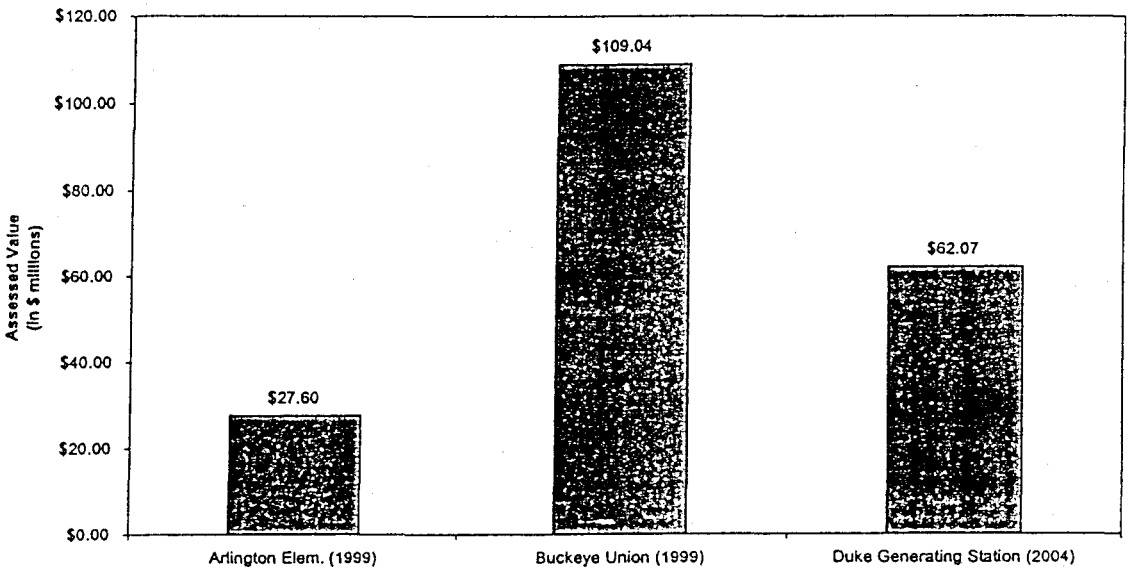


Table 7 has been developed as an example of the effect of the plant on primary tax rates. The primary rate has been used because of the uncertainty on the future of the secondary rate due to Students FIRST. The assumptions are the following:

- The existing primary property tax base for Arlington Elementary continues to decline in the future at the rate of 3.37% per year, similar to the rate experienced between 1996 and 1999. Buckeye Union's primary tax base is assumed to grow at a 2.25% annual rate.

- The Duke Energy generating station is added to the tax rolls in 2003 as partially completed. In 2004, the full value of the completed plant takes effect.

- The "desired revenue" column represents the 1999 primary tax revenue generated to each school district, increased by 3% per year thereafter.

- The "projected tax rate" column is the primary rate that would need to be levied to achieve the desired revenue.

As noted on Table 7, the projected tax rate for both Arlington Elementary and Buckeye Union should experience significant decreases. For instance, Arlington Elementary's rate should drop by about 63% between 1999 and 2004 when the plant is completed. The rate declines from the current $2.2040 to $0.8187. However, if the need for revenues increases at 3% per year, the tax rate would rise to $2.6692 by 2002 before the effects of

the generating station are noticed, then drop to $0.8187 by 2004. This represents a decline of about 69%.

Table 7

Impact of Duke Energy Electric Generating Station On Local School Districts' Primary Tax Rate

(In Inflated Dollars)

Arlington Elementary District			
	Projected Assessed Value	Desired Revenue	Projected Tax Rate*
1999	$27,601,070	$608,328	$2.2040
2000	$26,671,153	$626,577	$2.3493
2001	$25,772,566	$645,375	$2.5041
2002	$24,904,253	$664,736	$2.6692
2003	$44,419,531	$684,678	$1.5414
2004	$86,139,195	$705,218	$0.8187
2005	$83,311,460	$726,375	$0.8719
2006	$80,511,783	$748,166	$0.9293
2007	$77,739,265	$770,611	$0.9913
2008	$74,993,042	$793,730	$1.0584
2009	$72,272,276	$817,541	$1.1312
2010	$69,576,162	$842,068	$1.2103

Buckeye Union High School District			
	Projected Assessed Value	Desired Revenue	Projected Tax Rate*
1999	$109,037,307	$2,326,529	$2.1337
2000	$111,490,505	$2,396,325	$2.1494
2001	$113,998,897	$2,468,215	$2.1651
2002	$116,563,724	$2,542,261	$2.1810
2003	$136,079,002	$2,618,529	$1.9243
2004	$181,260,257	$2,697,085	$1.4880
2005	$181,924,846	$2,777,997	$1.5270
2006	$182,650,509	$2,861,337	$1.5666
2007	$183,438,623	$2,947,177	$1.6066
2008	$184,290,601	$3,035,593	$1.6472
2009	$185,207,884	$3,126,660	$1.6882
2010	$186,191,949	$3,220,460	$1.7296

*Expressed in dollars per $100 or assessed value.

Sources: AZ Dept. of Revenue; Maricopa County Assessor; Elliott D. Pollack & Co.

Likewise, Buckeye Union's rate declines by 30% between 1999 and 2004 and then continues to grow slowly as the desired revenue figure grows by 3% per year. The tax rate falls from $2.1337 in 1999 to a projected $1.4880 in 2004.

Residents of the area will, therefore, see a large decline in their property tax bills for the school districts over the next five years as the burden shifts to the power plant. The impact on County property taxes will not be noticeable because of the large size of the County's tax base. However, as noted previously, the power plant will help to stabilize County tax rates and relieve some of the burden on local residents.

To illustrate the fiscal impact of the power plant on individual property owners, Table 8 outlines the projected school district tax savings for three property types in the Arlington Valley area. The properties include a residence on a one acre lot, a 40 acre vacant, desert parcel and a 160 acre site currently in cultivation. The residence is assessed at a 10% assessment ratio while the larger, unimproved properties have a 16% ratio. Homeowners also receive a 35% discount on the primary school tax under current State law. The projected market values of the properties have been confirmed with the County Assessor's office and through sampling of property tax records. The calculations do not include County property taxes or any special district taxes that may apply to certain parcels.

Table 8

Estimated Annual School District Property Tax Savings Resulting From Duke Energy Electric Generating Station

Property type	Residence on 1 acre lot	40 acre vacant parcel	160 acre parcel in agriculture
Market value	$70,000	$23,280	$103,200
Assessed value	$7,000	$3,725	$16,512
1999 combined school property tax[1]	$282	$206	$914
Projected 2004 combined school property tax[2]	$153	$111	$493
Tax savings	**$129**	**$95**	**$421**
Percentage tax decrease	**45.7%**	**46.0%**	**46.0%**

[1]Combined Arlington Elementary and Buckeye Union tax rate of $5.5364; reduced homeowner rate of $4.0341.

[2]Projected combined rate of $2.9887; reduced homeowner rate of $2.1899.

Note: Tax calculations do not include County or special district property taxes.

Sources: AZ Dept. of Revenue; Maricopa County Assessor; Elliott D. Pollack & Co.

The table shows that property owners should see a 46% decline in school district property taxes between 1999 and 2004 as a result of the construction of the electric generating station. The annual savings range from $95 for the 40 acre vacant parcel to $421 for the agricultural parcel. While these savings seem small for each property owner, the effect across both the Arlington Elementary and Buckeye Union Districts is substantial. Based on the projected future assessed values for the plant and expected property tax rates, Duke Energy will be absorbing over $1.8 million in school district property taxes each year, once the plant is in service. These are expenses that previously accrued to all other property owners located within the school districts.

6.3 Students FIRST Legislation

In July 1998, the State Legislature passed the Students FIRST bill that dramatically reformed the way public schools are constructed. Passage of the bill was in response to the State Supreme Court's finding that Arizona's capital school finance system was unconstitutional. The basis for school construction financing until 1998 had been bonded indebtedness, i.e. the local secondary property tax. The system was found by the courts, however, to be unconstitutional since it failed to treat all school children equally.

Students FIRST establishes that the State must provide the funding for building adequate schools. The use of bonding is still permitted, but only to go above and beyond the minimum standards provided by the State. Capital overrides must be approved in an election.

Students FIRST will eventually have an impact on the revenues that are generated locally for school construction. Previously approved capital improvement bonds will continue to be paid by school districts, but will be phased out as bonds are retired. The extent of override bonds that will be issued in the future to augment the State capital funding is, obviously, unknown.

There are misconceptions by the public that Students FIRST will eventually do away with school property taxes. Nothing could be further from the truth. Students FIRST only affects the secondary school property tax that is used to construct capital facilities. The primary tax levy, representing the majority of the property tax, will continue to provide support for school operations as in the past.

In addition, existing outstanding debt carried by a school district will continue to be paid by the secondary levy in the future. According to the 1997-1998 Annual Report of the Arizona Superintendent of Public Instruction, Arlington Elementary has no outstanding debt while Buckeye Union has $3.25 million. Therefore, even with Students FIRST, Buckeye Union will need to levy a secondary property tax in the future. Students FIRST also permits the issuance of local school district debt to enhance the State's capital improvement funding. Bonding is limited to a maximum of 10% of the district's assessed value compared to a 30% limit prior to Students FIRST.

The financing of public education is an extremely complex and emotional issue. It is too early to tell whether Students FIRST will be able to address all the needs of districts throughout the State. Changes in the system will undoubtedly occur in the future as experience is gained. In the meantime, the local school district property tax will continue to be a primary source of funding.

2

EXHIBIT
A-3
admitted

Economic and Real Estate Consulting

October 11, 2001

Mr. H. Max Shilstone
Duke Energy
5400 Westheimer
Houston, TX 77056

Re: Economic Impact of Arlington Valley Generating Facility Expansion

Dear Mr. Shilstone:

This firm prepared an economic and fiscal impact report for Duke Energy in December 1999 concerning the proposed construction of an electrical generating facility in the Arlington Valley area of Maricopa County. We understand Duke Energy intends to expand that generating facility by doubling its size, i.e. constructing a second plant that is similar to the first. The purpose of this letter is to outline the expected additional economic and fiscal impacts that may result due to the expansion. Our original report has been used as the basis for estimating the expected impact of a second generating facility.

In our December 1999 report, we assumed that the initial investment by Duke Energy would be $250 million, with local construction spending estimated at $67 million. The operation of the facility was expected to generate 25 full-time jobs. The economic impact of a particular facility or land use is typically proportional to the spending and employment associated with that facility or use. In other words, if Duke Energy's investment in a generating facility doubles, the economic impact would be expected to double as well.

We now understand that the expansion of the site will require an investment by Duke Energy of $400 million or approximately 60% higher than the cost of the original generating facility. The local construction expenditure occurring in Maricopa County, the spending that drives the local economic impact, is estimated at $40 million more than the original $67 million or a total of $107 million according to representatives of Duke Energy. The total investment in the generating plant is important since it establishes the market value of the site for property tax purposes.

From an operations perspective, the only difference between the impact of the original plant and the second, additional facility is that number of full-time jobs required to operate second plant is 10, making a total of 35 jobs for the entire expanded generating site. The economic impact of the second facility's operations is, therefore, only 40% as large as the operation of the original generating plant.

Elliott D. Pollack & company

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Given the above assumptions, the additional generating facility would yield approximately $99 million annually in economic activity in Maricopa County over its two-year construction schedule and an average of $2.1 million annually in economic activity over the first eight years of its operation. The construction of the facility would create over 1,000 jobs each year over the two-year construction period. The following table summarizes those impacts.

Average Annual Economic Impact
Duke Energy Electric Generating Facility Addition
(in Inflated Dollars)

	Construction[1]	Operations[2]
Local Economic Output		
Direct output	$53,500,000	$1,551,000
Indirect output	$45,076,000	$598,000
Total output	$98,576,000	$2,149,000
Employment		
Direct jobs	476	10
Indirect jobs	551	17
Total jobs	1,027	27
Wages	$22,718,000	$739,800
Population		
Population supported by project	2,415	63
Households supported by project	921	24

[1]Annual total for each year of two year construction period.
[2]Average annual impact over first eight years of operation..

Sources: IMPLAN; Duke Energy; Elliott D. Pollack & Co.

The impact of the combined operations of the original and second generating facility is shown on the following table. The site will create an average of $7.5 million in economic activity annually in Maricopa County over the first eight years of combined operations. A total of 94 jobs (35 direct and 59 indirect jobs) will be created by the generating site with wages of nearly $2.6 million. The construction of both generating facilities results in the injection of $174 million in direct spending in the Maricopa County economy over the four years required to construct the two plants, resulting in $320 million in total direct and indirect economic activity.

Average Annual Operations Economic Impact
Duke Energy Expanded Electric Generating Site
(in Inflated Dollars)

	Operations[1]
Local Economic Output	
Direct output	$5,428,000
Indirect output	$2,094,000
Total output	$7,522,000
Employment	
Direct jobs	35
Indirect jobs	59
Total jobs	94
Wages	$2,589,300
Population	
Population supported by project	222
Households supported by project	85

[1]Average annual impact over first eight years of operation.

Sources: IMPLAN; Duke Energy; Elliott D. Pollack & Co.

The fiscal impact of the second generating facility on city, county and state taxing authorities will be 22% larger than the original. Most of the fiscal impact of the generating facility is associated with property taxes levied on the capital investment in the facility and sales taxes levied on construction and fuel consumption. While the second facility will consume similar amounts of natural gas as the original plant, the construction cost and property taxes associated with the second facility will be 60% larger. This results in higher tax collections to governmental entities.

As noted in the earlier impact report, Duke Energy's investment will have a significant impact on the assessed value and property tax rates of local school districts. The expanded site with the two generating facilities will have an assessed value greater than the current value of the entire Buckeye Union High School District. This should lead to significant reductions in property tax rates for local property owners once the facilities are added to the tax rolls.

This analysis does not take into account the impact on property tax collections of House Bill 2324 passed by the State legislature in 2000. We understand this bill would modify the manner in which personal property associated with electric generating facilities is valued and depreciated. An interview with the Arizona Department of Revenue indicates that there are numerous concerns with the bill and, in conjunction with utility companies, legislation is being drafted to rectify some of the problems. The valuation methodology outlined in the bill has not been implemented. It is this firm's understanding that the bill will not have a material change in the property tax collections outlined in either this letter report or the original economic impact analysis for the Arlington Valley facility.

If you should have any questions or comments about the information contained in the letter, please do not hesitate to contact us. We appreciate the opportunity to consult with you on your expansion plans.

Sincerely,

Richard C Merritt

Richard C. Merritt, AICP
Senior Vice President

cc: Tom Campbell
Ed Bull

EXHIBIT
A-4
admitted

APPLICATION FOR A CERTIFICATE OF ENVIRONMENTAL COMPATIBILITY

ARLINGTON VALLEY ENERGY FACILITY II PROJECT

Prepared for

STATE OF ARIZONA POWER PLANT AND TRANSMISSION LINE SITING COMMITTEE

Prepared by

DUKE ENERGY MARICOPA, LLC

Date: July 2001
Case No. _____

Duke Energy North America
A Duke Energy Company

Duke Energy
North America, LLC
5400 Westheimer Court
Houston, TX 77056-5310
P.O. Box 1642
Houston, TX 77251-1642
(713) 627-6500

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AZ CORP COMMISSION
DOCUMENT CONTROL

July 13, 2001

HAND DELIVERED

Deborah Scott, Director
Utilities Division
Arizona Corporation Commission
1200 West Washington Street
Phoenix, AZ 85007

RE: Application for a Certificate of Environmental Compatibility for the Arlington Valley Energy Facility II (AVEF II) Project

Dear Ms. Scott: DOCKET NO. L00000P-01-0117

Duke Energy Maricopa LLC ("Duke") is pleased to provide 25 copies of the attached Application for a Certificate of Environmental Compatibility ("CEC"). This CEC Application is for the AVEF II Project proposed to be located adjacent to the AVEF I that is currently under construction near Arlington in Maricopa County, Arizona.

We also have enclosed a check for $10,000 as per A.R.S. § 40-360.09.

Duke requests that the public hearing before the Power Plant and Transmission Line Siting Committee for this Application be set at the first available date. We have enclosed a form of notice to the Power Plant and Transmission Line Siting Committee for its convenience.

If we can be of assistance to the Power Plant and Transmission Line Siting Committee on this Application, please contact me at (713) 627-6572.

Sincerely,

Max Shilstone
Manager

Enc. 25 copies of the CEC Application
Check for $10,000
Form of Notice

BEFORE THE
POWER PLANT AND TRANSMISSION LINE SITING COMMITTEE

In the Matter of the Application of Duke Energy Maricopa, LLC in conformance with the requirements of Arizona Revised Statutes 40-360.01 et seq., for a Certificate of Environmental Compatibility authorizing construction of a natural gas-fired, combined-cycle generating facility (Arlington Valley Energy Facility II) near Arlington in Maricopa County, Arizona	)))))))))	Case No. _____

APPLICATION FOR
CERTIFICATE OF ENVIRONMENTAL COMPATIBILITY

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INTRODUCTION

Duke Energy Maricopa, LLC (Duke) is requesting a Certificate of Environmental Compatibility (CEC) from the Arizona Power Plant and Transmission Line Siting Committee (Siting Committee) for construction of the Arlington Valley Energy Facility II (AVEF II), which is an expansion of Duke's approved Arlington Valley Energy Facility I (AVEF I). The proposed project will include the construction and operation of a 600-megawatt (MW) (nominal) gas turbine/steam turbine combined-cycle merchant power plant in Maricopa County, Arizona. The key elements of the proposed project include:

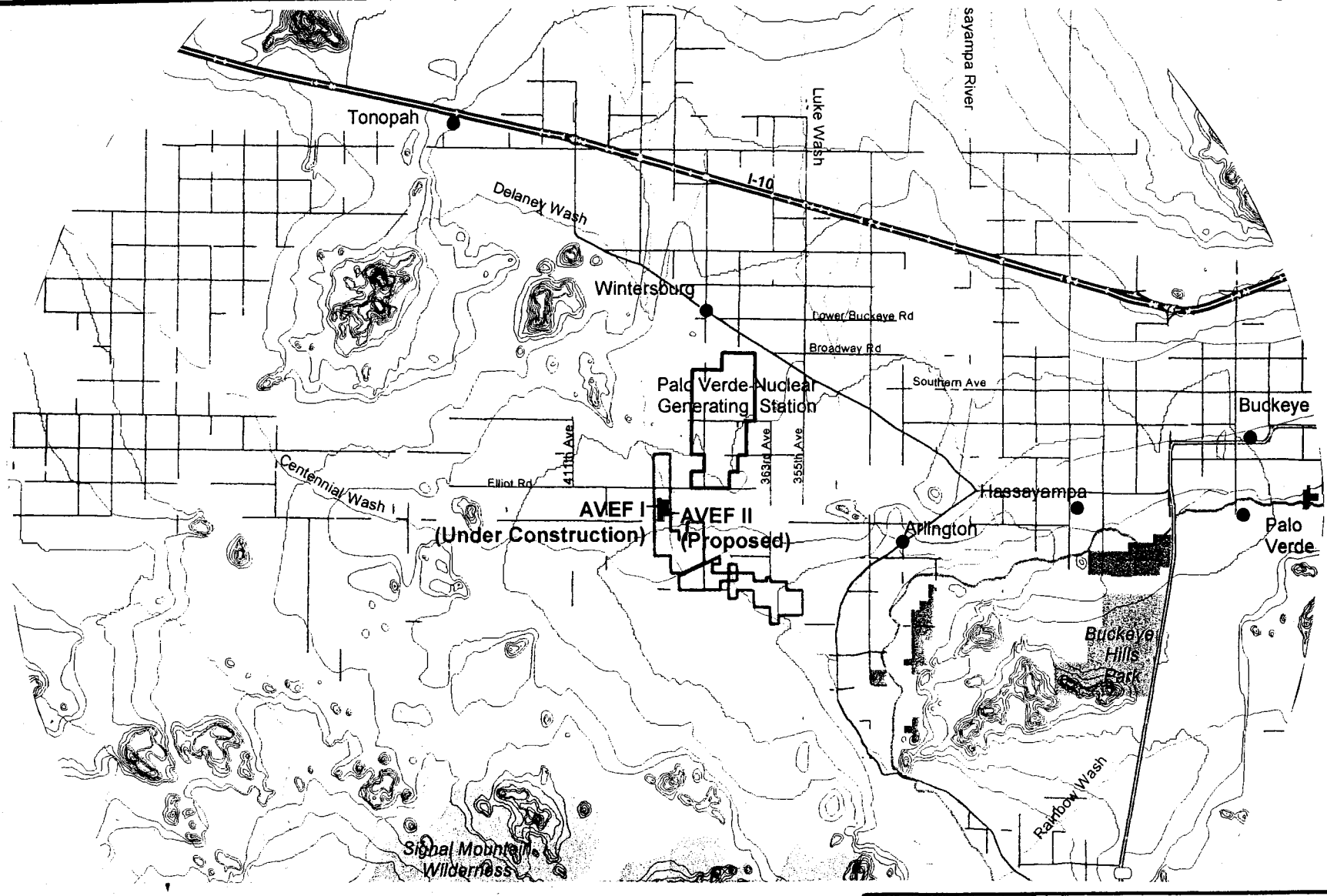
- Two combustion turbine generators (CTGs) with inlet chilling fueled by pipeline-quality natural gas;
- Two natural gas supplementary-fired Heat Recovery Steam Generators (HRSG);
- One steam turbine generator (STG) set;
- One gas-fired (intermittent) auxiliary boiler;
- One surface condenser; and
- Two mechanical draft cooling systems.

Construction will begin in February 2002, with commercial operation scheduled to begin in June 2003. The plant will generate 600 MW, enough electricity to serve approximately 480,000 homes during peak summer demand. The project is designed to use the latest combined cycle generating technology to produce reliable and low-cost electrical power and minimize environmental impacts.

The project will be located approximately 50 miles west of Phoenix, in unincorporated Maricopa County near Arlington, Arizona, which is about 8 miles south of Interstate 10 (Figure 1). This facility will be located immediately south and adjacent to AVEF I that is currently under construction. The project site was selected for the following reasons:

- A natural gas pipeline, water sources, roads, and railroad access needed for construction and operation of the project are already in place at or near the proposed plant site. Electrical transmission lines are available near the project site to provide interconnections with the existing power grid through the Hassayampa switchyard, currently under construction east of the proposed AVEF II plant site.

- The area presently supports energy production and transmission facilities. The PVNGS, which has been in operation for 15 years, is located 2 miles from the project site. The Redhawk Generating Station, the Mesquite Generating Station, and AVEF I plants which were recently approved by the ACC are within a 5 mile radius of the project site. The Hassayampa switchyard that will connect the plant to the existing distribution system is located approximately 1.5 miles east of the project site. The new generation units will be compatible with existing land uses in the vicinity of the project site and will not conflict with any future development plans.



0 1 2 3 4 5
Miles

Duke Energy

Figure 1:

Site Location

- Local community services are available to support the additional workforce required for this project. The project location is within commuting distance of the Phoenix metropolitan area, which would be expected to supply the majority of the facility's work force and thereby cause no changes in the area population.

This application includes the environmental evaluation and documentation relevant to the proposed project as specified by Arizona Administrative Code Rule R14-3-219. Environmental controls will be provided to ensure that the project complies with all applicable environmental regulations. In summary, impacts will be avoided and minimized as follows:

- All groundwater pumped at the facility will be withdrawn and used in accordance with the Groundwater code and the associated Phoenix Active Management Area Management Plan.

- Prior to building AVEF I, Duke acquired 6,800 acre-feet of water rights through the purchase of former agricultural land. In preparation for AVEF II, Duke purchased an additional 1,000 acre-feet of water on adjacent lands. Therefore, the total water available to Duke is approximately 7,800 acre-feet/year. Duke will operate both AVEF I and AVEF II, along with its land management plan water obligations, on 7,800 acre-feet/year. This result is achieved through the use of a High Efficiency Reverse Osmosis ("HERO") water treatment system.

- In anticipation of the CEC application, Duke performed an impact study on the withdrawal of an additional 1,000 acre-feet/ year from the aquifer. The results of that study, which is set forth in full at Exhibit B-2, establishes that the withdrawal of 7,800 acre-feet/year (the sum of the original 6,800 acre-feet/year and the additional 1,000 acre-feet/year) will have minimal impact on the aquifer. The study at Exhibit B-2 also addresses the cumulative impact the additional pumping will have on groundwater in the Arlington Valley area, and found those impacts to be relatively unchanged from the original study by Dr. Peter Mock.

- In an effort to offset the additional groundwater pumping that will occur as a result of AVEF II, Duke intends to participate in the Central Arizona Water Conservation District's Agua Fria Recharge Project, in cooperation with the Arizona Water Banking Authority. Duke anticipates recharging 1,000 acre-feet/year of water through the recharge project for the life of the AVEF II facility, subject to reasonable limitations on costs and availability of water supplies. Although the Agua Fria project will not directly replenish groundwater withdrawn from beneath the facility, it will add recharge water to the Phoenix Active Management Area in a Critical Area of concern for the Department of Water Resources under the Third Management Plan.

- The plant site is located on land previously used for agriculture.

- Based on discussions with agencies, database review, and field evaluations, impacts to sensitive plants or wildlife populations/habitat are not anticipated.

- No documented archaeological or historic resources are located at the proposed plant site.

- Noise from the new generating facilities is expected to have minimal impacts on residents in the vicinity of the plant (see Exhibit I for results of noise surveys conducted in May 2001).

- The proposed natural gas-fired combustion turbines operating in combined cycle mode use the lowest emitting fossil fuel fired technology available, on a per-unit generating capacity basis, and produce the least amount of waste per unit of electricity.

The total project cost is estimated to be about $250 million. The new generating units will provide social and economic benefits to the community in the following ways:

- Annual property tax revenues from AVEF II will increase funds available to any one of a number of public services (see Exhibit J-4, Economic and Fiscal Impact Report and Update).

- Approximately 300 jobs, including many technical and skilled craft positions, will be created during the 12- to 14-month construction period. Up to 10 moderate- to high-wage permanent jobs also will be generated for commercial operations. In addition, a comparable number of secondary employment opportunities (services, vendors, and suppliers) will likely be generated during the construction and operational phases of the proposed project (see Exhibit J-4, Economic and Fiscal Impact Report and Update).

- The project will increase electrical energy supply capacity and help moderate large swings in wholesale electricity prices during periods of high consumer demand, such as during the hottest summer months.

- As evidenced in Exhibit J, AVEF II is supported by the community. Duke has been an active contributor and participant in the Arlington community and the expansion of the AVEF I will strengthen the relationship between Duke and the community.

After evaluating the factors to be considered by the Siting Committee (as defined in ARS §40-360.06), Duke has concluded that the project is environmentally compatible with the surrounding area.

APPLICATION

APPLICATION

1. *Name and address of the applicant:*

Duke Energy Maricopa, LLC
5400 Westheimer Court
Houston, Texas 77056-5310

2. *Name, address, and telephone number of a representative of the application who has access to technical knowledge and background information concerning this application, and who will be available to answer questions or furnish additional information:*

Mr. Max Shilstone, Manager
Duke Energy North America
5400 Westheimer Court
Houston, Texas 77056-5310
(713) 627-6572

3. *State each date on which applicant has filed a 10-year plan in compliance with ARS §40-360.02,and designate each such filing in which the facilities for which this application is made were described. If they have not been previously described in a 10-year plan, state the reasons therefore.*

Not applicable because new transmission lines are not the subject of this application. Duke has filed a 10-year plan for its transmission line that was approved in ACC Decision No. 62995.

4. *Description of the proposed facilities, including:*

4.a. *With respect to an electric generating plant:*

4.a.i *Type of Generating Facilities.*

The proposed AVEF II will utilize two, 170-MW GE 7FA natural gas-fired combustion turbines operating in combined-cycle mode with two supplementary fired, three-pressure HRSGs and a common, reheat condensing steam turbine. Steam generation in the HRSGs will be augmented with supplementary natural gas-fired duct burners. Each HRSG will produce high-pressure steam at approximately 1,800 pounds per square inch gauge (psig) for introduction into the steam turbine. The steam turbine will drive an additional generator to increase the

total plant output to about 500 MW without duct firing or 600 MW with duct firing and inlet air chilling.

The production of electricity using a combustion turbine engine coupled with a shaft driven generator is referred to as the Brayton Cycle. This also is referred to as a "simple-cycle" and has been traditionally utilized for electricity peaking generation since the unit and its output can be brought on line very quickly. The Rankine Cycle represents the traditional method of generating power from utility steam electric power plants. In this cycle, boilers are used to produce high-pressure steam, which expands in a steam turbine to drive an electric generator. Each AVEF II generator connects through the 500 kV switches and connects to a strain bus connected as a continuation of the existing strain bus of AVEF I, which is connected to a single tie line to the Hassayampa switchyard.

The proposed project will combine the Brayton and Rankine cycles to maximize thermal efficiency. Natural gas will be combusted in two Brayton Cycle turbines that will generate most of the electrical output. Instead of being discarded to the environment, the exhaust heat will be recovered in a Rankine Cycle HRSG/steam turbine, and the heat will be extracted until the exhaust temperature is about 200°F before being discharged through the stacks. This will result in an overall thermal efficiency for the proposed project of over 55 percent. The project, therefore, will consume only about two thirds of the fuel that would be consumed in a conventional utility power plant to produce the same amount of electricity. This state-of-the-art, high-efficiency technology combined with the exclusive use of the cleanest fossil fuel (natural gas) and the application of Best Available Control Technology, will yield a small fraction of the air emissions of a similarly sized conventional power plant.

4.a.ii Number and size of proposed units.

The proposed 600-MW merchant power plant will include the following components:

- Two CTGs with inlet chilling fueled by pipeline-quality natural gas;
- Two natural gas supplementary-fired HRSGs;
- One STG set;
- One gas-fired (intermittent) auxiliary boiler;

- One surface condenser;
- Two mechanical draft cooling systems (one for the condenser and one for the chiller);
- Cooling tower water treatment system;
- Plant sumps, sump pumps, and oily water separator;
- Feed water treatment systems including demineralizer regeneration and neutralization tanks;
- Plant and instrument air compressors and auxiliary equipment;
- Sanitary lift station;
- Steam and water sampling systems;
- Deaerator vent; and
- Several buildings for warehouse/maintenance administration and operational activities.

4.a.iii The source and type of fuel to be utilized, including a proximate analysis of fossil fuels.

The combustion turbines will be fueled entirely by natural gas supplied by El Paso Natural Gas Company. A proximate analysis of the natural gas is provided in Table 1. Pipeline quality natural gas will be delivered to the facility at a pressure sufficient for use in the CTGs without additional fuel compression. The gas will be heated to approximately 365°F using steam from the HRSGs. AVEF II service connection within the plant will require the installation of a tee on the 20-inch-diameter natural gas fuel lines to be constructed for AVEF I. Natural gas usage and pressure for AVEF II will be measured at the same regulator stations developed for AVEF I.

Natural gas will first be sent through a knockout drum for removal of any liquid which may have been carried through from the pipeline. The gas will then pass through a filter/separator to remove particulate matter and entrained liquid. The

gas will flow through the filter/separator's first chamber, the filtration section, where entrained liquid will coalesce on the filter cartridges, drop to the bottom of the chamber and either vaporize and return to the main gas stream or drain to the sump below. The gas will then flow through the coalescing filters that will remove particulate matter. The gas will then pass to the second chamber, the separation section, where any entrained liquid remaining in the stream will be returned to the gas stream. The gas will be preheated and split into two streams, one for each CTG. Finally, the gas will be delivered to the CTGs and combusted as part of the power generation operation.

Table 1
Natural Gas Analysis

Component	Normalized Percent
Carbon Dioxide	0.78
Nitrogen	1.33
Methane	96.08
Ethane	1.49
Propane	0.21
Iso. Butane	0.03
Normal Butane	0.03
Iso. Pentane	0.01
Normal Pentane	0.01
Hexane and Heavier	0.03
Gallons Per Minute	0.776
BTU (standard cubic feet)	1,020
Specific Gravity	0.587

Source: Casa Grande Gravitometer 01 April, 2001; El Paso Natural Gas, June 1999 to June 2000 (annual average).

One emergency diesel engine, nominally 400 horsepower (hp), will be located on-site and operated as an emergency fire-water pump driver. The facility operations plan calls for this unit to be operated less than 500 hours per year. The engine will be equipped with a 150-gallon fuel storage tank.

4.a.iv Amount of fuel to be utilized daily, monthly, and yearly.

Maximum natural gas usage for the proposed project will be approximately 100 million standard cubic feet (100 MMscf) per day; 3,000 MMscf per month; and

37,000 MMscf per year. This projected gas usage is based on lower heating value (LHV). The fuel use will vary based on the actual number of hours of operation of the combustion turbines, duct burner, and auxiliary boiler, and start-up/shut-down conditions. In the unlikely event of a fire, diesel will be used to fuel fire-water pump operations.

4.a.v Type of cooling to be utilized and the source of any water to be utilized.

4.a.v.1 Type of cooling:

A ten-cell cooling tower will be integral to operation of the facility. The majority of the cooling water will be used in the surface condenser to absorb the heat rejected from the steam turbine. Water from the cooling tower is commonly referred to as "main" cooling water. A dedicated set of cooling water pumps will be provided for this service. Additional cooling water will be required for auxiliary plant cooling. Cooling tower water will not be used for direct cooling of plant auxiliaries; a closed loop auxiliary cooling system consisting of pumps, expansion tank, and heat exchangers will be provided for this purpose. Cooling tower water circulated through a set of plate and frame heat exchangers will cool a closed loop coolant, usually a glycol/water mixture; this is commonly referred to as "auxiliary" cooling water. The cooling tower itself is a device designed to evaporate clean water, which provides cooling. Some small water droplets (referred to as drift) will escape from the top of the tower, and may liberate dissolved solids as they evaporate in the atmosphere.

The turbines will employ inlet chillers during hot ambient conditions to recover power output that would normally be lost due to lower air density at higher ambient temperatures. The process of cooling takes place at the cooling coils where inlet air is cooled before entering the CTG compressor. At lower temperature, the air becomes more dense and therefore more mass flows through the CTGs. The net increase in mass flow will result in higher output for each of the CTGs by up to 22 MW. In addition to the output enhancement from the CTGs, the additional mass flow also will increase output of the STG by approximately 12 MW.

The inlet chilling system is a mechanical system using refrigerant for cooling. A second, smaller (7 celled) cooling tower will reject heat for the chillers. This tower will be similar to the process cooling tower, except that it will only operate when the chillers are on (high ambient temperatures).

4.a.v.2 Water Source:

Sufficient water exists for Duke to operate both facilities (AVEF I and II) efficiently and to complete its obligations set forth in the Land Management Plan.

AVEF I and AVEF II will use approximately 7,800 acre-feet/year of water. This water will be used mainly for the purpose of steam generation and system cooling. Small quantities of water will be required for on-site drinking water, landscaping and other less demanding uses. Water will be pumped from existing or new wells located on Duke's property. All groundwater pumped at the facility will be withdrawn and used in accordance will the Groundwater Code and the associated Phoenix Active Management Area Management Plan.

Groundwater for both projects will be supplied by Grandfathered Right 58-101121. This right is the result of consolidation of six distinct rights located on the lands Duke acquired in preparation for building AVEF I. In anticipation of AVEF II, Duke has acquired additional Irrigation Grandfathered Rights Nos. 58-105005 and 58-100105. Duke anticipates consolidating these rights into Right No. 58-101121. Combined, it is estimated that Duke will have approximately 7,800 acre-feet/year of Type I groundwater available for use at its sites. Duke will convert the Irrigation Grandfathered Rights into Type I rights as they become necessary to meet the needs of the two facilities.

An evaluation of the physical availability of water over the lifetime of the two projects has been conducted and is attached as Exhibit B-2. This study took into account the impact to the aquifer of the additional pumping associated with AVEF II. This study also renders an opinion regarding cumulative impacts of this additional pumping on the aquifer. Duke's water impact analysis concludes that the withdrawal of 7,800 acre-feet per year will have minimal impact to the aquifer.

The evaluation of the potential impact of groundwater pumping on groundwater levels was conducted using two approaches. The first approach compared projected pumpage (7,800 acre-feet per year) for this proposed project to historic pumpage to provide insight into potential future impacts. The proposed water use is less than half of the historic withdrawals for irrigation on the parcels being acquired by Duke, and about a quarter of the historic pumpage in the project area. The potential impacts of the proposed are therefore expected to be considerably less than what was experienced historically when the area was under irrigation.

The second approach simulated the potential effects of the proposed groundwater pumping (7,800 acre-feet per year) on the aquifer. Groundwater modeling over the expected life of the expanded power plant was conducted to simulate water level changes from the proposed pumping alone. After 30 years of pumping, minimal water level changes (up to 10 feet) are projected within 3 miles of the plant production wells, and smaller level changes at greater distances. These projections are considered conservative as they do not consider the retirement of current irrigation pumpage or the natural recovery of water levels that has occurred in recent years.

The same model also was used to simulate water level changes from the addition of the proposed pumping for AVEF II. After 30 years of pumping, minimal water level changes (up to 3 feet) are projected within about 0.5 mile of the plant production wells, and smaller level changes at greater distances. Again, these projections are considered conservative as they do not consider the retirement of current irrigation pumpage or the natural recovery of water levels that has occurred in recent years.

An assessment of the cumulative impact to groundwater levels in the Arlington area, from the withdrawals from three separate power generating facilities (AVEF I, Sempra Mesquite, and Pinnacle West Redhawk) was conducted in 2000 by Dr. Peter Mock. Duke has asked Dr. Mock to update his study to take into consideration the additional groundwater use (1,000 acre-feet per year) proposed by AVEF II. Duke has asked that Dr. Mock undertake the update under the same elements of impartiality that he used to conduct his original study. We anticipate that Dr. Mock's update will be completed in time for the hearing on this CEC.

Duke anticipates utilizing lined evaporative ponds with leak detection monitors, to be permitted by ADEQ, for disposal of its wastewater.

4.a.vi Proposed height of stacks and number of stacks, if any:

A total of 5 stacks will be constructed at the plant site. Both CTG and HRSG units will include stacks 185 feet above ground surface. The auxiliary boiler will require a 37-foot-high stack. The diesel engine fire pump and the diesel engine backup systems will require approximately 14-foot-high stacks.

4.a.vii Dates for scheduled start-up and firm operation of each unit and date construction must commence in order to meet schedules:

A primary contractor (Duke-Fluor Daniel) will design and construct the facility. Duke has firm contracts for the delivery of essential turbine equipment to meet the

construction schedule. Construction activities will be initiated by February 2002 and are expected to extend over a period of 12 to 14 months into 2003. During this period, the construction work force will include up to 300 people. An area at the site will be used temporarily for construction parking, work trailers, storage, and laydown areas. Water and electrical power facilities will be made available at the site for use during construction. The primary access during construction to the project site will be from the existing access road that enters the site from the north off of Elliot Road. Commercial operations are scheduled to begin in June 2003.

4.a.viii To the extent available, the estimated costs of the proposed facilities and site, stated separately.

Estimated construction costs for the power plant associated natural gas and water pipelines, and related facilities are $250 million.

4.a.ix Legal description of the proposed site.

The AVEF II site, which will include approximately 65 acres associated with the plant facility and evaporation ponds, is located approximately 50 miles west-southwest of Phoenix, in Maricopa County, Arizona. It's anticipated that additional acreage of previously disturbed agricultural land will be disturbed temporarily during construction activities. The project site is situated approximately 1.5 miles southwest of the PVNGS property and 5 miles west of the town of Arlington. The site is located on the south side of Elliot Road between 387th Avenue and 391st Avenue. The site is located at 112° 53' 34" longitude and 33° 20' 54" latitude. The plant site will be located in Section 17, Township 1 South, Range 6 West, Gila and Salt River Base and Meridian.

4.b With respect to a proposed transmission line:

4.b.i Nominal voltage for which the line is designed; description of the proposed structures and switchyards or substations associated therewith; and purpose for constructing said transmission line.

No new transmission lines, switchyards, or substations will be required. AVEF II will use the already approved intertie line from the AVEF I to the Hassayampa switchyard.

4.b.ii Description of geographical points between which the transmission line will run, the straight-line distance between such points, and the length of the transmission line for each alternative route for which application is made.

No transmission line will be required (see 4.b.i)

4.b.iii *Nominal width of right-of-way required, nominal length of spans, maximum height of supporting structures, and minimum height of conductor above ground.*

No transmission line will be required (see 4.b.i)

4.b.iv *To the extent available, the estimated costs of proposed transmission line and route, stated separately.*

No transmission line will be required (see 4.b.i)

4.b.v *Description of proposed route and switchyard locations.*

No transmission line will be required (see 4.b.i)

4.b.vi *For each alternative route for which application is made, list the ownership percentages of land traversed by the entire route (Federal, State, Indian, private, etc.).*

No transmission line will be required (see 4.b.i)

5. *List the areas of jurisdiction (as defined in ARS §40-360) affected by each alternative site or route and designate those proposed sites or routes, if any, which are contrary to the zoning ordinances or master plans of any of such areas of jurisdiction.*

All components of the project will be located entirely within an unincorporated area of Maricopa County. The plant site, access road, and natural gas and water pipelines will be located on private lands currently owned or controlled by Duke.

The proposed project is located within the Rural-190 Zoning District as designated by Maricopa County and shown on the Maricopa County Zoning Maps. For the AVEF I, Duke obtained from Maricopa County (a) a Special Use Permit for an electrical generating facility and (b) a Comprehensive Plan Amendment to an Industrial land use designation. AVEF II will require an Amendment of AVEF I's Special Use Permit, which will be in conformance with the site's Industrial designation on Maricopa County's Tonopah/Arlington Area Plan.

6. *Describe any environmental studies applicant has performed or caused to be performed in connection with this application or intends to perform or cause to be performed in such connection, including the contemplated date of completion.*

Duke has engaged several experienced consultants who have conducted studies and impact evaluations of the project. The results of these studies are included in Exhibits B through I. For the proposed plant site, evaluations of the existing environment were completed for land use, air quality, water resources, visual resources, biological resources, cultural resources, and noise effects.

Environmental studies of the project area began with the collection of existing environmental data, including literature, maps, and other agency data. Background information and data collected and utilized for AVEF I were reviewed, updated, and incorporated into this application, where applicable to AVEF II. Interviews were conducted with appropriate agencies and organizations. Resource specialists conducted field studies of the project area.

Potential environmental effects of the proposed project were assessed for the disciplines addressed above. Where appropriate, mitigation measures were identified to minimize or eliminate impacts. Duke will implement identified mitigation measures as integral elements of the project. These include state-of-the-art combustion technology and continuous air emissions monitoring.

Duke therefore affirms, upon thorough, expert scientific environmental investigation and analyses, that the proposed project is environmentally compatible, and respectfully requests the Committee to issue its Certificate of Environmental Compatibility for the proposed AVEF II project.

DUKE ENERGY MARICOPA, LLC

By: Bradley K Parker

Authorized Officer

ORIGINAL and 25 copies of the foregoing hand delivered and filed With the Director of Utilities, Arizona Corporation Commission, this 5th day of July, 2001.

EXHIBIT A
LOCATION AND LAND USE MAPS

EXHIBIT A
LOCATION AND LAND USE MAPS

As stated in Arizona Corporation Commission Rules of Practice R-14-3-219:

"Where commercially available, a topographic map, 1:250,000 scale, showing the proposed plant site and the adjacent area within twenty (20) miles thereof. If application is made for alternative plant sites, all sites may be shown on the same map, if practicable, designated by applicant's order of preference."

"Where commercially available, a topographic map, 1:62,500 scale, of each proposed plant site, showing the area within two (2) miles thereof. The general land use plan within this area shall be shown on the map, which shall also show the areas of jurisdiction affected and any boundaries between such areas of jurisdiction. If the general land use plan is uniform throughout the area depicted, it may be described in the legend in lieu of an overlay."

The following maps are included as exhibits:

- Exhibit A-1 – Proposed Project and Adjacent Area within 20-mile Radius
- Exhibit A-2 – Proposed Project and Adjacent Area within 2-mile Radius

More detailed discussion regarding land ownership and existing and future land use conditions and potential impacts on such resources within the vicinity of the proposed project are provided in Exhibit B-3.

EXHIBIT A-1

PROPOSED AVEF II PROJECT – 20-MILE RADIUS

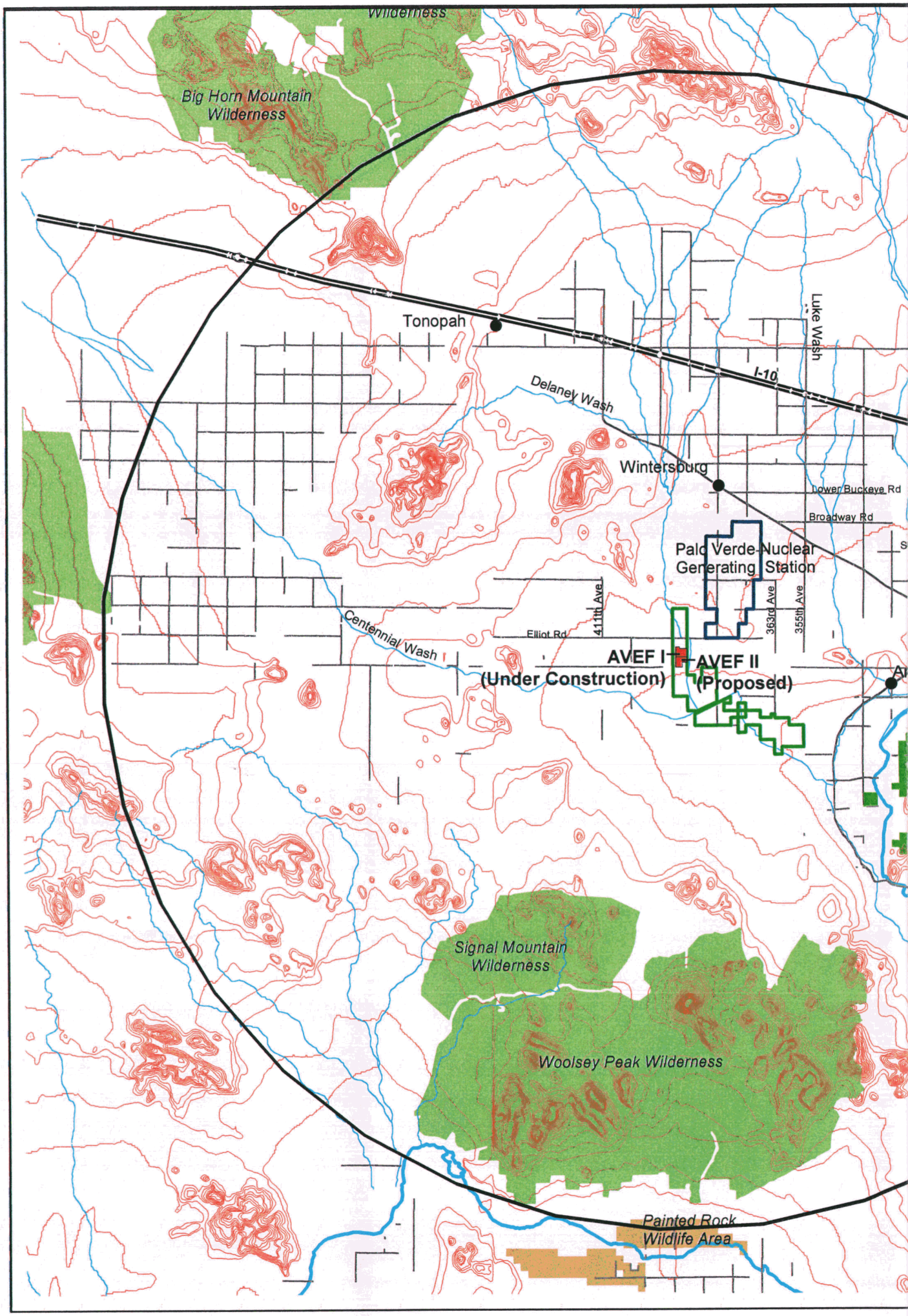
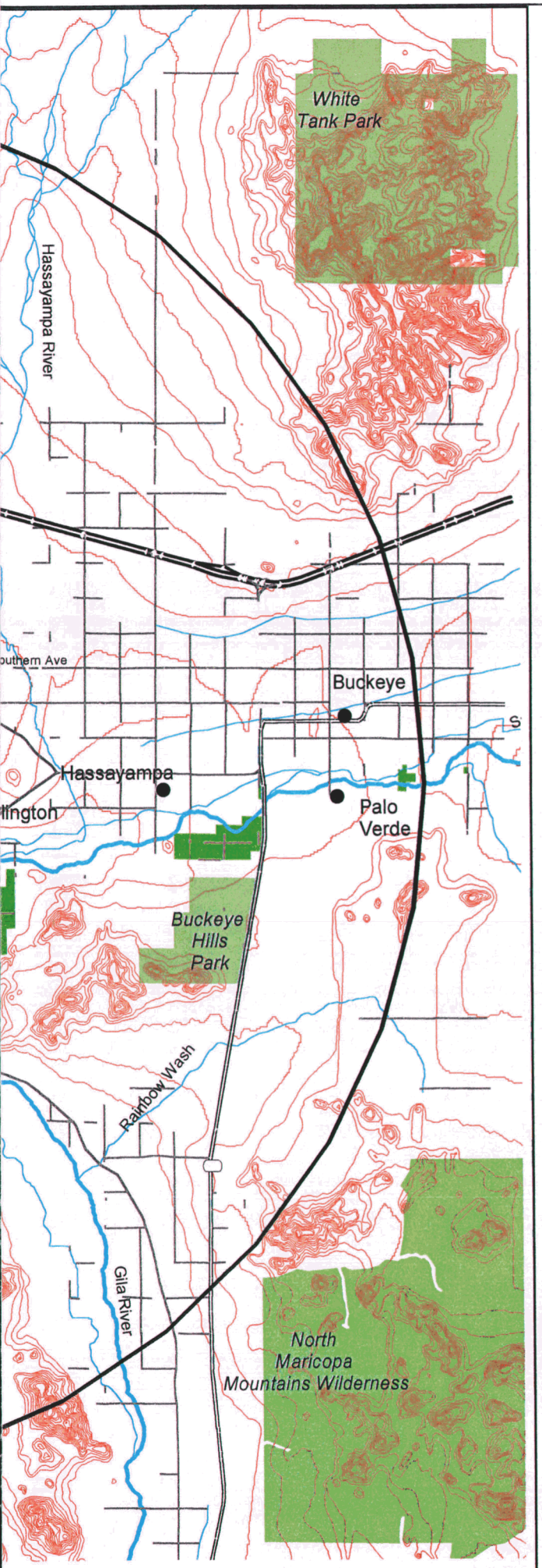

Wilderness
Big Horn Mountain Wilderness
Tonopah
I-10
Luke Wash
Delaney Wash
Wintersburg
Lower Buckeye Rd
Broadway Rd
Palo Verde Nuclear Generating Station
411th Ave
363rd Ave
355th Ave
Elliot Rd
Centennial Wash
AVEF I
(Under Construction)
AVEF II
(Proposed)
Signal Mountain Wilderness
Woolsey Peak Wilderness
Painted Rock Wildlife Area

Exhibit A-1:

Proposed AVEF II Project and Adjacent Area within 20-mile Radius



- Arlington Valley Energy Facility
- Duke Properties
- Palo Verde Nuclear Generating Station
- Elevation Contours
- Rivers and Washes
- Cities and Towns
- 20-mile Radius
- Streets
- BLM Wilderness Areas
- Parks and Recreation
- Game and Fish
- Painted Rock Wildlife Area

0 1 2 3 4 5
Miles

Duke Energy

EXHIBIT A-2

PROPOSED AVEF II PROJECT – 2-MILE RADIUS

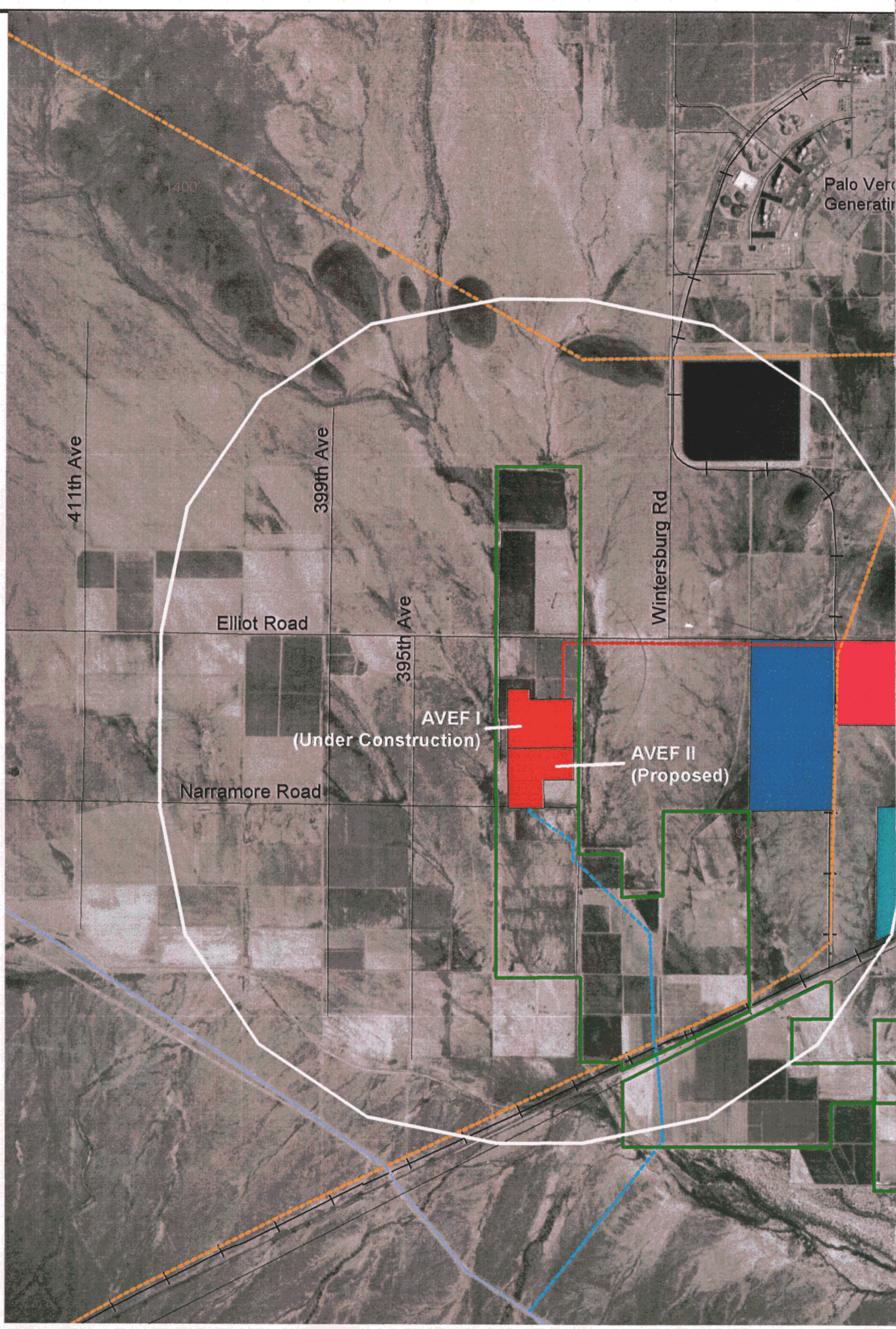

Palo Verd
Generatin
411th Ave
399th Ave
395th Ave
Wintersburg Rd
Elliot Road
Narramore Road
AVEF I
(Under Construction)
AVEF II
(Proposed)

Exhibit A-2:

Proposed AVEF II Project and Adjacent Area within 2 Miles of Project

- Arlington Valley Energy Facility
- Hassayampa Switchyard (Under Construction)
- Redhawk Generating Station (Under Construction)
- Mesquite Generating Station (Approved)
- Duke Properties
- AVEF Transmission Line (Under Construction)
- Existing Transmission Lines
- AVEF Natural Gas Line (Approved)
- Existing Natural Gas Line
- Streets
- Area within 2 Miles of Project
- Large Lot Residential Land Use

Land use for the remainder of the area is Rural.

0 0.5 1
Miles

Duke Energy

Aerial photograph base from Landiscor, 1986

EXHIBIT B
ENVIRONMENTAL REPORTS

EXHIBIT B
ENVIRONMENTAL REPORTS

As stated in Arizona Corporation Commission Rules of Practice R-14-3-219:

"Attached any environmental studies which applicant has made or obtained in connection with the proposed site(s) or route(s). If an environmental report has been prepared for any federal agency or if a federal agency has prepared an environmental statement pursuant to Section 102 of the National Environmental Policy Act, a copy shall be included as part of this exhibit."

Duke retained the services of consultants to complete the environmental studies for the proposed project. The environmental studies completed for this project are described in this exhibit and include the following:

- Exhibit B-1 – Air Quality Permit Application (Summary)
- Exhibit B-2 – Groundwater Assessment
- Exhibit B-3 – Land Use Study

Descriptions of other resource studies including biology, cultural, visual, and noise are discussed in Exhibits C, D, E, G, and I.

EXHIBIT B-1

AIR QUALITY PERMIT APPLICATION (SUMMARY)

Air Quality Permit Application (Summary)

Introduction

Duke Energy Maricopa, LLC (Duke) is in the process of constructing the Arlington Valley Energy Facility I (AVEF I), a 580-megawatt (MW) (nominal) gas turbine/steam turbine combined-cycle merchant power plant in Maricopa County, Arizona. Duke received a Title V and Prevention of Significant Deterioration (PSD) air quality permit from Maricopa County in 2000 allowing AVEF I's construction and operation. Duke now proposes to add an additional 600 MW of generating capacity at the AVEF site through a significant revision to its existing Title V/PSD air quality permit. The new project will be known as AVEF II.

AVEF II will employ best available control technology (BACT) for oxides of nitrogen (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), volatile organic compounds (VOC), and particulate matter with a nominal aerodynamic diameter of 10 microns or less (PM_{10}) to minimize air emissions. Consistent with Duke's objectives and the stated desires of the Corporation Commission, the project will be operated so as to meet a 2.5 parts per million NO_x emissions level, within the parameters established in its Title V/PSD air quality permit to be issued by Maricopa County.

Duke has already started the process to apply to the Maricopa County Environmental Services Department (MCESD) for an air quality pre-construction permit as required by Maricopa County Air Pollution Control Regulation (MCAPCR) II, "Permits and Fees." Duke has submitted a request for expedited permit processing to MCESD. In the expedited review process, MCESD selects an outside consultant, at the applicant's expense, to assist the MCESD staff in reviewing and processing the permit application. MCESD has not yet selected its outside consultant for the AVEF II application. Duke has been informed by MCESD in a pre-application meeting that the results of an air quality modeling analysis must be part of the air quality permit application for AVEF II. Before the modeling can be conducted, MCESD and its outside consultant must approve the protocol for the modeling.

As soon as MCESD assigns an outside consultant to the AVEF II project, Duke intends to submit its protocol for the required air quality modeling analyses. Once the modeling analysis is completed, Duke will incorporate the modeling results and submit its application for a significant revision to the existing AVEF I air quality permit. Duke anticipates that it will have the necessary approvals from MCESD to file its air quality permit application by mid-August 2001.

Project Description

The key elements of the new AVEF II project include:

- Two combustion turbine generators with inlet chilling fueled by pipeline-quality natural gas;
- Two natural gas supplementary-fired Heat Recovery Steam Generators (HRSG);
- One steam turbine generator set;
- One gas-fired (intermittent) auxiliary boiler;
- One surface condenser; and
- Two mechanical draft cooling systems.

These are the same elements that were permitted for AVEF I, except that the steam turbine is slightly larger in AVEF II, so that the proposed equipment will have the capacity to produce more electricity than the AVEF I equipment.

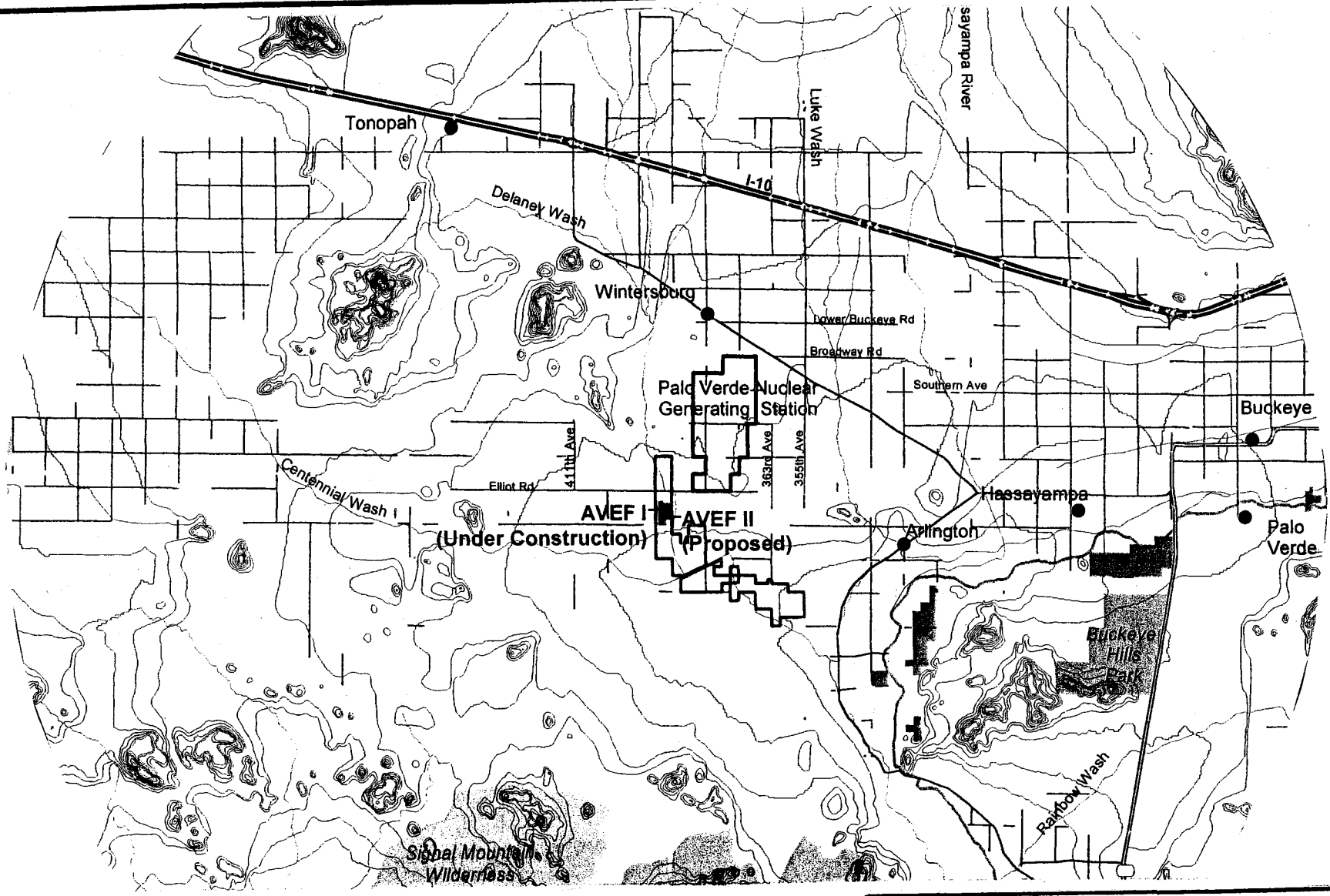
AVEF II will be constructed on approximately 65 acres of undeveloped property immediately adjacent to and south of AVEF I. The approximate project property boundary and local road network is shown on Figure 1. Figure 1 also shows the land use within the region surrounding the proposed site. Within this area are:

- The Palo Verde Nuclear Generating Station;
- The residential communities of Arlington and Palo Verde to the east and Wintersburg to the north; and
- Roadways including Interstate 10 and U.S. Route 85.

Beside AVEF I and II, two other power plants are planned in this area. They are the Pinnacle West (Redhawk) and Sempra (Mesquite) power generating stations.

The proposed AVEF II project will be a natural gas-fired combined-cycle power plant. The plant will operate commercially as a merchant power plant. A merchant power plant is a power generation facility designed to produce electricity for the emerging deregulated electricity market without pre-arranged long-term utility power purchase agreements. As a merchant plant in a deregulated electricity market, AVEF II is being designed to convert clean natural gas to useful power at high efficiency and low cost. Commercial operation is scheduled to commence in the year 2003.

AVEF II will include two 170-MW General Electric 7FA natural gas-fired combustion turbines operating in combined-cycle mode with two supplementary fired, three-pressure HRSGs and a common, reheat condensing steam turbine. Steam generation in the HRSGs is augmented with supplementary natural gas-firing using duct burners. Each HRSG will produce high pressure steam at approximately 1,800 pounds per square inch gauge for introduction into the steam turbine. The steam turbine will drive an additional generator to increase the total plant output to about 500 MW without duct firing or 600 MW with duct firing and inlet air chilling.



0 1 2 3 4 5
Miles

Duke Energy.

Figure 1:

Site Location

Other potential sources of criteria pollutants associated with this facility include a gas-fired auxiliary boiler, a cooling tower, an emergency generator, and a small diesel fire-water pump. There will be a minor amount of emissions associated with ancillary facilities, including a small diesel storage tank for the fire-water pump, small acid storage tank(s) used in the treatment of process water, and an ammonia tank used to store the aqueous ammonia solution that will be used with the Selective Catalytic Reduction system used to control NO_x emissions.

Air Emissions

Criteria pollutants are those for which the U.S. Environmental Protection Agency (USEPA) has established National Ambient Air Quality Standards (NAAQS) and consist of PM_{10}, CO, NO_x, SO_2, lead, and ozone, which is formed through the photochemical reaction of VOC and NO_x in the atmosphere. These pollutants also are known as "conventional air pollutants" under State law.

As indicated earlier, AVEF II will employ BACT to minimize its criteria pollutant emissions of NO_x, CO, VOC, PM_{10}, and SO_2. Consistent with Duke's objectives and the stated desires of the Corporation Commission the project will be designed and operated to meet a 2.5 NO_x emissions level, within the parameters that will be established in its Title V/PSD air quality permit from MCESD. The project will not produce significant emissions of lead.

AVEF II also will emit federally listed hazardous air pollutants as a result of the combustion turbines, duct burner and auxiliary boiler. AVEF II also will emit other substances that are not regulated, but which MCESD has a practice of comparing to informal guidelines that have not been adopted as rules. These informal comparative guidelines are known as the Ambient Air Quality Guidelines.

Regulatory Requirements

1. Air Quality Permitting Requirements

New and existing stationary sources are classified as either major or minor based on their potential-to-emit regulated air contaminants. This classification also is affected in part by whether the area in which the source is located has attained the NAAQS. An area is classified as attainment if the ambient air quality concentration for a specific pollutant as measured by a monitor is below the standard concentration level for a set averaging period. The area in which AVEF II will be located is designated as attainment for all the NAAQS.

This project will be subject to the requirements of two permit programs applicable to major sources under the federal Clean Air Act (CAA): PSD and Title V. MCESD is authorized by the USEPA to issue PSD permits and permit revisions in Maricopa County under MCAPCR 240. MCESD's Title V program, set forth in MCAPCR 220, has been approved by USEPA. As an

electrical energy producer, AVEF II will also subject to the Title IV Acid Rain provisions of the CAA Amendments of 1990, set forth in MCAPCR 371. New Source Performance Standards also will apply to the gas turbines and duct burners.

The PSD program applies to the construction or major modification of a major source in an attainment area. If a source is 1 of 28 "categorical sources," the major source threshold is 100 tons per year (tpy) of a regulated air pollutant; otherwise the threshold is 250 tpy. AVEF I is 1 of the 28 categorical sources (fossil-fuel-fired steam electric plants of more than 250 million British thermal unit per hour heat input) with a PTE of more than 100 tpy for three regulated pollutants: NO_x, PM_{10}, and CO. AVEF I, therefore, is a major source. Major modifications to major sources also are required to go through PSD review. Major modifications are those changes at a major stationary source that increase potential emissions of criteria pollutants by more than a specified threshold. AVEF II will have potential emissions above the major modification thresholds and therefore will have to undergo PSD review.

Major modifications must also be included in the major source's operating permit under Title V of the CAA. Duke's existing Title V permit will be revised to include AVEF II.

2. Air Quality Modeling Requirements

Duke Maricopa will be required to perform certain air quality modeling analyses in connection with its application for a revision to its air quality permit for the proposed AVEF II project.

PSD regulations require an ambient air quality impact analysis for sources located within 50 kilometers (km) of non-attainment areas. As described earlier, AVEF II will be located in an area designated as attainment for all criteria air pollutants. The nearest ozone, CO, and PM_{10} non-attainment areas in Maricopa County are the metropolitan Phoenix area located east of the facility. The non-attainment areas are within 50 km of the proposed facility.

A cumulative air quality impact analysis is required for pollutants that are modeled to be greater than the Significant Impact Levels (SILs) established by USEPA. Based on preliminary modeling of both AVEF I and II, only PM_{10} is expected to be greater than the SILs. Therefore, an ambient impact analysis with other sources in the area is only required for PM_{10}. The area of influence for PM_{10} is expected to be 5 km. This is the maximum distance to which the maximum modeled concentration for any averaging time drops to below the SIL. For the NAAQS analysis, all sources within the area of influence, or that are within 50 km of the area of influence and have the potential to contribute a significant impact within the area, must be modeled. If the background air quality data are available, however, only nearby sources, i.e., within the area of influence, need to be modeled. An inventory of other PM_{10} emissions sources within 55 km of AVEF I has been obtained from MCESD.

PSD regulations require also that facilities within 100 km of a Federal Class I areas perform a modeling evaluation of ambient air quality in terms of Class I PSD Increments and Air Quality Related Values (AQRVs). PSD increments are numerical values of ambient concentration of criteria pollutants that cannot be exceeded. For this project, the AQRVs relate to changes in visibility as it could affect the experience of visitors to the Class I area and deposition of acidic species.

In addition, large projects between 100 and 200 km or more from a Class I area may be requested by the Federal Land Managers to conduct an evaluation of air quality impacts. The designated FLM in this case is the U.S. Forest Service. Due to technical limitations in the applicable dispersion model (CALPUFF), modeling of sources much more than 200 km from a PSD Class I area is not recommended.

The project is located in a PSD Class II area. There are no Class I areas within 100 km. The nearest Class I area to the facility is the Superstition Wilderness Area located 120 km west of the project site. Other Class I areas within 200 km are Mazatzal, Pine Mountain, Sierra Ancha, and Sycamore Canyon Wilderness Areas. As a courtesy, the analysis of impacts from this project also will be determined on the following Class II areas:

- Signal Hill Wilderness Area;
- Woolsey Peak Wilderness Area;
- Gila Bend Indian Reservation;
- North Maricopa Mountain Wilderness Area;
- Sierra Estrella Wilderness Area;
- Hummingbird Springs Wilderness Area;
- Big Horn Wilderness Area; and
- Eagletail Mountain Wilderness Area.

EXHIBIT B-2

GROUNDWATER ASSESSMENT

REVISED WATER RESOURCE IMPACT ASSESSMENT
ARLINGTON VALLEY ENERGY FACILITY
ARLINGTON VALLEY, ARIZONA

Submitted to

Duke Energy Maricopa, LLC

Submitted by

Philip C. Briggs
Water Resources Consulting Southwest, LLC
6631 S. 38th Street
Phoenix, Arizona 85040

JULY 9, 2001

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6. Historical Analytical Model of Regional Response to Groundwater Extraction
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A. Methodology and Calculations for Aquifer Tests
B. Application of a Numerical Groundwater Model (THWELLS) to the Region Surrounding the Proposed Arlington Valley Energy Facility

1 INTRODUCTION

Duke Energy Maricopa, LLC (Duke) retained Water Resources Consulting Southwest to conduct a hydrologic analysis for a proposed expansion of a combined-cycle natural gas power plant in Arlington Valley, in western Maricopa County, Arizona. This report summarizes the results of the hydrologic analysis conducted by Water Resources Consulting Southwest, and provides conclusions as to the physical availability of a water supply over the lifetime of the proposed project and the expected impact of groundwater pumping on groundwater levels in the area. The proposed project (known as the Arlington Valley Energy Facility) will occupy a portion of the east half of Section 17, Township 1 South (T1S), Range 6 West (R6W), approximately 1.5 miles south of the Palo Verde Nuclear Generating Station (PVNGS). The location of the proposed project is shown on Figures 1 and 2. This property is located within the Lower Hassayampa sub-basin of the Phoenix Active Management Area (Phoenix AMA).

2 PURPOSE AND SCOPE OF ANALYSIS

This hydrologic assessment has been conducted to support an Application for a Certificate of Environmental Compatibility to be submitted to the Power Plant and Transmission Line Siting Committee of the Arizona Corporation Commission (ACC). The specific purpose of this report is to demonstrate the physical availability of a water supply over the expected lifetime of the proposed project, and to assess the impact of groundwater extraction on groundwater levels in the Arlington Valley area. Specific statutory or regulatory guidelines for this hydrologic analysis do not exist. However, the scope of this analysis was modeled after guidelines developed by the Arizona Department of Water Resources (ADWR) for hydrologic studies for assured and adequate water supplies (ADWR, 1995).

3 METHOD OF ANALYSIS

3.1 Elements of Demand Methodology

Preliminary estimates of expected water demand were obtained from Duke, and vary based on the expected operational parameters of the proposed project, including methods of pre-treatment, use of duct-firing for greater efficiency, expected cycles of concentration of cooling water, and disposal options for blowdown water. For the purposes of this hydrologic analysis, the water demand is assumed to be the maximum amount of water available to Duke through the conversion of Irrigation Grandfathered Rights (IGRs) that have been obtained by Duke, as discussed in the next section.

3.2 Elements of Supply Methodology

Water demand for the proposed project will be supplied fully through groundwater pumpage. Duke has obtained eight IGRs from approximately 2,750 acres of contiguous, irrigated land located in the vicinity of the proposed project. The 1999 irrigation allotment of these rights is approximately 13,000 acre-feet per year, which is based on the

application of varying water duties to approximately 2,600 water duty acres. Duke will convert the existing IGRs to Type 1 Non-Irrigation Grandfathered Rights (Type 1 Rights). For the purposes of this study, it is estimated that the conversion will occur using a water duty of approximately 3 acre-feet per acre, resulting in a total estimated Type 1 Right of approximately 7,800 acre-feet per year. Details of the water rights obtained by Duke and the Type 1 Right conversion are summarized in Table 1.
For the purposes of this study, all water is expected to be withdrawn from five production wells located at the site (four of these are new wells, one is a replacement well for existing production well 8-1).

3.3 Elements of Adequacy Methodology

Several methods were used to determine the adequacy of water supply for the proposed project and to determine the impacts to groundwater levels expected from groundwater extraction to meet the project water supply. These methods include the development of an analytical model based on historical response of groundwater levels to agricultural pumpage, and the use of a two-dimensional analytical groundwater flow modeling software package. In addition, a regional three-dimensional groundwater flow model was prepared by Dr. Peter Mock to describe the cumulative impacts from pumping from all power plants in the Arlington Valley (Mock, 2000).

Historically, water use in the study area has been largely related to agricultural irrigation, beginning approximately in the early 1940's and continuing to present. As a result, water levels in the area have decreased significantly since the 1940's, although they began to rebound beginning in the early 1980's as agricultural pumpage decreased. Based on annual groundwater pumpage as reported to ADWR since 1986 and available aerial photographs for the area, an estimated amount of groundwater extracted over the last 40 years has been developed. By comparing this estimate to known declines in water levels over this time period, a simple analytical model of regional groundwater level response to pumpage has been developed. This model has been used to estimate the expected impact regionally due to pumpage by Duke over the lifetime of the proposed project.

In addition to the analytical model based on historic data, the expected impact from the five production wells was modeled using THWELLS, an analytical two-dimensional groundwater flow modeling software. The transient modeling analysis used by THWELLS solves for the Theis equation. The model assumes a uniform, isotropic, homogeneous aquifer with an infinite lateral extent. No recharge or leakage was applied to the model for this analysis. The groundwater flow model was used to calculate the amount of drawdown over the 30-year expected lifetime of the proposed project that can be attributed to withdrawals from the Duke supply wells.

The regional three-dimensional flow model developed by Dr. Mock included several projected future demand scenarios for the area. One of these assumed the operation of the three approved power plants in the area, supplied by groundwater withdrawals equal to the sum of the individual facilities Type I Rights. The total use was approximately 22,000 acre-feet per year. For the purposes of Dr. Mock's study, 6,800 acre-feet per year

was used as the demand for the Arlington Valley Energy Facility. Our assessment will add only 1,000 acre-feet to this model. An additional two-dimensional modeling run was conducted using THWELLS to estimate the amount of drawdown expected above and beyond Dr. Mock's results due to the increase of water use at the Arlington Valley Energy Facility.

4 ELEMENTS OF DEMAND

A review of aerial photos and the pumpage data reported to ADWR indicate that the withdrawals from the wells associated with the IGRs for the subject parcels has decreased since the 1980's as noted for the area in general. Based on quantity of groundwater available under the IGRs, irrigation pumpage for the Duke parcels could be as high as approximately 13,000 acre-feet/year. Conversion of the IGRs to Type I Rights will reduce the allowable pumpage from the subject parcels to approximately 7,800 acre-feet/year, as shown in Table 1. Since approximately 1988, irrigation has continued on three of the Duke parcels (Shepard, Hardison, and Popoff properties) under the associated IGRs, averaging approximately 3,500 acre-feet/year over the past three years, as shown in Table 2.

The proposed pumpage for the project is expected to increase over the current irrigation withdrawal, but to no more than the amount allowed under the converted Type I Rights. For the purpose of this modeling it is presumed that the pumping will be equivalent to the full groundwater rights, or approximately 7,800 acre-feet/year. The combined pumpage for both facilities represents a 4,300 acre-feet/year increase over the current irrigation pumpage of 3,500 acre-feet/year, but a 5,200 acre-feet/year decrease over the potential agricultural groundwater pumpage.

5 ELEMENTS OF SUPPLY

5.1 Hydrogeologic Setting

5.1.1 Geology

The Lower Hassayampa sub-basin of the Phoenix AMA is an alluvial plain bounded by the White Tank Mountains on the east, on the south by the Buckeye Hills and the Gila Bend Mountains, and on the west by the Palo Verde Hills.

Bedrock in the Lower Hassayampa area consists of granitic and metamorphic rocks (basement complex), and locally of interbedded volcanic and sedimentary deposits that overlie the basement complex. The main water-bearing unit in the area consists of the basin-fill sediments, comprised of gravel, sand, silt and clay (Sanger and Appel, 1980); however, the interbedded volcanic and sedimentary deposits are also comprise the regional aquifer (Mock, 2000a). These sediments range from a few tens of feet thick near the mountains to more than 1,000 feet thick near the center of the plain.

Basin-fill sediments in the area are divided into three major units and include the upper, middle and lower alluvium (U.S. Bureau of Reclamation, 1976). The upper alluvium ranges from 30 to 60 feet thick and consists of silty-sands and gravelly-sands with discontinuous lenses of clay and silty clay (Long, 1983). Caliche may be present in the upper 50 feet of the upper alluvium. The middle alluvium ranges from 230 to 300 feet thick and is comprised of clay and silty clay interbedded with discontinuous lenses of clayey silt, clayey sand, and silty sand. It includes the Palo Verde clay that varies north of the project site from 80 to 130 feet thick. The middle alluvium is intermittent within the bounds of the project site, disappearing entirely in the northwest corner. However, further southeast, the middle alluvium appears in driller's logs to be over 200 feet thick. The lower alluvium consists of less than 100 to greater than 1,000 feet of unconsolidated silty sand, sand, and gravelly sand (Long, 1983).

5.1.2 Hydrology

5.1.2.1 Groundwater Resources

Groundwater occurs predominantly in the basin-fill sediments of the three alluvial layers and the interbedded volcanic and sedimentary deposits. The upper alluvium is unsaturated in most of the Lower Hassayampa area. The middle alluvium consists of two fine-grained layers. Agricultural irrigation water has percolated through the permeable upper alluvium over time and now forms a local perched water table on top of the relatively impermeable upper layer of the middle alluvium (Long, 1983). Studies of the perched aquifer indicate that it probably formed between 1950 and 1975, and contained very little water prior to that time-interval (APS, 1997). Groundwater in this perched zone flows radially outward from the center of the groundwater mound. The areal size of the mound has stabilized at a size which allows downward percolation to equal or exceed recharge rates. The approximate location of the perched groundwater is shown on Figure 3 (APS, 1997).

The lower alluvium is typically saturated throughout the region. Most productive wells in the area are completed in the lower alluvium.

5.1.2.2 Water Levels

Regionally, groundwater flows from northeast to southwest. In the general vicinity of the proposed project, groundwater converges around a cone of depression that formed due to the long-term pumping for agricultural activity in the basin (APS, 1997). The cone of depression appears centered near the western-most edge of the Duke property, with a radius of about 5 miles in 1992 (APS, 1997). Since approximately 1980 agricultural pumping has decreased substantially and water levels are rebounding. Regional water level contours are shown in Figure 3, and primarily represent water levels in the lower alluvium. Representative hydrographs of the area are included as Figures 4 and 5 (the locations of these hydrographs are shown on Figure 3). Available data indicate that water levels decreased as much as 100 feet in response to agricultural pumpage in the area, and have recovered approximately 50 feet as pumpage began to decease in the early 1980's.

5.1.2.3 Hydraulic Parameters

Hydraulic parameters for the area were derived from aquifer test conducted on production wells in the area, including tests conducted on Duke production wells. Estimates of transmissivity range from approximately 27,000 to 437,000 gallons per day per foot (gpd/ft), which corresponds to a hydraulic conductivity range of approximately 4 to 59 feet/day. A complete summary of estimates of aquifer parameters obtained from various sources is included in Table 3. A complete description of the aquifer tests conducted on Duke production wells is included as Appendix A.

A Well Spacing Analysis was submitted to ADWR in April 2001 for the permitting of two new production wells at the site. The Well Spacing Analysis utilized an identical modeling technique (THWELLS) as that used for this impact assessment. After review by ADWR, a transmissivity value of 156,346 gpd/ft was agreed on as appropriate for the site (SWCA, 2001). The ADWR approved the Well Spacing Analysis using the agreed value.

5.2 Well Inventory and Water Supply Wells

A well inventory for the immediate vicinity of the proposed project (Township 1 South, Range 6 West) is included as Table 4. The well inventory was derived from several databases maintained by ADWR, including the Well Registry database (also known as the "55-files") and the Groundwater Site Inventory (GWSI) database. Based on these sources there are approximately 158 wells located within the above township. Due to overlap and uncertainty between the two databases, there are likely to be less than 158 wells in actuality. Duplicates have been removed from Table 4 where possible.
With the acquisition of the property needed for the IGRs, Duke acquired nine wells that have been used in the past to supply irrigation demands for the subject properties. These wells are indicated on Table 4. Of the remaining wells, approximately 100 are monitoring wells associated with PVNGS. All wells in the immediate vicinity of the proposed project are shown on Figure 6.

5.3 Water Quality

Detailed site-specific groundwater samples were obtained from four of the Duke production wells in September and October 2000. Laboratory analytical results for these samples are summarized in Table 5. Groundwater quality is adequate to meet the needs of the project water supply.

6 ELEMENTS OF ADEQUACY

6.1 Historical Analytical Model of Regional Groundwater Usage

All known water rights in Arlington Valley and the approximate irrigated acreage for each are summarized in Table 6. Adequate information exists from aerial photographs

and records of groundwater use as reported to ADWR to determine the approximate water use per acre for the area. Details of these calculations are shown in Table 6.

Based on this information, an estimate of the approximate annual groundwater use prior to 1980 was calculated as approximately 25,700 acre-feet/year for the period from the early 1940's to 1980, as shown in Table 6. From existing hydrographs, this magnitude of pumpage caused a long-term groundwater decline in the area of approximately 80 feet, or approximately 3.1 feet per 1,000 acre-feet/year of groundwater pumpage. This value was used to extrapolate the expected regional groundwater response to Duke pumpage over the 30-year lifetime of the proposed project.

To the extent that the past can be used to predict the future, the estimated pumpage for the proposed project would have contributed approximately a 24-foot decline in the area of the facility over a similar period. This is about a quarter of the observed water level declines over a historic period about the same length as the projected lifetime of the plant. This estimated impact is a worst-case estimate, as water levels have increased since the 1980's and are continuing to rise in the Arlington Valley area under the current reduced rate of agricultural pumpage. Impacts of the rebound from the current reduced pumpage and the future projected pumpage can be expected to be offset to an extent.

Application of the historical analytical model is meant only as an informal examination of proposed project impacts relative to previous impacts to Arlington Valley and expected future recovery of water levels. More reliable specific impacts due to project production wells were developed using a numerical groundwater flow model, as discussed in the next section.

6.2 Theis Hydrologic Impact Analysis

The transient numerical model employed by Water Resources Consulting Southwest utilizes values of hydraulic conductivity, pumpage, and storativity to produce expected groundwater levels at a specific time in the future resulting from the projected pumpage. The model illustrates the impacts of the projected pumpage only, and no attempt was made to model groundwater recharge or inflows that are the cause of the ongoing increases in groundwater levels. The model results therefore predict the changes in water levels due to the projected pumpage, and should be combined with ongoing water level trends to project future depths to groundwater and water levels. A complete description of the modeling effort employed is included as Appendix B.

Conservative estimates of all parameters were used in the model. The pumpage amount used was also conservative, as the maximum possible water demand of 7,800 acre-feet/year was used, rather than the increase over current pumpage on the parcels. Pumpage by well was determined by dividing this demand between five modeled production wells.

The transmissivity/hydraulic conductivity value used in the model was that already agreed upon by ADWR, and represents a spatially-weighted average of aquifer tests conducted for on-site production wells and other local wells.

In order to assess the likely expected groundwater conditions at the end of the project's expected lifetime, impacts to water levels were modeled for a 30-year period. Results of the modeling are summarized in Table 7.

At the end of 30 years, the maximum drawdown projected in the immediate vicinity of the site is approximately 32 feet within the well field, and over 25 feet for a distance of 0.4 miles. Drawdowns from projected annual withdrawals of 7,800 acre-feet of up to 10 feet extend a distance of approximately 3.4 miles radially from the site. Water level declines are shown on Figure 7.

To estimate the drawdown expected for the additional 1,000 acre-feet/year now projected to be used by the facility (7,800 acre-feet minus 6,800 acre-feet), an additional two-dimensional model run was conducted. The results of this model are shown in Figure 8. This represents an approximate 3 foot increase in drawdown over that originally modeled for the area.

6.3 Cumulative Impacts Using Three-Dimensional Model

Dr. Mock's modeling for the power plant scenario projected the estimated regional cumulative impact from pumping from all major water users in the Arlington Valley, including remaining agriculture uses and proposed power plants (Mock, 2000b). Dr. Mock estimated that approximately 70 feet of drawdown would occur over 30 years, taking into account the observed increase in water levels observed over the last few decades.

The results of Dr. Mock's model are shown on Figure 9. The combination of the results from Dr. Mock's model and the impact of an additional 1,000 acre-feet/year used at the Arlington Valley Energy Facility is shown on Figure 10. The expected maximum increase over Dr. Mock's result is approximately 3 feet of drawdown over 30 years (Figure 8).

7 CONCLUSIONS

Based on the information presented in this report, the following conclusions are warranted:

1. Water supply for the proposed project will be met completely through the use of groundwater. Approximately 13,000 acre-feet/year of Irrigation Grandfathered Rights will be converted to Type 1 Non-Irrigation Grandfathered Rights to provide a

water supply of approximately 7,800 acre-feet/year. Current pumpage under the irrigation rights is about 3,500 acre-feet/year.

2. Historically, the Arlington Valley area experienced approximately 80 feet of groundwater decline due to agricultural pumpage prior to 1980. Water levels have recovered approximately 50 feet in the area since approximately 1980 and are continuing to recover. Impacts of future pumpage can be expected to be offset by this recovery.

3. Adequate information is available for the vicinity of the proposed project to obtain a reliable estimate of changes in groundwater levels due to the groundwater pumpage for the proposed project and to support the conclusions set forth in this report. This includes the analysis of site-specific pumping and recovery tests.

4. Groundwater quality is adequate to provide a water supply for the proposed project.

5. Modeling of impacts to the groundwater system over the 30 year expected lifetime of the proposed project indicate that sufficient water is physically available to supply the project water demands. Projected impacts of groundwater pumpage were estimated. Based on groundwater flow modeling, projected maximum water level changes due to withdrawals of the full 7,800 acre-foot Type I Right are approximately 32 feet in the immediate vicinity of the site, and minimal water level changes (up to 10 feet of decline) are projected within about 3 miles of the project production wells. Based on an analytical model of historical response to groundwater pumpage, water levels are estimated to change no more than 24 feet over the lifetime of the proposed project. Actual future water level changes will be less than projected as these projections do not include retirement of current agricultural pumpage and the ongoing recovery of water levels in the area.

6. The same model was also used to simulate water level changes from the addition of the proposed pumping for AVEF II. After 30 years of pumping 1,000 acre-feet/year, minimal water level changes (up to 3 feet) are projected within about a half mile of the plant production wells, and smaller level changes at greater distances. Again, these projections are considered conservative as they do not consider the retirement of current irrigation pumpage or the natural recovery of water levels that has occurred in recent years.

7. Estimates of the cumulative impact of the three power plants approved and proposed were made using previous modeling (Mock, 2000b) and modeling of a proposed increase in pumping from the previous modeling of 1,000 acre-feet per year. The projected increase in drawdown is less than 3 feet for the area beyond 0.5 miles from the Arlington Valley Energy Facility.

8. Sufficient water is available to supply the proposed project needs. The proposed withdrawal of this water will have minimal impact on the aquifer.

8 REFERENCES

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Mock, Peter A., 2000a. Evaluation of Groundwater Responses to the Pumping for Proposed Power Plants in the Centennial Wash Area, Maricopa County, Arizona, Peter Mock Groundwater Consulting, Inc., April, 2000.

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SWCA Environmental Consultants, Inc., 2001. Well Spacing Analysis for Two Proposed Production Wells, Arlington Valley Energy Project, Revised April 18, 2001.

U.S. Bureau of Reclamation, 1976. Central Arizona Project—Geology and Ground-Water Resources Report, Maricopa and Pinal Counties, Arizona, December 1976.

Table 1. Details of Water Rights Obtained by Duke Energy Maricopa
Arlington Valley Energy Facility,
Arlington Valley, Arizona

Parcel Identification		Current Allotment (1999)	Irrigation Acres	Water Duty (Acre-feet/acre)			Calculated Water Duty Acres	Type I Conversion @ 3 a-f/a
Parcel No.	Irrigation Grandfathered Right	(acre-feet/year)	(acres)	1992-1994	1995-1999	2000-	(acres)	(acre-feet/year)
1	58-105414.0000	3,352	740	5.98	4.70	3.87	713	2,139
2	58-104995.0000	3,467	618	7.09	5.74	5.29	604	1,812
3	58-130196.0000	144	34	5.31	4.37	3.75	33	99
4	58-102369.0000	1,617	395	5.35	4.20	3.46	385	1,155
7	58-101121.0001	1,297	320	5.78	4.54	3.74	286	857
8	58-100902.0003	1,343	284	6.80	5.34	4.40	252	755
Popoff	58-105005.0000	1,372	279	5.38	5.38	5.38	255	765
Marven	58-100105.0002	378	81	5.05	4.67	4.34	81	243
Totals		**12,969**	**2,750**				**2,608**	

Estimated Total Type 1 Non-Irrigation Grandfathered Right = 7,824

Table 2. Annual Groundwater Withdrawals Reported to ADWR for Duke Parcels
Arlington Valley Energy Facility
Arlington Valley, Arizona

			Annual Withdrawals Reported to ADWR (Acre-feet)												
Parcel No.	**Right No.**	**Pumped From Well**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
1	58-105414.0000	624677	1069.29	656.7	0	0	0	0	-	-	-	-	-	0	-
		624678	67.67	826.4	0	0	55.7	0	-	-	-	-	-	0	-
2	58-104995.0000	611935	-	1426.6	1345.76	997.74	953.46	1019.29	870.82	1164.09	1105.44	1257.92	1453.14	1149.78	863.38
		611936	-	0	0	0	0	0	0	0	0	1107.1	1196.75	1443.4	0
		611937	-	1278.4	1094.3	1092.92	908.59	969.23	831.1	1083.7	1130.96	0	0	0	1499.58
3	58-130196.0000	None specified	0	0	0	0	0	0	0	-	-	-	-	0	-
4	58-102369.0000	602601	379	698.3	450.94	293.57	301.79	0.81	2.49	1.9	27.62	16.24	455	303.75	159
		602602	594	583.23	416.79	563.98	445.32	0	0.67	0	160.38	173.45	367	257.67	335
7	58-101121.0001	610922	-	-	-	-	-	-	-	-	-	-	369.91	0	-
8	58-100902.0003	627971	-	-	-	-	-	-	-	-	-	-	0	0	0
Popoff	58-105005.0000	628079	763.9	1385.6	930.81	996.36	1024.61	621.37	442.2	628.65	717.14	540.99	404.34	294.11	85
Marven	58-100105.0002	None specified	-	-	-	-	-	-	-	-	-	-	0	0	-
	Annual Total Groundwater Usage for Duke Parcels		**2,874**	**6,855**	**4,239**	**3,945**	**3,689**	**2,611**	**2,147**	**2,878**	**3,142**	**3,096**	**4,246**	**3,449**	**2,942**

- No annual withdrawal report on file with ADWR

Table 3. Estimates of Aquifer Hydraulic Parameters
Arlington Valley Energy Facility, Arlington Valley, Arizona

Source of Data	Well	Method of Estimation	Date	Discharge During Pumping Test (gpm)	Duration of Pumping Test	Transmissivity of Well (gpd/ft)[1]	Hydraulic Conductivity of Aquifer (feet/day)[2]	Transmissivity of Aquifer (gpd/ft)[3]
Site-specific aquifer tests	4-1	Recovery	October 2000	2,000	23.5 Hours	83,810	14.3	106,716
	7-1	Pumping	October 2000	2,300	19 Hours	129,191	19.7	147,015
	7-1	Recovery	October 2000	2,300	19 Hours	189,750	29.0	216,418
	8-1	Pumping	September 2000	2,200	21.5 Hours	58,080	13.5	100,746
	8-1	Recovery	September 2000	2,200	21.5 Hours	252,522	58.6	437,313
Site-specific aquifer tests	4-1	Specific Capacity	October 2000	2,000	23.5 Hours	60,606	10.4	77,612
	7-1	Specific Capacity	October 2000	2,300	19 Hours	30,263	4.6	34,328
	8-1	Specific Capacity	September 2000	2,200	21.5 Hours	15,789	3.7	27,612
Regional data compilation[4]	Sempra #1			2,100	168 Hours			239,392
	Sempra #8			2,500	24 Hours			187,025
	Sempra #10			933	24 Hours			59,848
	Sempra #14			490	25 Hours			216,949
	C-01-06 14DBB			2,500	120 Hours			130,918
	C-01-06 23ABD			1,875	6 Hours			44,886
	B-01-06 34ABB			2,360	24 Hours			97,253

Minimum Transmissivity	**27,612**
Maximum Transmissivity	**437,313**
Arithmetic Average Transmissivity	**141,602**
Median Transmissivity	**106,716**
Transmissivity Estimated by Inverse Distance Method[5]	**156,346**

[1] $T_w = 264 * Q / \Delta s$

T_w = Transmissivity of well, in gpd/ft
Q = Pumping rate, in gpm
Δs = Drawdown, in ft (one log-cycle on semi-log plot)

[2] $K_a = 0.134 * T / b'$

K_a = Hydraulic conductivity of aquifer, in ft/day
b' = Saturated thickness of well (saturated screened interval), in ft

[3] $T_a = 7.481 * K_a * b$

T_a = Transmissivity of aquifer, in gpd/ft
b = Saturated thickness of aquifer, in ft (1,000 feet)

[4] All transmissivity values shown as provided by Peter Mock Groundwater Consulting, Inc.

[5] Calculated by ADWR.

Table 4. Complete Inventory of Wells for Township 1 South, Range 6 West
Arlington Valley Energy Facility, Arlington Valley, Arizona

Category	Duke Parcel	Duke Well ID	Cadastral Location	Registration Number	Water Use	Site Use	Owner	Depth (feet)	Diameter (inches)	Perforated Interval (feet)	Year Constructed	Source
Duke Wells	Parcel 1	Well 1-1	C-01-06 26DAD	624677	Irrigation	Withdrawal	W PERRY; B YOUNGKER	1135	20	126-1135	1948	Registry; GWSI
	Parcel 1	Well 1-2	C-01-06 35ADA	624678	Irrigation	Withdrawal	W PERRY	1000	20		1974	Registry; GWSI
	Parcel 2	Well 2-1	C-01-06 28ACC2	611937	Irrigation	Withdrawal	LEON HARDISON	337	15	124-337	1961	Registry; GWSI
	Parcel 2	Well 2-2	C-01-06 27BBC	611935	Irrigation	Withdrawal	HARDISON	1090	20		1947	Registry; GWSI
	Parcel 2	Well 2-3	C-01-06 28ACC1	611936	Stock	Withdrawal	LEON HARDISON	0				Registry; GWSI
	Parcel 4	Well 4-1	C-01-06 21CBB2	602602	Irrigation	Withdrawal	SHEPPARD	1012	20		1958	Registry; GWSI
	Parcel 4	Well 4-2	C-01-06 21BCB	602601	Irrigation	Withdrawal	ROBERT SHEPPARD	1001	20	350-980	1980	Registry; GWSI
	Parcel 7	Well 7-1	C-01-06 17ABB	610922	Irrigation	Withdrawal	E SHEPARD; BETTY MARTIN	1219	20	260-1219	1960	Registry; GWSI
	Parcel 8	Well 8-1	C-01-06 20AAB2	627971	Irrigation	Withdrawal	SHIRLEY DESHETLER	1110	20	508-1110	1968	GWSI
	Popoff	Popoff	C-01-06 08ACC1	628079	Irrigation	Withdrawal	L MARTIN; PETE POPOFF	936	18		1977	Registry; GWSI
Non-Palo Verde Wells			C-01-06 03BBB1		Unused	Unused		1085	20		1948	GWSI
			C-01-06 04CBA	556600	Domestic	Withdrawal	BERRYMAN, MICHAEL	320	8		1996	Registry
			C-01-06 07AAD	610921	Irrigation	Withdrawal	JOHN HALL ASSOCIATES; J HODGES; JAMES BIRMINGHAM	819	16	120-819	1979	Registry; GWSI
			C-01-06 07BBB	610923	Irrigation	Withdrawal	J HODGES; JAMES BIRMINGHAM	605	20	20-605	1979	Registry; GWSI
			C-01-06 07BCC	610924	Irrigation	Withdrawal	JOHN HALL ASSOCIATES; J HODGES; JAMES BIRMINGHAM	936	16	264-936	1979	Registry; GWSI
			C-01-06 08ACC2		Domestic	Withdrawal	L MARTIN	300	8		1979	GWSI
			C-01-06 09ABC		Unused	Unused		176	4			GWSI
			C-01-06 10DDD	609047	Irrigation	Withdrawal	PAUL GARBER	322	8	240-320	1974	Registry; GWSI
			C-01-06 12BBC		Unused	Unused		1000	20		1951	GWSI

Table 4. Complete Inventory of Wells for Township 1 South, Range 6 West
Arlington Valley Energy Facility, Arlington Valley, Arizona

Category	Duke Parcel	Duke Well ID	Cadastral Location	Registration Number	Water Use	Site Use	Owner	Depth (feet)	Diameter (inches)	Perforated Interval (feet)	Year Constructed	Source
Non-Palo Verde Wells			C-01-06 13	802026	Irrigation	Withdrawal	BECK WAYNE E	1100	8			Registry
			C-01-06 13CAB		Irrigation	Withdrawal		1200	20			GWSI
			C-01-06 14AAA	608004			JACKSON	700	18		1967	Registry; GWSI
			C-01-06 14ADB	608003	Unused	Unused	J JACKSON	1000	18	325-1000	1967	Registry; GWSI
			C-01-06 14CBB	623232	Irrigation	Withdrawal	GLADDEN BROTHERS; GLADDEN BROTHERS; WILLIAM MCMURTRY	1140	20	375-1126	1978	Registry; GWSI
			C-01-06 14DBB	623227	Irrigation	Withdrawal	BEN YOUNGKER; WILLIAM MCMURTRY	1114	20	190-1114	1948	Registry; GWSI
			C-01-06 15BAB	514110	Domestic	Withdrawal	SICHI, MIKE	595	8		1986	Registry
			C-01-06 18ABC	627864	Irrigation	Withdrawal	GARY CACCIOGUIDE; OLIVIA DALTON	500	10	235-495	1973	Registry; GWSI
			C-01-06 18BBB	629645	Irrigation	Withdrawal	VANOSDELL	1333	20		1953	Registry; GWSI
			C-01-06 19ABB	629644	Irrigation	Withdrawal	CAMPILLO	1045			1959	Registry; GWSI
			C-01-06 19BAA	535718	Domestic	Withdrawal	CAMPILLO, CELEDONIO	360	6		1992	Registry
			C-01-06 19BBB		Irrigation	Withdrawal	RONALD HARPER	940	20	225-940	1976	GWSI
			C-01-06 19BBB	628647	Irrigation	Withdrawal	CAMPILLO	980	18		1975	Registry
			C-01-06 19BBB	629650	Irrigation	Withdrawal	VANOSDELL, CHARLES	0	0		1975	Registry
			C-01-06 19BBC	628645	Irrigation	Withdrawal	CAMPILLO	822	18		1954	Registry
			C-01-06 19CBB	629651	Irrigation	Withdrawal	VANOSDELL, CHARLES	0	0			Registry
			C-01-06 20AAB1		Unused	Unused	DE SHETLER FARMS	340	20	150-340	1930	GWSI
			C-01-06 20ABA					280	8		1968	GWSI
			C-01-06 20BCA	614948	Stock	Withdrawal	AZ STATE LAND DEPT	200	9		1973	Registry

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Arlington Valley Energy Facility, Arlington Valley, Arizona

Category	Duke Parcel	Duke Well ID	Cadastral Location	Registration Number	Water Use	Site Use	Owner	Depth (feet)	Diameter (inches)	Perforated Interval (feet)	Year Constructed	Source
Non-Palo Verde Wells			C-01-06 21AAB	86398	Irrigation	Withdrawal	YOUNGKER	0	0			Registry
			C-01-06 21AAB	501579	Irrigation	Withdrawal	YOUNGKER	0	0			Registry
			C-01-06 21AAB	504407	Irrigation	Withdrawal	YOUNGKER	0	0			Registry
			C-01-06 21ABB	633945	Domestic	Withdrawal	TERRELL	350	8		1977	Registry
			C-01-06 21CBB1	602600	Irrigation	Withdrawal	SHEPPARD	408	20			Registry; GWSI
			C-01-06 22DDD	555667	Domestic	Withdrawal	MCCOLLUM, PATRICK	230	7		1997	Registry
			C-01-06 23ADB	623230	Irrigation	Withdrawal	JG LAND AND CATTLE; WILLIAM MCMURTRY	1158	20	140-930	1948	Registry; GWSI
			C-01-06 23BA	803973	Domestic	Withdrawal	WOODMANSEE, PERRY	302	10		1986	Registry
			C-01-06 23BAB	623228	Irrigation	Withdrawal	JG LAND AND CATTLE; B YOUNGKER FARMS; WILLIAM MCMURTRY	1010	20	355-1010	1950	Registry; GWSI
			C-01-06 23CAA	623229	Irrigation	Withdrawal	JG LAND AND CATTLE; BEN YOUNGKER JR; WILLIAM MCMURTRY	1157	20	380-1157	1959	Registry; GWSI
			C-01-06 26ABA	623231	Irrigation	Withdrawal	B YOUNGKER; WILLIAM MCMURTRY	1130	20	200-1130	1948	Registry; GWSI
			C-01-06 27ACC	611938	Domestic	Withdrawal	HARDISON & HARDISON	0	0			Registry
			C-01-06 29ABB	620365	Irrigation	Withdrawal	GARY ACCOMAZZO; OLIVER HARPER	960	18	300-490	1970	Registry; GWSI

Table 4. Complete Inventory of Wells for Township 1 South, Range 6 West
Arlington Valley Energy Facility, Arlington Valley, Arizona

Category	Duke Parcel	Duke Well ID	Cadastral Location	Registration Number	Water Use	Site Use	Owner	Depth (feet)	Diameter (inches)	Perforated Interval (feet)	Year Constructed	Source
Non-Palo Verde Wells			C-01-06 30AAA	629647	Irrigation	Withdrawal	PAUL HARPER; CAMPILLO	800	18	150-800	1976	Registry; GWSI
			C-01-06 30ABB	629646	Irrigation	Withdrawal	PAUL HARPER; CAMPILLO	980	18	225-480	1975	Registry; GWSI
			C-01-06 30CDD	541428	None	Cathodic	ALL AMERICAN PIPELN	400	10		1993	Registry
			C-01-06 31ADB	626716	Stock	Withdrawal	SOUTHERN PACIFIC TRN	315	5		1926	Registry; GWSI
			C-01-06 31DAC	559905	Domestic	Withdrawal	DERESH, ROBERT	0	0			Registry
			C-01-06 34CAB	614949			AZ STATE LAND DEPT	0	0			Registry
			C-01-06 34CAB	614950	Stock	Withdrawal	AZ STATE LAND DEPT	0	0			Registry
Palo Verde Wells			C-01-06 02BBB	86025	Monitoring	Observation	AZ NUCLEAR POWER	58	0		1980	Registry
			C-01-06 02BBB	86036	Monitoring	Observation	AZ NUCLEAR POWER	28	4		1980	Registry
			C-01-06 02BBB	502303	Monitoring	Observation	AZ NUCLEAR POWER	64	4		1982	Registry
			C-01-06 02BBB	502304	Monitoring	Observation	AZ NUCLEAR POWER	62	4		1982	Registry
			C-01-06 02BBB	502305	Monitoring	Observation	AZ NUCLEAR POWER	0	0			Registry
			C-01-06 02BCC	502318	Monitoring	Observation	AZ NUCLEAR POWER	100	4		1982	Registry
			C-01-06 02BCC	502319	Monitoring	Observation	AZ NUCLEAR POWER	100	4		1982	Registry
			C-01-06 03ACA	519356	Test	Piezometer	AZ PUBLIC SERVICE	35	6		1987	Registry
			C-01-06 03ACA	519371	Test	Piezometer	AZ PUBLIC SERVICE	15	6		1987	Registry

Table 4. Complete Inventory of Wells for Township 1 South, Range 6 West
Arlington Valley Energy Facility, Arlington Valley, Arizona

Category	Duke Parcel	Duke Well ID	Cadastral Location	Registration Number	Water Use	Site Use	Owner	Depth (feet)	Diameter (inches)	Perforated Interval (feet)	Year Constructed	Source
Palo Verde Wells			C-01-06 03ACC	502306	Monitoring	Abandoned	AZ NUCLEAR POWER	47	4		1982	Registry
			C-01-06 03ADA	519357	Test	Piezometer	AZ PUBLIC SERVICE	36	6		1987	Registry
			C-01-06 03ADA	519372	Test	Piezometer	AZ PUBLIC SERVICE	15	6		1987	Registry
			C-01-06 03BAD	613281	Monitoring	Observation	AZ PUBLIC SERVICE	45	2		1977	Registry
			C-01-06 03BBA	502327	Monitoring	Observation	AZ NUCLEAR POWER	75	7		1982	Registry
			C-01-06 03BBA	613277	Monitoring	Observation	AZ PUBLIC SERVICE	41	2		1977	Registry
			C-01-06 03BBB	613276	Monitoring	Observation	AZ PUBLIC SERVICE	48	2		1977	Registry
			C-01-06 03BBB2	613251	Unused	Observation	APS	75	4	30 - 75	1976	GWSI; Registry
			C-01-06 03BBB3	613273	Unused	Observation	APS	49	2	37 - 49	1977	GWSI
			C-01-06 03BBC	613280	Monitoring	Observation	AZ PUBLIC SERVICE	30	2		1977	Registry
			C-01-06 03BBC		Unused	Observation	APS	44		22 - 42	1978	GWSI
			C-01-06 03BBD	502329	Monitoring	Observation	AZ NUCLEAR POWER	60	4		1982	Registry
			C-01-06 03BBD	613274	Monitoring	Observation	AZ PUBLIC SERVICE	41	2		1977	Registry
			C-01-06 03BBD	613282	Monitoring	Observation	AZ PUBLIC SERVICE	45	2		1977	Registry
			C-01-06 03BBD	613283	Monitoring	Observation	AZ PUBLIC SERVICE	44	8		1978	Registry
			C-01-06 03BBD	613284	Monitoring	Observation	AZ PUBLIC SERVICE	41	3		1978	Registry
			C-01-06 03BBD	613285	Monitoring	Observation	AZ PUBLIC SERVICE	47	3		1978	Registry
			C-01-06 03BBD	613286	Monitoring	Observation	AZ PUBLIC SERVICE	44	3		1978	Registry

Table 4. Complete Inventory of Wells for Township 1 South, Range 6 West
Arlington Valley Energy Facility, Arlington Valley, Arizona

Category	Duke Parcel	Duke Well ID	Cadastral Location	Registration Number	Water Use	Site Use	Owner	Depth (feet)	Diameter (inches)	Perforated Interval (feet)	Year Constructed	Source
Palo Verde Wells			C-01-06 03BBD	613287	Monitoring	Observation	AZ PUBLIC SERVICE	41	3		1978	Registry
			C-01-06 03BBD	613288	Monitoring	Observation	AZ PUBLIC SERVICE	44	3		1978	Registry
			C-01-06 03BBD	613289	Monitoring	Observation	AZ PUBLIC SERVICE	41	3		1978	Registry
			C-01-06 03BCB	502177	Monitoring	Observation	ANPP	0	0			Registry
			C-01-06 03BCD	502169	Monitoring	Observation	ANPP	0	0			Registry
			C-01-06 03BDA	613278	Monitoring	Observation	AZ PUBLIC SERVICE	61	2		1977	Registry
			C-01-06 03BDA	613279	Monitoring	Observation	AZ PUBLIC SERVICE	44	2		1977	Registry
			C-01-06 03BDA	613290	Monitoring	Observation	AZ PUBLIC SERVICE	44	3		1978	Registry
			C-01-06 03BDB	519348	Monitoring	Observation	AZ PUBLIC SERVICE	70	6		1987	Registry
			C-01-06 03BDB	519355	Test	Piezometer	AZ PUBLIC SERVICE	25	6		1987	Registry
			C-01-06 03BDB	519364	Monitoring	Observation	AZ PUBLIC SERVICE	70	6		1987	Registry
			C-01-06 03BDB	519370	Test	Piezometer	AZ PUBLIC SERVICE	15	6		1987	Registry
			C-01-06 03BDD		Unused	Observation	PVNGS	50		20 - 50	1973	GWSI
			C-01-06 03CAC	519351	Monitoring	Observation	AZ PUBLIC SERVICE	130	6		1987	Registry
			C-01-06 03CAC	519367	Monitoring	Observation	AZ PUBLIC SERVICE	130	6		1987	Registry
			C-01-06 03CBD	502170	Monitoring	Observation	ANPP	0	0			Registry
			C-01-06 03CCA	502167	Monitoring	Observation	ANPP	0	0			Registry
			C-01-06 03CCC	502307	Monitoring	Observation	AZ NUCLEAR POWER	62	4		1982	Registry
			C-01-06 03CCD	502171	Monitoring	Observation	ANPP	0	0			Registry

Table 4. Complete Inventory of Wells for Township 1 South, Range 6 West
Arlington Valley Energy Facility, Arlington Valley, Arizona

Category	Duke Parcel	Duke Well ID	Cadastral Location	Registration Number	Water Use	Site Use	Owner	Depth (feet)	Diameter (inches)	Perforated Interval (feet)	Year Constructed	Source
Palo Verde Wells			C-01-06 03CDC	519362	Test	Piezometer	AZ PUBLIC SERVICE	40	6		1987	Registry
			C-01-06 03CDC	519375	Test	Piezometer	AZ PUBLIC SERVICE	15	6		1987	Registry
			C-01-06 03DAA	519358	Test	Piezometer	AZ PUBLIC SERVICE	31	6		1987	Registry
			C-01-06 03DAA	519373	Test	Piezometer	AZ PUBLIC SERVICE	15	6		1987	Registry
			C-01-06 03DAC	519359	Test	Piezometer	AZ PUBLIC SERVICE	45	6		1987	Registry
			C-01-06 03DAC	519374	Test	Piezometer	AZ PUBLIC SERVICE	15	6		1987	Registry
			C-01-06 03DCC	519350	Monitoring	Observation	AZ PUBLIC SERVICE	100	6		1987	Registry
			C-01-06 03DCC	519361	Test	Piezometer	AZ PUBLIC SERVICE	50	6		1987	Registry
			C-01-06 03DCC	519366	Monitoring	Observation	AZ PUBLIC SERVICE	85	6		1987	Registry
			C-01-06 03DCC	519376	Test	Piezometer	AZ PUBLIC SERVICE	15	6		1987	Registry
			C-01-06 03DDB	86024	Monitoring	Abandoned	ANPP	24	4		1980	Registry
			C-01-06 03DDB	86037	Monitoring	Abandoned	ANPP	45	4		1980	Registry
			C-01-06 03DDB	519349	Monitoring	Observation	AZ PUBLIC SERVICE	110	6		1987	Registry
			C-01-06 03DDB	519365	Monitoring	Observation	AZ PUBLIC SERVICE	80	6		1987	Registry
			C-01-06 03DDC	519360	Test	Piezometer	AZ PUBLIC SERVICE	49	6		1987	Registry
			C-01-06 03DDC	519377	Test	Piezometer	AZ PUBLIC SERVICE	15	6		1987	Registry
			C-01-06 03DDD	86030	Monitoring	Observation	ANPP	65	4		1980	Registry
			C-01-06 03DDD	86031	Monitoring	Observation	ANPP	27	4		1980	Registry

Table 4. Complete Inventory of Wells for Township 1 South, Range 6 West
Arlington Valley Energy Facility, Arlington Valley, Arizona

Category	Duke Parcel	Duke Well ID	Cadastral Location	Registration Number	Water Use	Site Use	Owner	Depth (feet)	Diameter (inches)	Perforated Interval (feet)	Year Constructed	Source
Palo Verde Wells			C-01-06 03DDD	502172	Monitoring	Observation	ANPP	0	0			Registry
			C-01-06 03DDD	502301	Monitoring	Observation	AZ NUCLEAR POWER	82	4		1982	Registry
			C-01-06 03DDD		Unused	Observation	PVNGS	50		20 - 50	1973	GWSI
			C-01-06 04AAD	613263	Unused	Observation	APS	41	3	23 - 41	1978	GWSI; Registry
			C-01-06 04AAD	613272	Monitoring	Observation	AZ PUBLIC SERVICE	36	2		1977	Registry
			C-01-06 04AAD	613275	Monitoring	Observation	AZ PUBLIC SERVICE	41	2		1977	Registry
			C-01-06 04ACC	502175	Monitoring	Observation	ANPP	0	0			Registry
			C-01-06 04ACC	502310	Monitoring	Observation	AZ NUCLEAR POWER	63	4		1982	Registry
			C-01-06 04ACC	502311	Monitoring	Observation	AZ NUCLEAR POWER	65	4		1982	Registry
			C-01-06 04ADA	613264	Monitoring	Observation	AZ PUBLIC SERVICE	42	3		1978	Registry
			C-01-06 04ADB	502176	Monitoring	Observation	ANPP	0	0			Registry
			C-01-06 04ADB	502316	Monitoring	Abandoned	AZ NUCLEAR POWER	130	4		1982	Registry
			C-01-06 04ADB	502317	Monitoring	Abandoned	AZ NUCLEAR POWER	130	4		1982	Registry
			C-01-06 04ADB	502325	Monitoring	Observation	AZ NUCLEAR POWER	80	4		1982	Registry
			C-01-06 04BDB	502324	Monitoring	Observation	AZ NUCLEAR POWER	80	4		1982	Registry
			C-01-06 04BDC	502314	Monitoring	Observation	AZ NUCLEAR POWER	100	4		1982	Registry
			C-01-06 04BDC	502315	Monitoring	Observation	AZ NUCLEAR POWER	100	4		1982	Registry
			C-01-06 04CBB	502312	Monitoring	Observation	AZ NUCLEAR POWER	100	4		1982	Registry

Table 4. Complete Inventory of Wells for Township 1 South, Range 6 West
Arlington Valley Energy Facility, Arlington Valley, Arizona

Category	Duke Parcel	Duke Well ID	Cadastral Location	Registration Number	Water Use	Site Use	Owner	Depth (feet)	Diameter (inches)	Perforated Interval (feet)	Year Constructed	Source
Palo Verde Wells			C-01-06 04CBB	502313	Monitoring	Observation	AZ NUCLEAR POWER	100	4		1982	Registry
			C-01-06 04DBC	502174	Monitoring	Observation	ANPP	0	0			Registry
			C-01-06 04DCC	502173	Monitoring	Observation	ANPP	0	0			Registry
			C-01-06 04DCC	613252	Monitoring	Observation	AZ PUBLIC SERVICE	94	4		1976	Registry
			C-01-06 09DDD	523299	Monitoring	Monitor	AZ PUBLIC SERVICE	270	8		1989	Registry
			C-01-06 10ACC	502322	Monitoring	Observation	AZ NUCLEAR POWER	102	4		1982	Registry
			C-01-06 10ACC	502323	Monitoring	Observation	AZ NUCLEAR POWER	102	4		1982	Registry
			C-01-06 10ADB	519352	Monitoring	Observation	AZ PUBLIC SERVICE	110	6		1987	Registry
			C-01-06 10ADB	519368	Monitoring	Observation	AZ PUBLIC SERVICE	110	6		1987	Registry
			C-01-06 10BAA	86022	Monitoring	Observation	ANPP	27	4		1980	Registry
			C-01-06 10BAA	86039	Monitoring	Observation	ANPP	47	4		1980	Registry
			C-01-06 10BAA	502308	Monitoring	Observation	AZ NUCLEAR POWER	67	4		1982	Registry
			C-01-06 10BAA		Unused	Observation	APS	50		20 - 50	1973	GWSI
			C-01-06 10BBB	86023	Monitoring	Observation	ANPP	58	4		1980	Registry
			C-01-06 10BBB	86038	Monitoring	Observation	ANPP	20	4		1980	Registry
			C-01-06 10BBB		Unused	Observation	APS	50		20 - 50	1973	GWSI
			C-01-06 10BCB	502320	Monitoring	Observation	AZ NUCLEAR POWER	102	4		1982	Registry
			C-01-06 10BCB	502321	Monitoring	Observation	AZ NUCLEAR POWER	102	4		1982	Registry

Table 5. Available Water Quality Information for Existing On-Site Production Wells
Arlington Valley Energy Facility, Arlington Valley, Arizona

Class	Analyte	Method	Units	Well	4-1	4-1	4-1	4-2	7-1	7-1	7-1	8-1	8-1	8-1
				Depth	480	620	Discharge	Discharge	370	450	Discharge	760	900	Discharge
				Sample ID	4-1-480	4-1-620	4-1-Discharge	4-2-Discharge	7-1-370	7-1-450	7-1-Discharge	8-1-760	8-1-900	8-1-Discharge
Organics	VOCs	EPA 524.2	ug/L		ND	ND	Toluene = 0.52	ND	ND	ND	ND	-	ND	Toluene = 1.2 1,2,4-Trimethylbenzene = 2.2 1,3,5-Trimethylbenzene = 0.66 Total Xylenes = 0.93
	SVOCs	-	-		-	-	ND	ND	-	-	ND	-	-	ND
Metals	Antimony	EPA 200.9	mg/L		<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	-	<0.0080	<0.0040
	Arsenic	EPA 200.7	mg/L		0.062	0.09	-	-	-	-	-	-	-	-
	Arsenic	EPA 200.9	mg/L		-	-	0.046	0.042	0.017	0.019	0.015	-	0.078	0.079
	Barium	EPA 200.7	mg/L		0.016	0.012	0.016	0.016	0.014	<0.010	<0.010	-	<0.010	<0.010
	Beryllium	EPA 200.7	mg/L		<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	-	<0.0040	<0.0040
	Cadmium	EPA 200.7	mg/L		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-	<0.0050	<0.0050
	Calcium	EPA 200.7	mg/L		60	74	94	56	16	15	14	-	37	37
	Chromium	EPA 200.7	mg/L		0.04	0.091	-	-	-	-	-	-	-	-
	Chromium	EPA 200.9	mg/L		-	-	0.024	0.027	0.015	0.016	0.018	-	0.047	0.043
	Copper	EPA 200.7	mg/L		<0.020	<0.020	0.021	<0.020	<0.020	<0.020	<0.020	-	<0.020	<0.020
	Iron	EPA 200.7	mg/L		0.74	1.6	<0.10	0.88	<0.10	<0.10	0.13	-	0.68	0.24
	Lead	EPA 200.9	mg/L		<0.0020	0.0034	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	-	<0.0040	<0.0020
	Magnesium	EPA 200.7	mg/L		11	6.5	16	10	5.9	4.9	4.9	-	5.1	5.3
	Manganese	EPA 200.7	mg/L		<0.020	0.029	<0.020	<0.020	<0.020	<0.020	<0.020	-	<0.020	<0.020
	Mercury	EPA 245.1	mg/L		<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	-	<0.00020	<0.00020
	Nickel	EPA 200.7	mg/L		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	-	<0.050	<0.050
	Potassium	EPA 258.1	mg/L		4.5	4.1	4.4	4.7	4.7	4.7	4.2	-	4.3	4.2
	Selenium	EPA 200.9	mg/L		<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	-	<0.0040	<0.0040
	Sodium	EPA 273.1	mg/L		420	400	460	530	310	320	270	-	190	410
	Thallium	EPA 200.9	mg/L		<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	-	<0.0020	<0.0020
	Zinc	EPA 200.7	mg/L		0.36	0.51	<0.050	<0.050	0.12	0.084	<0.050	-	0.12	<0.050
Inorganics	Alkalinity (as CaCO3)	SM2320B	mg/L		96	45	91	110	110	110	120	81	80	80
	Bicarbonate Alkalinity (as CaCO3)	SM2320B	mg/L		96	45	91	110	110	110	120	81	80	80
	Carbonate Alkalinity (as CaCO3)	SM2320B	mg/L		<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
	Chloride	EPA 300.0	mg/L		480	470	550	580	320	340	280	430	460	450
	Fluoride	EPA 300.0	mg/L		5.9	6	5.5	7.1	5.7	6.8	6.2	6.6	6.6	6.6
	Hydroxide Alkalinity	SM2320B	mg/L		<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
	Nitrate (as N)	EPA 300.0	mg/L		1.3	1.2	5.2	14	1.33	1.36	1.8	1.6	1.6	1.6
	Nitrate/Nitrite (as N)	EPA 300.0	mg/L		-	-	-	-	-	-	-	1.6	1.6	1.6
	Nitrite (as N)	EPA 300.0	mg/L		<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
	Phosphorus	EPA 365.3	mg/L		<0.50	<0.50	<5.0	<5.0	<0.25	<0.25	<0.50	<0.050	<0.050	<0.050
	Sulfate	EPA 300.0	mg/L		320	310	360	320	170	170	150	250	260	260
	TDS	SM2540C	mg/L		1500	1400	1700	1700	970	1000	900	1300	1300	1300
	TKN	SM4500-N-O,C	mg/L		<0.50	<0.50	-	-	<0.50	2.8	<0.50	-	0.56	<0.50
Biological	Total Coliform	SM9223B	P/A		Present	Present	Present	Present	Present	Present	Present	-	Present	Present
	E.Coli	SM9223B	P/A		Absent	Absent	Absent	Absent	Absent	Absent	Absent	-	Absent	Absent

Table 5. Available Water Quality Information for Existing On-Site Production Wells
Arlington Valley Energy Facility, Arlington Valley, Arizona

Class	Analyte	Method	Units	Well Depth Sample ID	4-1 480 4-1-480	4-1 620 4-1-620	4-1 Discharge 4-1-Discharge	4-2 Discharge 4-2-Discharge	7-1 370 7-1-370	7-1 450 7-1-450	7-1 Discharge 7-1-Discharge	8-1 760 8-1-760	8-1 900 8-1-900	8-1 Discharge 8-1-Discharge
Radiochemical	Gross Alpha	600/00-02	pCi/L		-	-	4.1 ± 1.0	5.0 ± 1.1	-	-	2.5 ± 0.5	-	-	<1.0
	Gross Beta	900	pCi/L		-	-	<3.6	<3.6	-	-	<4.2	-	-	25.8 ± 1.6
	Radium 226	903.1	pCi/L		-	-	<0.5	<0.4	-	-	<0.9	-	-	<0.5
	Radium 228	904	pCi/L		-	-	<0.4	<0.4	-	-	<0.3	-	-	<0.3
	Total Radium	-	pCi/L		-	-	<0.5	<0.4	-	-	<1.0	-	-	<0.9
	Total Uranium	00-07	pCi/L		-	-	3.1 ± 0.4	4.5 ± 0.5	-	-	3.3 ± 0.5	-	-	1.4 ± 0.5

Table 6. Historical Analytical Model of Regional Response to Groundwater Extraction
Arlington Valley Energy Facility, Arlington Valley, Arizona

Right No.	Year Earliest Well Drilled	Approximate Irrigated Acreage*	Approximate Annual Water Use (acre-feet)**
100037.0001	1974	20	62
100105.0002	Unknown	60	186
100229.0002	Unknown	25	78
100291.0001	Unknown	20	62
100608.0000	Unknown	40	124
100902.0003	1980	260	806
101121.0001	1960	320	992
102369.0000	1958	380	1,178
103054.0001	Unknown	160	496
104995.0000	1947	650	2,015
105005.0000	1977	280	868
105414.0000	Unknown	650	2,015
106422.0001	Unknown	40	124
106422.0002	Unknown	40	124
106422.0003	Unknown	40	124
106422.0004	Unknown	40	124
106422.0005	Unknown	40	124
106422.0006	Unknown	40	124
106422.0007	Unknown	40	124
106422.0008	Unknown	40	124
106981.0001	1954	60	186
107182.0000	1947	110	341
107183.0000	Unknown	200	620
107804.0001	Unknown	1,750	5,425
107805.0001	1978	400	1,240
108354.0003	1974	360	1,116
109909.0001	1953	320	992
111348.0002	1954	880	2,728
112193.0000	1975	640	1,984
115649.0001	Unknown	20	62
116602.0001	1942	80	248
117240.0002	1973	80	248
130196.0000	Unknown	30	93
130197.0000	Unknown	50	155
130493.0000	Unknown	80	248
130754.0000	Unknown	40	124
130755.0000	Unknown	10	31

Approximate Annual Pumpage Prior to 1980 =	**25,715**	**Acre-Feet**
Amount of Regional Drawdown to 1980 =	**80**	**Feet**
Long-Term Regional Response to Groundwater Pumpage =	**3.1**	**Feet**
(Feet of Drawdown per 1,000 Acre-feet/year of Groundwater Extracted)		
Expected Long-Term Regional Response to Plant Pumpage (7,800 Acre-feet/year) =	**24**	**Feet**

Table 6. Historical Analytical Model of Regional Response to Groundwater Extraction
Arlington Valley Energy Facility, Arlington Valley, Arizona

Taken from 1986 and 1992 aerial photographs and ADWR maps of extent of groundwater rights

** Average water use per acre calculated as follows

Parcel No.	Irrigation Right	1986 Reported Groundwater Usage (acre-feet)	1986 Irrigated Acreage (from aerial photograph)	1992 Reported Groundwater Usage (acre-feet)	1992 Irrigated Acreage (from aerial photograph)	Calculated Water Use (acre-feet/acre)
1	8-105414.000	1137	504	-	-	2.3
2	8-104995.000	-	-	1702	471	3.6
4	8-102369.000	973	288	-	-	3.4
					Average Water Use Per Acre =	**3.1**

Table 7. Results of Groundwater Flow Modeling
Arlington Valley Energy Facility
Arlington Valley, Arizona

Modeling Run	Pumpage Used (Acre-feet/year)[1]	Hydraulic Conductivity Used (feet/day)[2]	Duration of Transient Run (Years)	Maximum Drawdown (feet)	Approximate Radius of 10-Foot Drawdown (Miles from Parcel Boundary)
1	7,800	21	30	31.67	3.4
2	1,000	21	30	4.02	-

[1] Total allotment obtained from Type I IGRs

[2] Calculated by ADWR for facility well spacing analysis (April 2001)

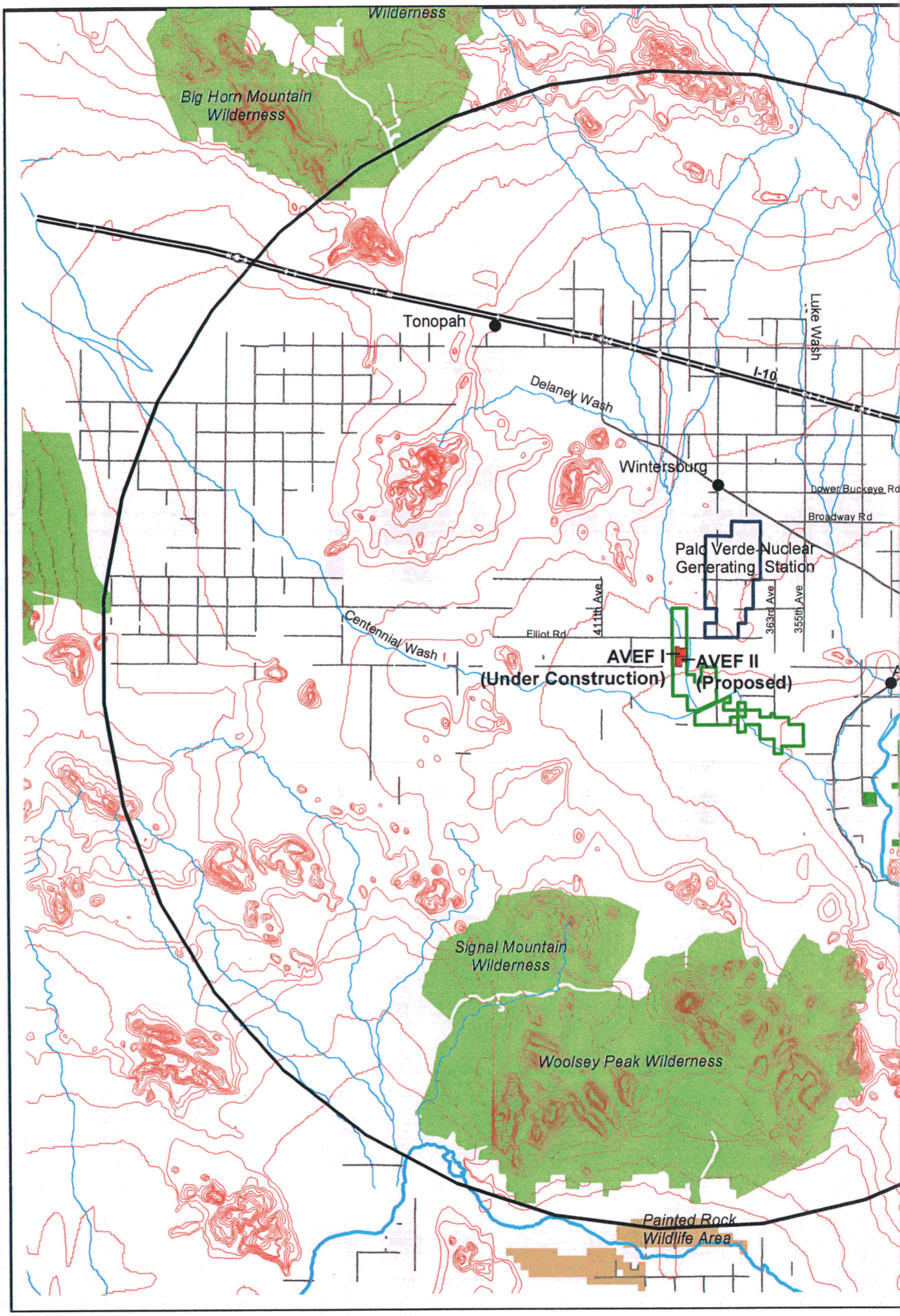
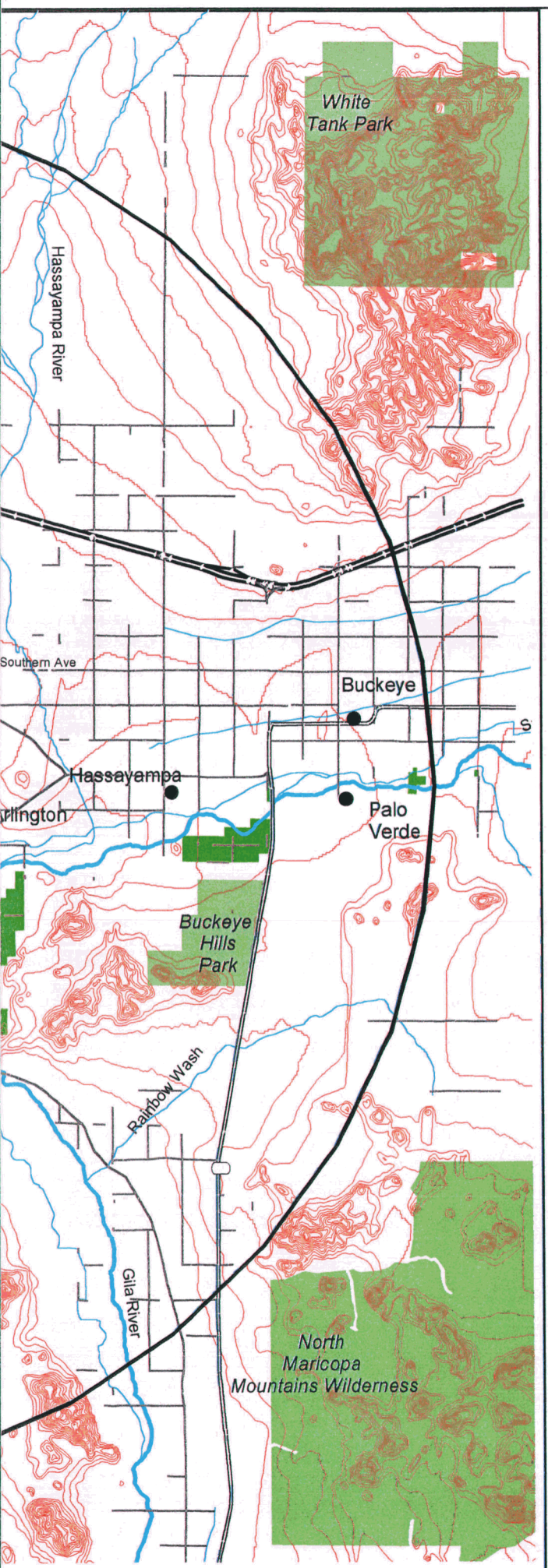

Wilderness
Big Horn Mountain Wilderness
Tonopah
I-10
Luke Wash
Delaney Wash
Wintersburg
Lower Buckeye Rd
Broadway Rd
Palo Verde Nuclear Generating Station
411th Ave
363rd Ave
355th Ave
Centennial Wash
Elliot Rd
AVEF I
(Under Construction)
AVEF II
(Proposed)
Signal Mountain Wilderness
Woolsey Peak Wilderness
Painted Rock Wildlife Area

Figure 1:

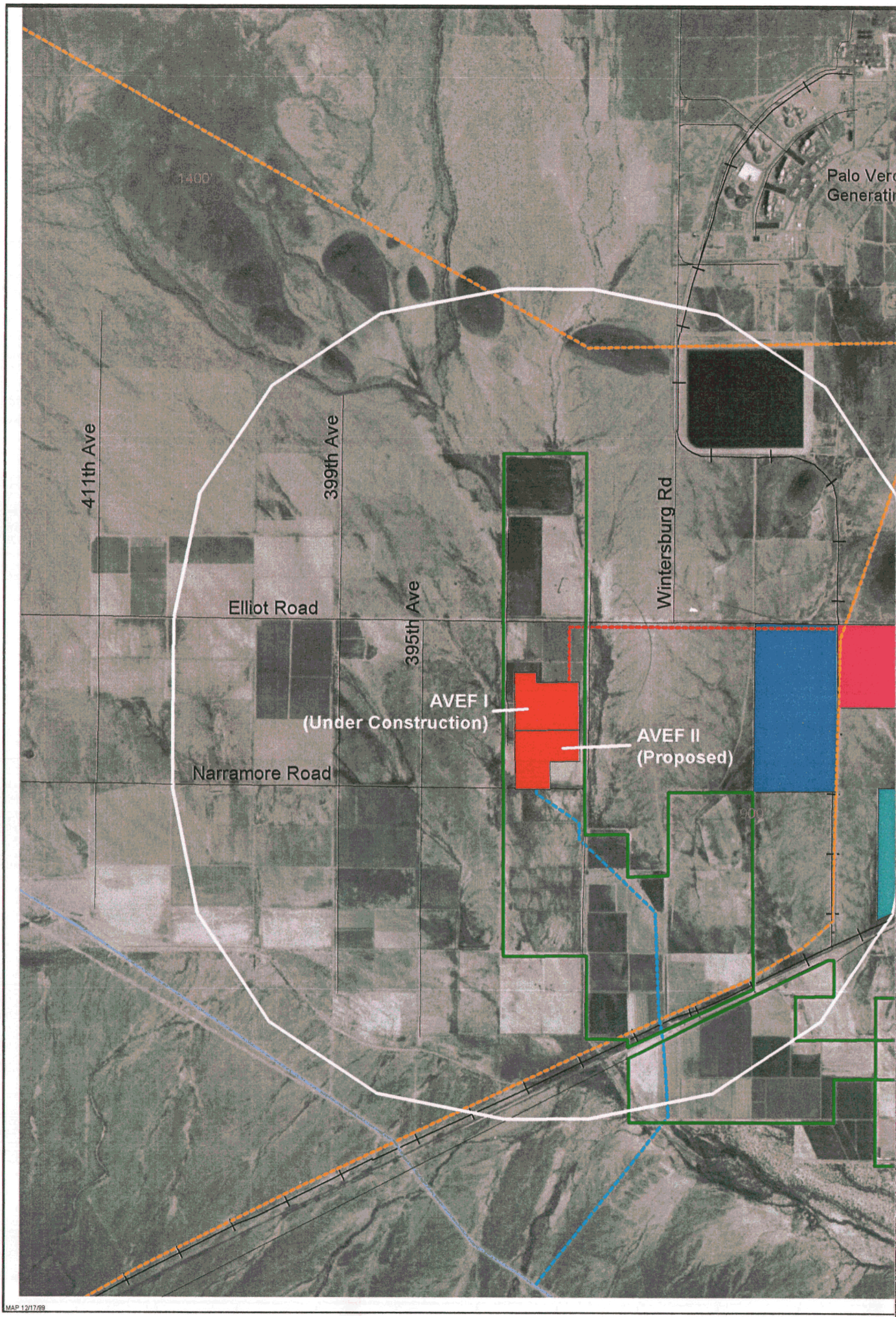
Site Location



- Arlington Valley Energy Facility
- Duke Properties
- Palo Verde Nuclear Generating Station
- Elevation Contours
- Rivers and Washes
- Cities and Towns
- 20-mile Radius
- Streets
- BLM Wilderness Areas
- Parks and Recreation
- Game and Fish
- Painted Rock Wildlife Area

0 1 2 3 4 5
Miles

Duke Energy


Palo Verde
Generati
411th Ave
399th Ave
395th Ave
Wintersburg Rd
Elliot Road
Narramore Road
AVEF I
(Under Construction)
AVEF II
(Proposed)

MAP 12/17/99

Figure 2:

Site Plan

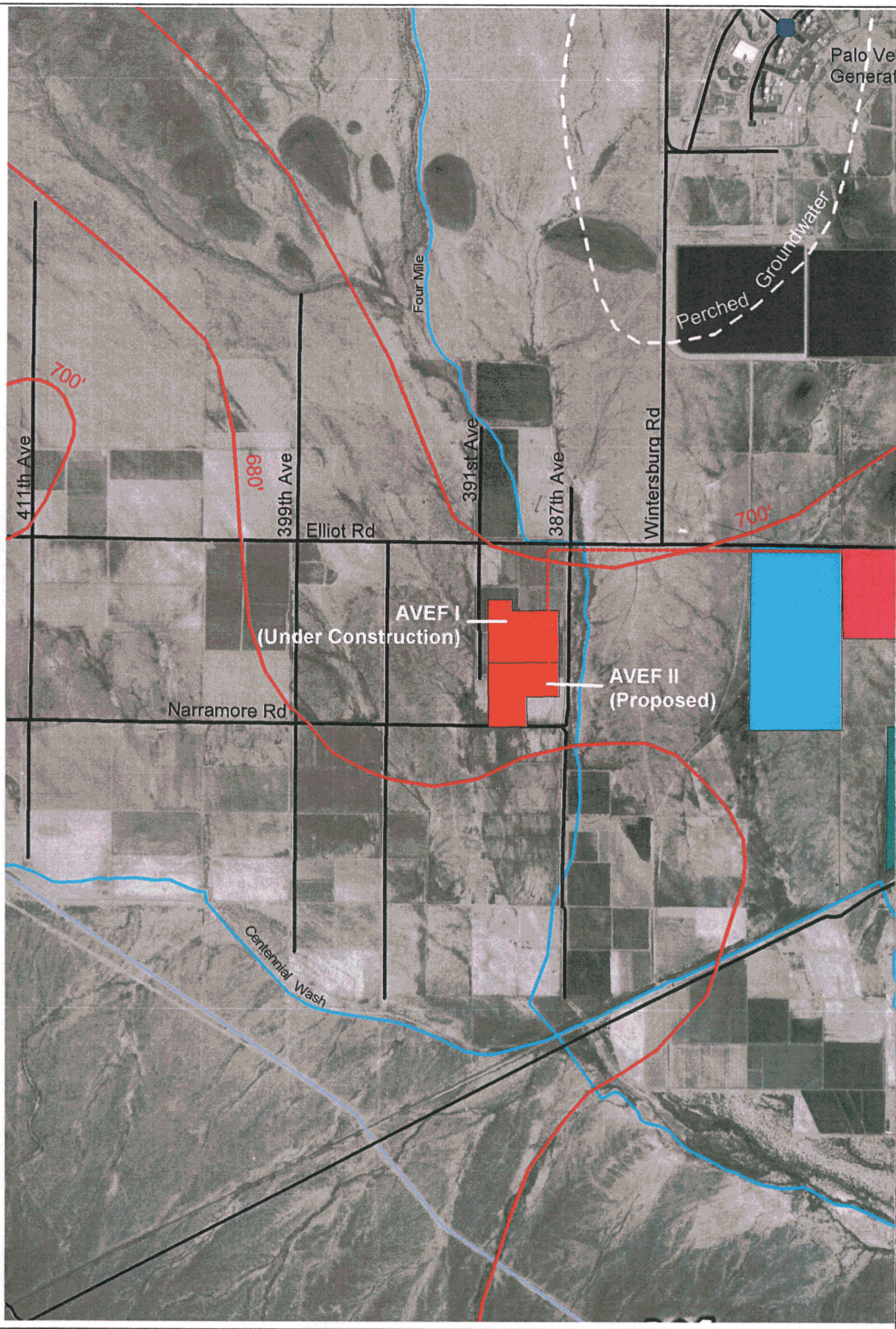
- Arlington Valley Energy Facility
- Hassayampa Switchyard (Under Construction)
- Redhawk Generating Station (Under Construction)
- Mesquite Generating Station (Approved)
- Duke Properties
- AVEF Transmission Line (Under Construction)
- Existing Transmission Lines
- AVEF Natural Gas Line (Approved)
- Existing Natural Gas Line
- Streets
- Area within 2 Miles of Project
- Large Lot Residential Land Use

Land use for the remainder of the area is Rural.

0 0.5 1
Miles

Duke Energy

Aerial photograph base from Landiscor, 1986


Palo Ve
Generat
Perched Groundwater
Four Mile
700'
680'
411th Ave
399th Ave
391st Ave
387th Ave
Wintersburg Rd
Elliot Rd
700'
AVEF I
(Under Construction)
AVEF II
(Proposed)
Narramore Rd
Centennial Wash

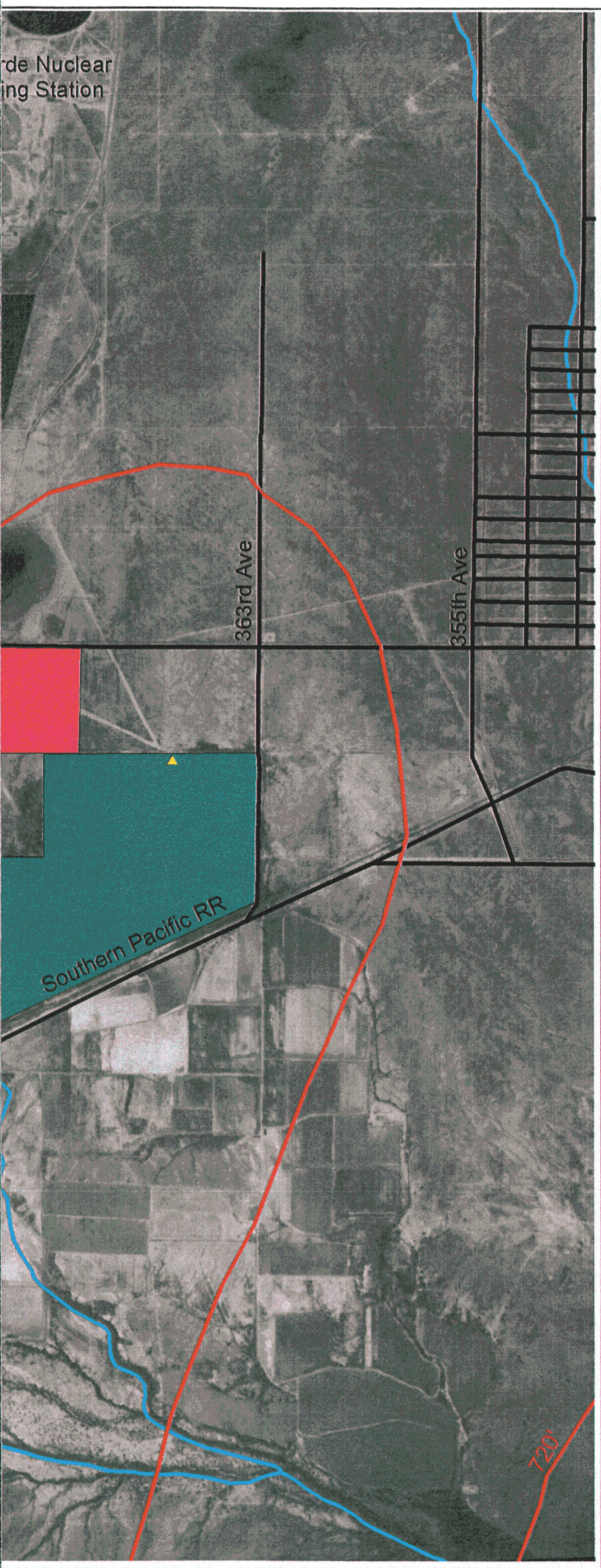


Figure 3:

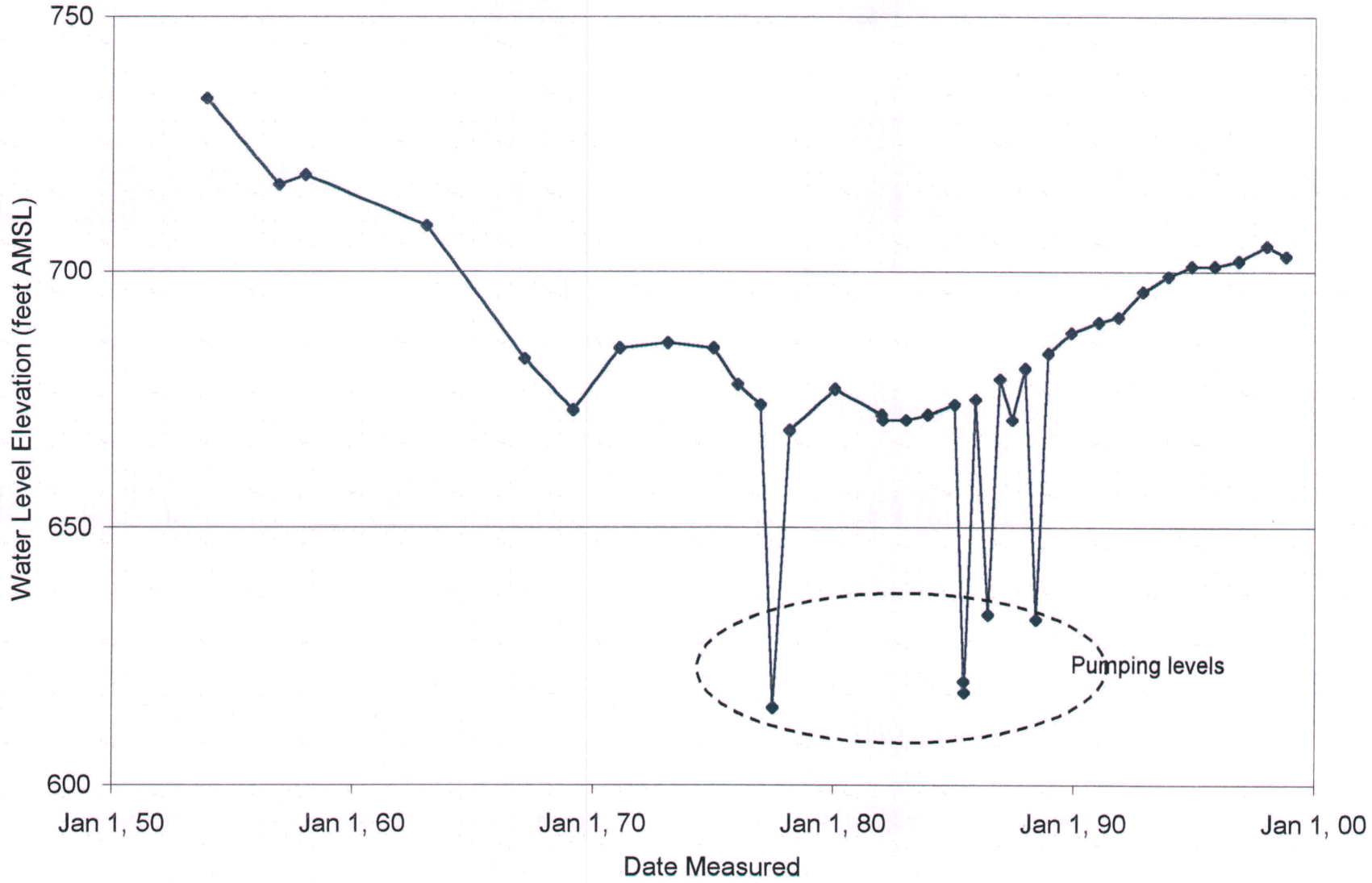
Regional Water Level Contours and Extent of Perched Aquifer

- Arlington Valley Energy Facility
- Hassayampa Switchyard (Under Construction)
- Redhawk Generating Station (Under Construction)
- Mesquite Generating Station (Approved)
- AVEF Transmission Line (Under Construction)
- Groundwater Elevation Contours (From APS, 1997)
- Approximate Area of Perched Groundwater
- Rivers and washes
- Streets
- Existing Natural Gas Line
- Palo Verde Nuclear Generating Station
- Location of Hydrographs Shown in Figures 4 and 5

0 0.5 1
Miles

Duke Energy

Aerial photograph base from Landiscor, 1986



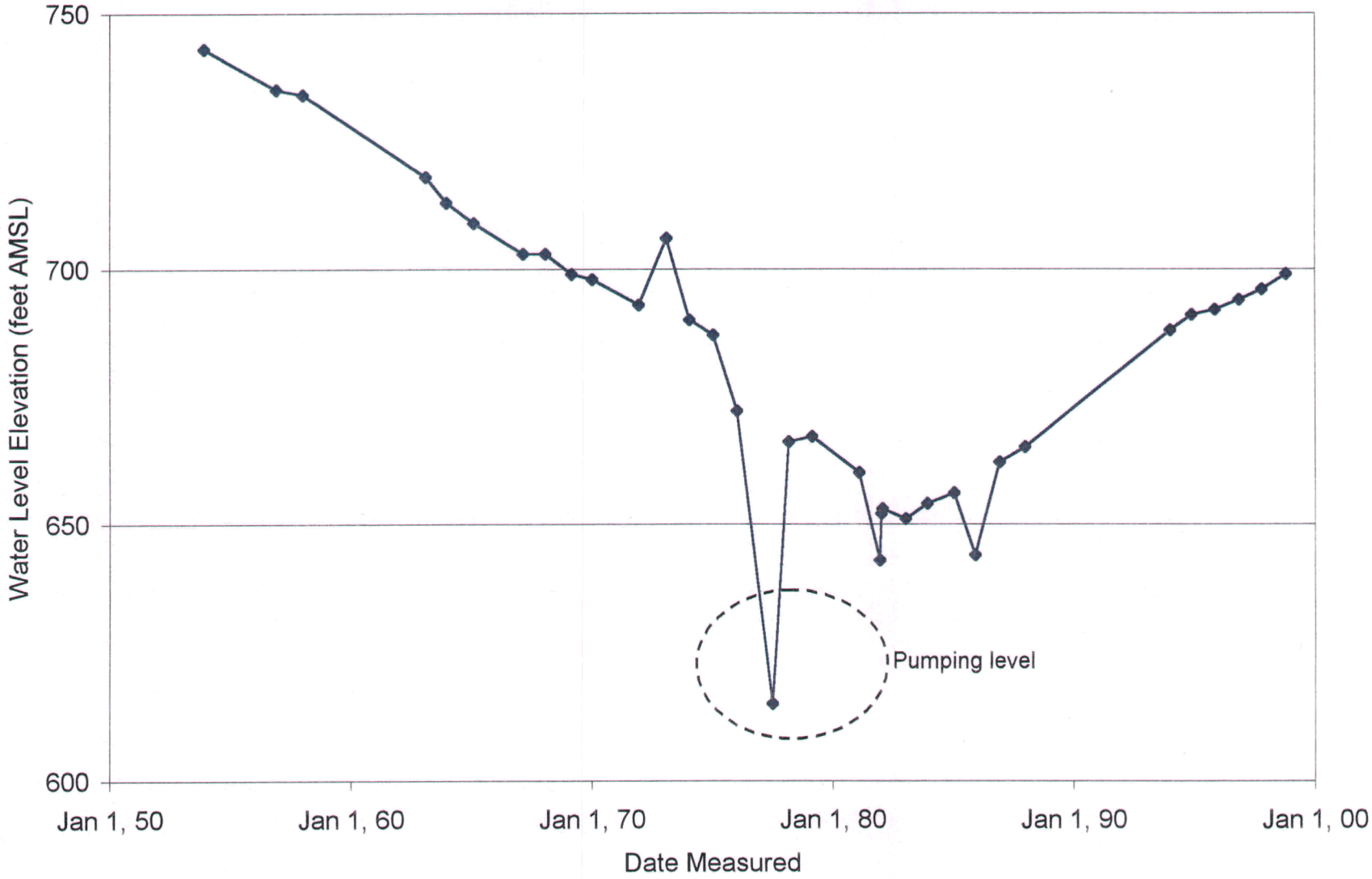
Duke Energy.

GROUNDWATER ELEVATIONS FOR WELL C-01-06 14DBB

Arlington Valley Energy Facility
Arlington Valley, Arizona

Figure

4



Duke Energy

GROUNDWATER ELEVATIONS FOR WELL C-01-06 18BBB

Arlington Valley Energy Facility
Arlington Valley, Arizona

Figure

5

Four Mile Wash
411th Ave
399th Ave
Elliot Rd
391st Ave
387th Ave
Wintersburg Rd
AVEF I
(Under Construction)
AVEF II
(Proposed)
Narramore Rd
Centennial Wash

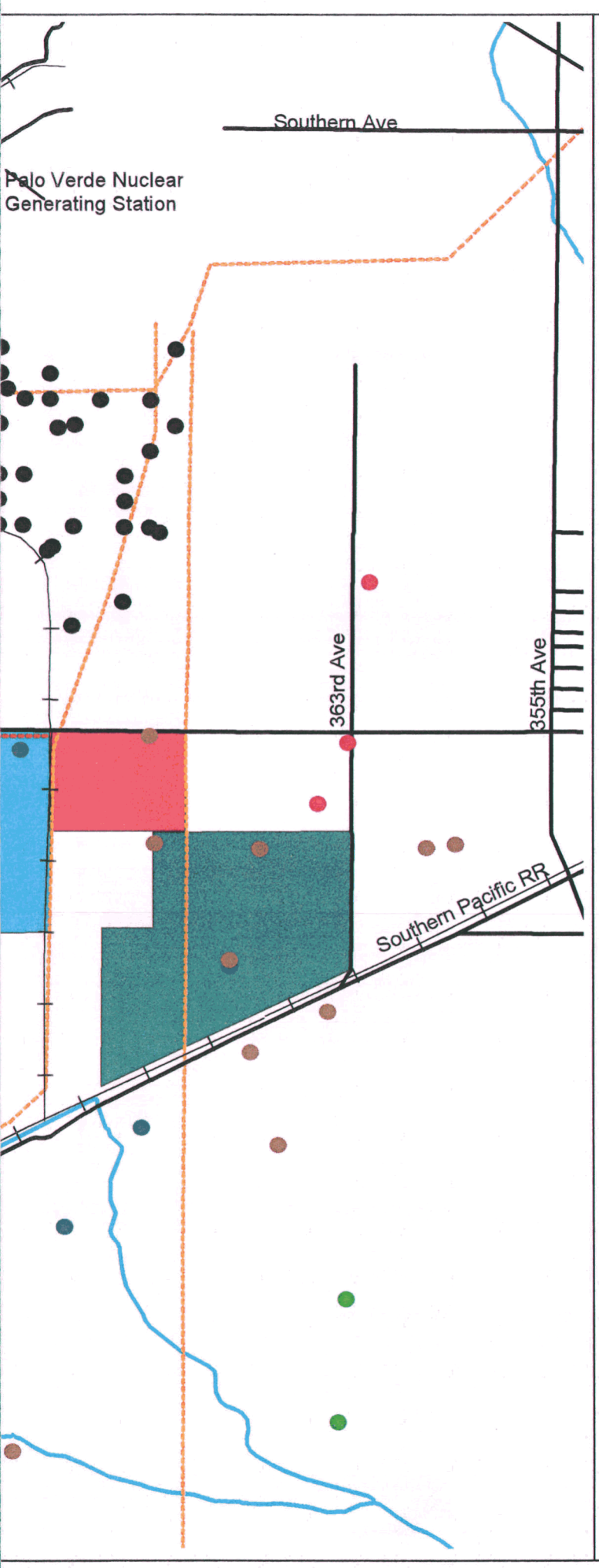


Figure 6:

Well Inventory

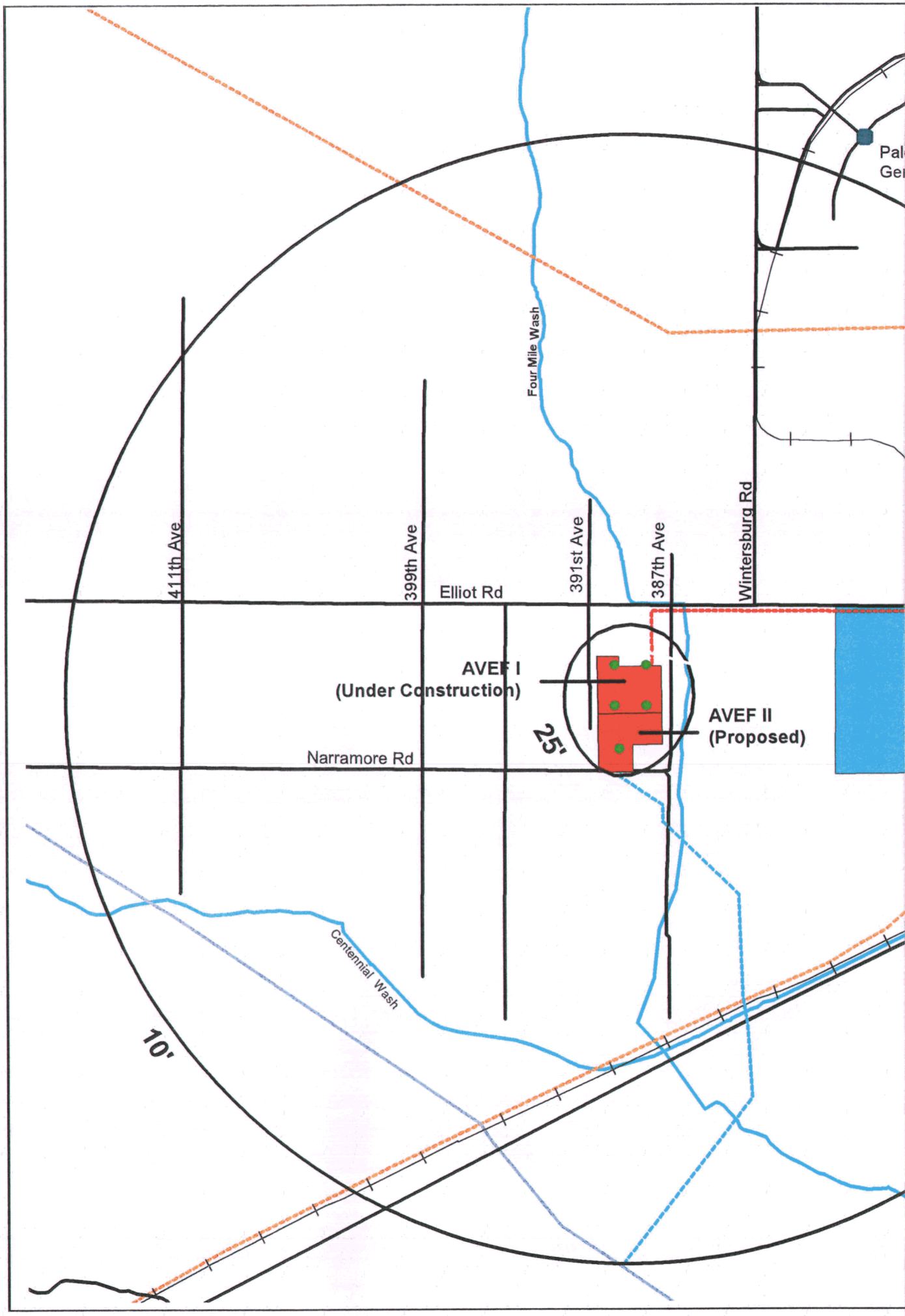
Wells

- Duke Well
- Irrigation/Stock Well
- Domestic Well
- Other Use
- Palo Verde Monitoring Well

- Arlington Valley Energy Facility
- Hassayampa Switchyard (Under Construction)
- Redhawk Generating Station (Under Construction)
- Mesquite Generating Station (Proposed)
- AVEF Transmission Line (Under Construction)
- Existing Transmission Lines
- AVEF Natural Gas Line (Approved)
- Existing Natural Gas Line
- Rivers and washes
- Streets
- Palo Verde Nuclear Generating Station

0 0.5 1
Miles

Duke Energy


Pal
Ger
Four Mile Wash
411th Ave
399th Ave
391st Ave
387th Ave
Wintersburg Rd
Elliot Rd
AVEF I
(Under Construction)
AVEF II
(Proposed)
25'
Narramore Rd
Centennial Wash
10'

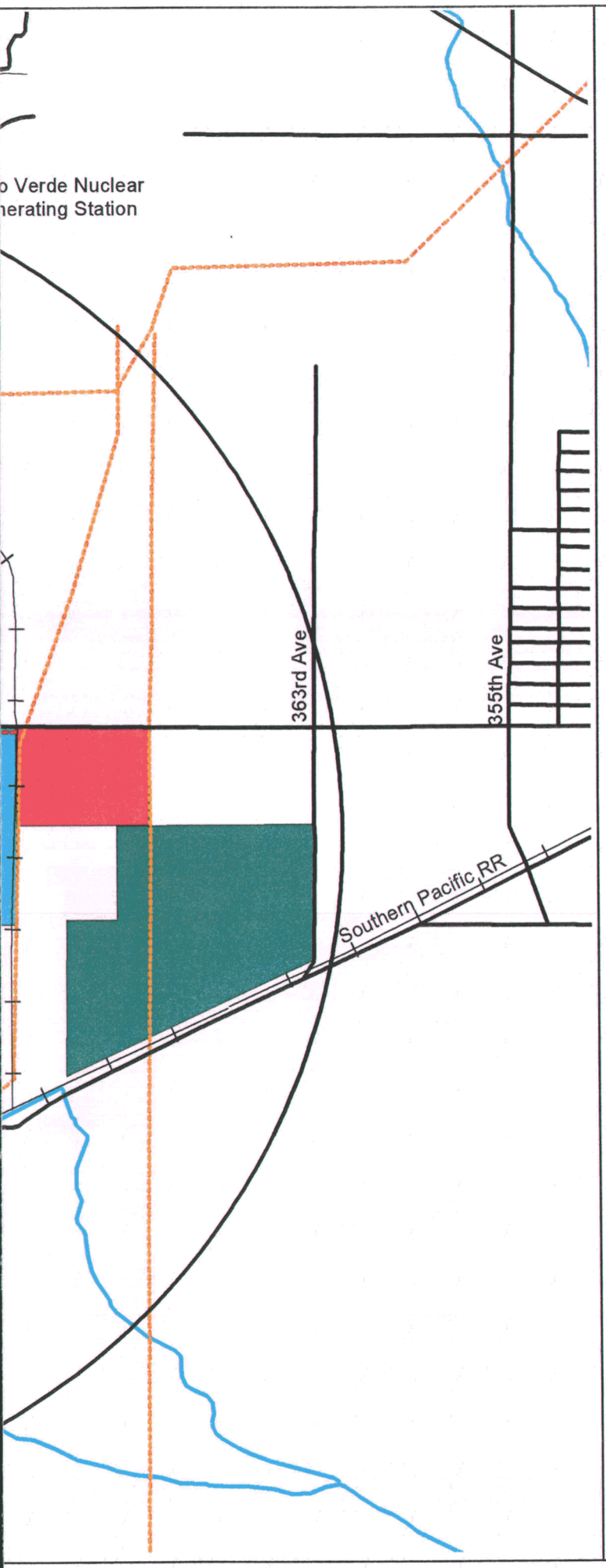


Figure 7:

Impact to Regional Groundwater Elevations (After 30 Years)

Drawdown Contours

Modeled with THWELLS℠ Version 4.01
Transient-state conditions at 30 years
Hydraulic Conductivity = 21 feet/day
Storage Coefficient = 0.1
Five wells pumping at 970 gpm each,
for a total of approximately 7,800 acre-feet/year

Future Duke Production Wells

Arlington Valley Energy Facility

Hassayampa Switchyard (Under Construction)

Redhawk Generating Station (Under Construction)

Mesquite Generating Station (Approved)

AVEF Transmission Line (Under Construction)

Existing Transmission Lines

AVEF Natural Gas Line (Approved)

Existing Natural Gas Line

Rivers and washes

Streets

Palo Verde Nuclear Generating Station

0 0.5 1
Miles

Duke Energy℠

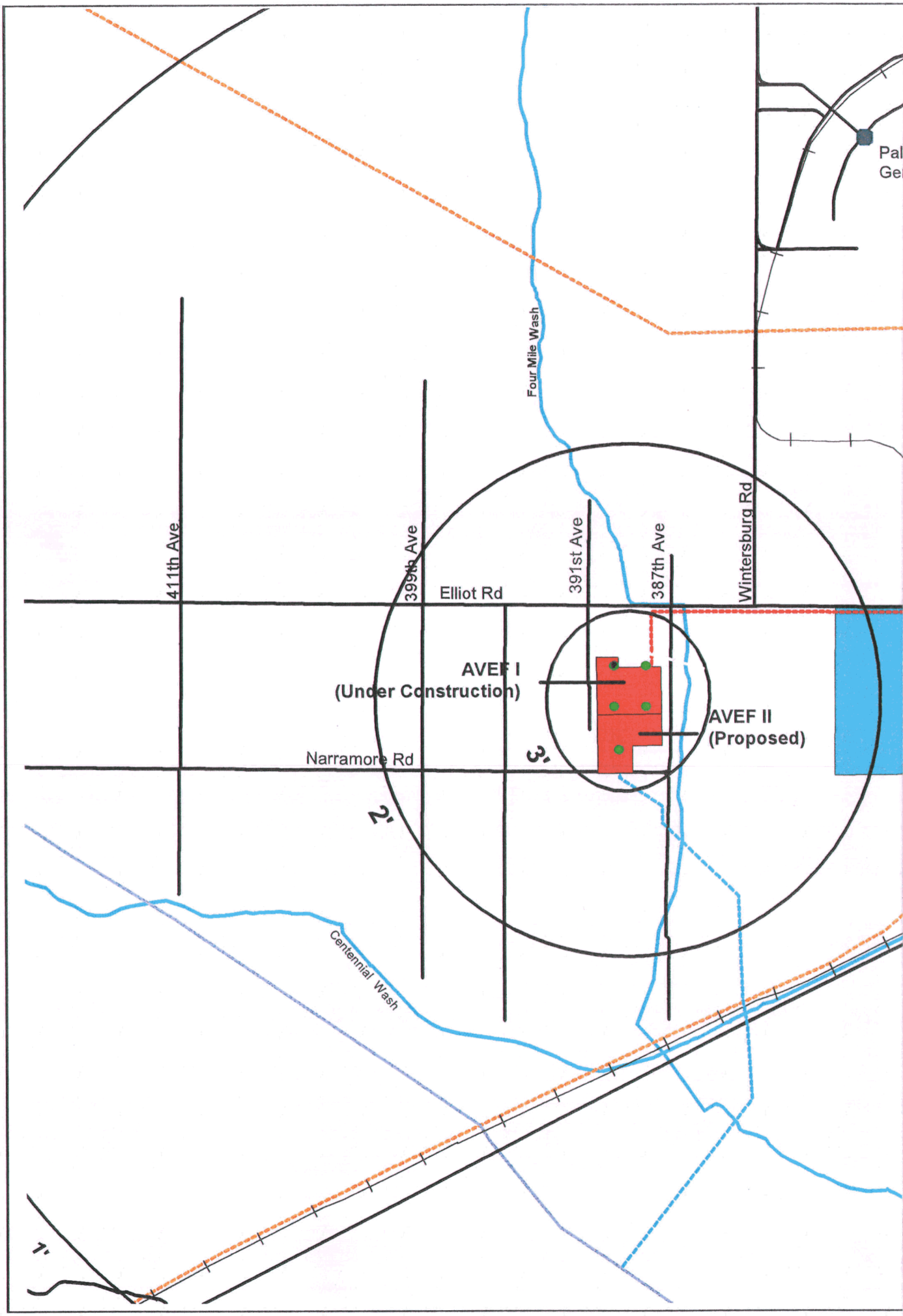

Pal
Ge
Four Mile Wash
411th Ave
399th Ave
391st Ave
387th Ave
Wintersburg Rd
Elliot Rd
AVEF I
(Under Construction)
AVEF II
(Proposed)
Narramore Rd
3'
2'
1'
Centennial Wash

Figure 8:

Additional Impact Above Cumulative Model (After 30 Years)

Drawdown Contours

Modeled with THWELLS℠ Version 4.01
Transient-state conditions at 30 years
Hydraulic Conductivity = 21 feet/day
Storage Coefficient = 0.1
Five wells pumping at 120 gpm each,
for a total of approximately 1,000 acre-feet/year

Future Duke Production Wells

Arlington Valley Energy Facility

Hassayampa Switchyard (Under Construction)

Redhawk Generating Station (Under Construction)

Mesquite Generating Station (Approved)

AVEF Transmission Line (Under Construction)

Existing Transmission Lines

AVEF Natural Gas Line (Approved)

Existing Natural Gas Line

Rivers and washes

Streets

Palo Verde Nuclear Generating Station

0 0.5 1
Miles

Duke Energy℠

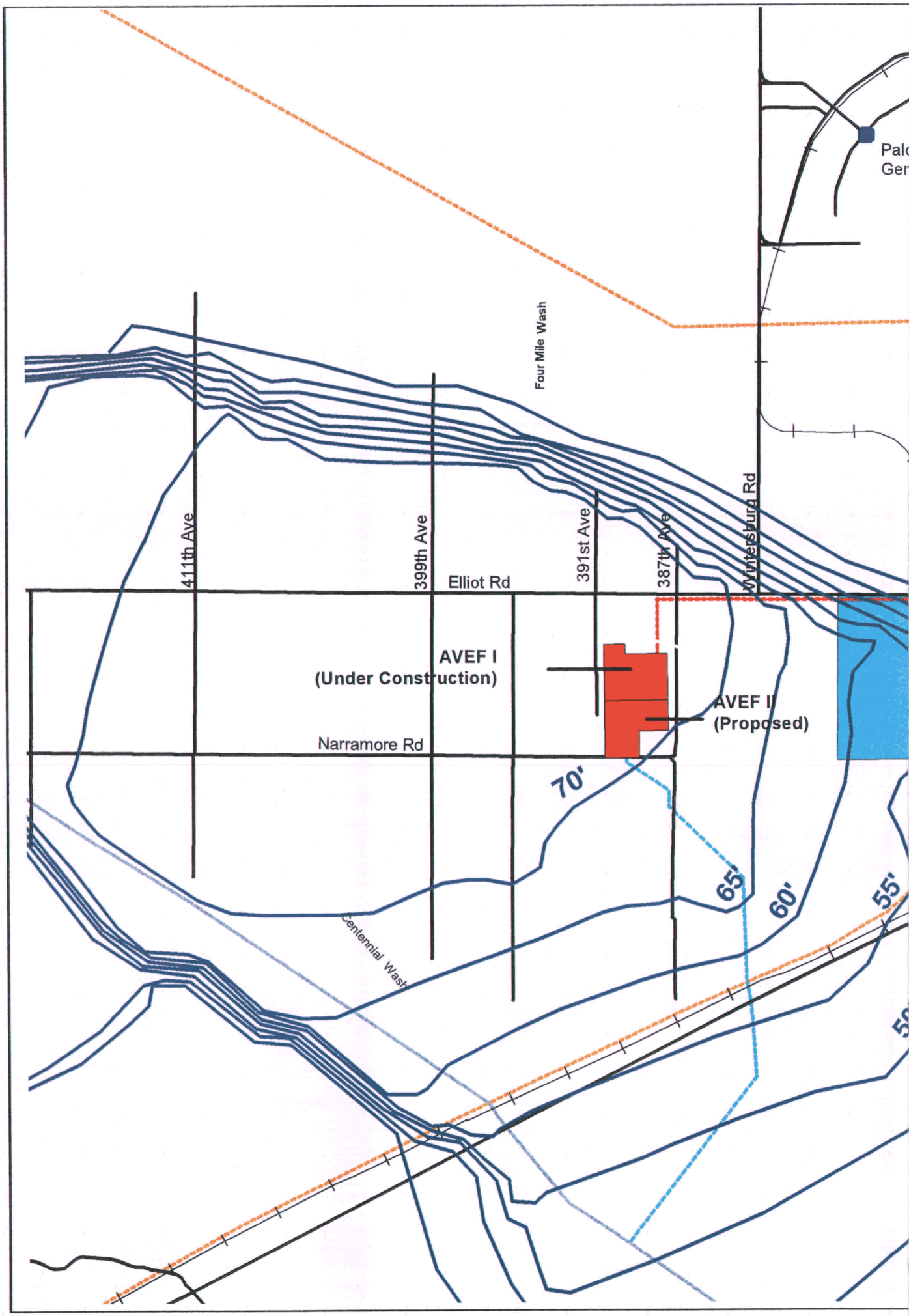

Four Mile Wash
411th Ave
399th Ave
391st Ave
387th Ave
Wintersburg Rd
Elliot Rd
Narramore Rd
AVEF I
(Under Construction)
AVEF II
(Proposed)
70'
65'
60'
55'
Centennial Wash

Figure 9:

Cumulative Impacts from Regional Model (After 30 Years)

Drawdown Contours

Modeled by Peter Mock Groundwater Consulting, Inc.

Regional pumping of 22,600 acre-feet/year

Arlington Valley Energy Facility

Hassayampa Switchyard (Under Construction)

Redhawk Generating Station (Under Construction)

Mesquite Generating Station (Approved)

AVEF Transmission Line (Under Construction)

Existing Transmission Lines

AVEF Natural Gas Line (Approved)

Existing Natural Gas Line

Streets

Palo Verde Nuclear Generating Station

0 0.5 1

Miles

Duke Energy

Four Mile Wash
411th Ave
399th Ave
391st Ave
387th Ave
Wintersburg Rd
Elliot Rd
Narramore Rd
AVEF I
(Under Construction)
AVEF II
(Proposed)
70'
65'
60'
55'
Centennial Wash

Figure 10:

Combined Impacts from Cumulative Regional Model and Additional AVEF Pumpage (After 30 Years)

Original Drawdown Contours

Combined Drawdown Contours

Cumulative model took into account 6,800 acre-feet/year for AVEF
Combined impacts include impacts from additional 1,000 acre-feet/year from AVEF

Arlington Valley Energy Facility

Hassayampa Switchyard (Under Construction)

Redhawk Generating Station (Under Construction)

Mesquite Generating Station (Approved)

AVEF Transmission Line (Under Construction)

Existing Transmission Lines

AVEF Natural Gas Line (Approved)

Existing Natural Gas Line

Streets

Palo Verde Nuclear Generating Station

0 0.5 1
Miles

Duke Energy

APPENDIX A

METHODOLOGY AND CALCULATIONS FOR AQUIFER TESTS

Method of Analysis – Pumping Tests

Data collected during the pumping tests were analyzed using the Cooper-Jacob method for drawdown data (Driscoll, 1986). For this method, pumping test data are plotted in a semi-logarithmic manner, with drawdown (in feet) plotted along the scalar y-axis, and elapsed time (in minutes) plotted along the logarithmic x-axis. Transmissivity is calculated using the following formula:

$$T=264 * Q / \Delta s$$

Where:

- T : coefficient of transmissivity of the well, in gallons per day per foot (gpd/ft)
- Q: pumping rate, in gpm
- Δs: slope of the time-drawdown graph expressed as the change in drawdown between any two times on the log scale whose ratio is 10 (one log cycle).

The Cooper-Jacob method is derived from the Theis nonequilibrium well equation, and relies on the same assumptions:

1. The water-bearing formation is uniform in character and the hydraulic conductivity is the same in all directions.
2. The formation is uniform in thickness and infinite in areal extent.
3. The formation receives no recharge from any source.
4. The pumped well penetrates, and receives water from, the full thickness of the water-bearing formation.
5. The water removed from storage is discharged instantaneously when the head is lowered.
6. The pumping well is 100-percent efficient.
7. All water removed from the well comes from aquifer storage.
8. Laminar flow exists throughout the well and the aquifer.
9. The water table or potentiometric surface has no slope.

The effect of partial penetration of the aquifer is accounted for when calculating hydraulic conductivity from transmissivity:

$$K = 0.134 * T / b'$$

Where:

K = hydraulic conductivity of the aquifer, in feet/day

T = coefficient of transmissivity of the well, in gpd/ft

b' = saturated thickness of perforated interval of well, in feet

Method of Analysis – Recovery Tests

Data collected during the recovery tests were analyzed using the Theis method for analyzing recovery data (Driscoll, 1986). For this method, recovery test data is plotted in a semi-logarithmic manner. Residual drawdown (in feet) is plotted along the scalar y-axis, and the ratio T/T' is plotted along the logarithmic x-axis, where T/T' is the ratio of time since the pump was started to time since the pump was stopped. Transmissivity is calculated using the following formula:

$$T = 264*Q/\Delta s'$$

Where:

T = coefficient of transmissivity of the well, in gpd/ft

Q = pumping rate, in gpm

$\Delta s'$ = slope of the time-residual drawdown graph expressed as the change in residual drawdown between any two times on the log scale whose ratio is 10 (one log cycle)

The Theis recovery method relies on similar assumptions as the Cooper-Jacob method for analysis of pumping tests.

Method of Analysis – Specific Capacity

Additional estimates of hydraulic conductivity can be obtained from an empirical relationship between specific capacity and transmissivity (Driscoll, 1986). For unconfined aquifers, this relationship is:

$$T = Q/s*1,500$$

Where:

T = coefficient of transmissivity of the well, in gpd/ft

Q = pumping rate, in gpm

s = drawdown in well, in feet

Calculations for Duke Energy Well 8-1

Estimate of Saturated Thickness of Perforated Interval of Well (b')

Static water level = 164 ft.

Dynamic water level = 373 ft.

Perforated Interval = 508 to 1,085 ft.

Saturated Thickness (b') = 577 ft.

Critical Time for Casing Storage

$t_c = 0.6 * (d_c^2 - d_p^2)/(Q/s)$

$d_c = 20$ inches

$d_p = 12$ inches

$Q = 2{,}200$ gpm

$s = 209$ feet

$t_c = 0.6 * (20^2 - 12^2)/(2{,}200/209) = 14.6$ minutes

Estimate of Transmissivity and Hydraulic Conductivity from Pumping Test

$T = 264 * Q / \Delta s$

$K = 0.134 * T / b'$

$Q = 2{,}200$ gpm

$\Delta s = 10$ feet

$b' = 577$ feet

$T = 264 * 2{,}200 / 10 = 58{,}080$ gpd/ft

$K = 0.134 * 58{,}080 / 577 = 13.5$ ft/day

Calculations for Duke Energy Well 8-1 (continued)

Estimate of Transmissivity and Hydraulic Conductivity from Recovery Test

$T = 264 * Q / \Delta s'$

$K = 0.134 * T / b'$

$Q = 2{,}200$ gpm

$\Delta s' = 2.3$ feet

$b' = 577$ feet

$T = 264 * 2{,}200 / 2.3 = 252{,}522$ gpd/ft

$K = 0.134 * 252{,}522 / 577 = 58.6$ ft/day

Estimate of Hydraulic Conductivity from Specific Capacity

$T = Q/s * 1{,}500$

$K = 0.134 * T / b'$

$Q = 2{,}200$ gpm

$s = 209$ feet

$b' = 577$ feet

$T = 2{,}200 / 209 * 1{,}500 = 15{,}789$ gpd/ft

$K = 0.134 * 15{,}789 / 577 = 3.7$ ft/day

Calculations for Duke Energy Well 4-1

Estimate of Saturated Thickness of Perforated Interval of Well (b')

Static water level = 164 ft.

Dynamic water level = 213.5 ft.

Perforated Interval = 229 to 1,012 ft.

Saturated Thickness (b') = 783 ft.

Estimate of Transmissivity and Hydraulic Conductivity from Recovery Test

$T = 264 * Q / \Delta s'$

$K = 0.134 * T / b'$

$Q = 2{,}000$ gpm

$\Delta s' = 6.3$ feet

$b' = 783$ feet

$T = 264 * 2{,}000 / 6.3 = 83{,}810$ gpd/ft

$K = 0.134 * 83{,}810 / 783 = 14.3$ ft/day

Estimate of Hydraulic Conductivity from Specific Capacity

$T = Q/s * 1{,}500$

$K = 0.134 * T / b'$

$Q = 2{,}000$ gpm

$s = 49.5$ feet

$b' = 783$ feet

$T = 2{,}000 / 49.5 * 1{,}500 = 60{,}606$ gpd/ft

$K = 0.134 * 60{,}606 / 783 = 10.4$ ft/day

Calculations for Duke Energy Well 7-1

Estimate of Saturated Thickness of Perforated Interval of Well (b')

Static water level = 190 ft.

Dynamic water level = 304 ft.

Perforated Interval = 260 to 1,181 ft.

Saturated Thickness (b') = 877 ft.

Critical Time for Casing Storage

$t_c = 0.6 * (d_c^2 - d_p^2)/(Q/s)$

$d_c = 20$ inches

$d_p = 12$ inches

$Q = 2{,}300$ gpm

$s = 114$ feet

$t_c = 0.6 * (20^2 - 12^2)/(2{,}300/114) = 7.6$ minutes

Estimate of Transmissivity and Hydraulic Conductivity from Pumping Test

$T = 264 * Q / \Delta s$

$K = 0.134 * T / b'$

$Q = 2{,}300$ gpm

$\Delta s = 4.7$ feet

$b' = 877$ feet

$T = 264 * 2{,}300 / 4.7 = 129{,}191$ gpd/ft

$K = 0.134 * 129{,}191 / 877 = 19.7$ ft/day

Calculations for Duke Energy Well 7-1 (continued)

Estimate of Transmissivity and Hydraulic Conductivity from Recovery Test

$T = 264 * Q / \Delta s'$

$K = 0.134 * T / b'$

$Q = 2{,}300$ gpm

$\Delta s' = 3.2$ feet

$b' = 877$ feet

$T = 264 * 2{,}300 / 3.2 = 189{,}750$ gpd/ft

$K = 0.134 * 189{,}750 / 877 = 29.0$ ft/day

Estimate of Hydraulic Conductivity from Specific Capacity

$T = Q/s * 1{,}500$

$K = 0.134 * T / b'$

$Q = 2{,}300$ gpm

$s = 114$ feet

$b' = 877$ feet

$T = 2{,}300 / 114 * 1{,}500 = 30{,}263$ gpd/ft

$K = 0.134 * 30{,}263 / 877 = 4.6$ ft/day

APPENDIX B

APPLICATION OF A NUMERICAL GROUNDWATER MODEL (THWELLS) TO THE REGION SURROUNDING THE PROPOSED ARLINGTON VALLEY ENERGY FACILITY

CALCULATION OF DRAWDOWN IN A HOMOGENEOUS, ISOTROPIC, CONFINED, LEAKY CONFINED OR UNCONFINED AQUIFER WITH MULTIPLE PRODUCTION AND INJECTION WELLS AND UNIFORM REGIONAL FLOW

AVEF II Well Impacts

********** INPUT DATA **********

UNCONFINED AQUIFER - THEIS EQUATION WITH JACOB'S CORRECTION

WATER TABLE CORRECTION APPLIED

AQUIFER THICKNESS = 1000 [ft]
TRANSMISSIVITY = 156346 [gpd/ft]

STORAGE COEFFICIENT = .1

REGIONAL FLOW GRADIENT
(positive--downwards--in flow direction) = 0

REGIONAL FLOW DIRECTION
(horizontal angle in degrees
counter-clockwise from positive x-axis) = 0

REGIONAL FLOW OFFSET AT ORIGIN
(positive in downwards direction) = 0 [ft]

WATER TABLE CORRECTION APPLIED

AQUIFER THICKNESS = 1000 [ft]

PUMPING/INJECTION WELL DATA

WELL NO. 1

```
                    X-COORDINATE  =  813 [ft]
                    Y-COORDINATE  =  1950 [ft]
          PUMPING/INJECTION RATE  =  1397055 [gpd]
TIME SINCE START PUMPING/INJECTION  =  10950 [day]
```

WELL NO. 2

```
                    X-COORDINATE  =  1827 [ft]
                    Y-COORDINATE  =  1950 [ft]
          PUMPING/INJECTION RATE  =  1397055 [gpd]
TIME SINCE START PUMPING/INJECTION  =  10950 [day]
```

WELL NO. 3

```
                    X-COORDINATE  =  813 [ft]
                    Y-COORDINATE  =  3250 [ft]
          PUMPING/INJECTION RATE  =  1397055 [gpd]
TIME SINCE START PUMPING/INJECTION  =  10950 [day]
```

WELL NO. 4

```
                    X-COORDINATE  =  1827 [ft]
                    Y-COORDINATE  =  3250 [ft]
          PUMPING/INJECTION RATE  =  1397055 [gpd]
TIME SINCE START PUMPING/INJECTION  =  10950 [day]
```

WELL NO. 5

```
                    X-COORDINATE  =  965 [ft]
                    Y-COORDINATE  =  4620 [ft]
          PUMPING/INJECTION RATE  =  1397055 [gpd]
TIME SINCE START PUMPING/INJECTION  =  10950 [day]
```

---------- Drawdown in [ft] -- Time in [days] ----------

X-coordinate observation well = 0 [ft]
Y-coordinate observation well = 0 [ft]

time	drawdown	time	drawdown	time	drawdown	time	drawdown
0.000	0.000	365.000	10.216	730.000	12.641	1095.000	14.079
1460.000	15.105	1825.000	15.904	2190.000	16.558	2555.000	17.112
2920.000	17.593	3285.000	18.017	3650.000	18.397	4015.000	18.741
4380.000	19.056	4745.000	19.345	5110.000	19.613	5475.000	19.862
5840.000	20.096	6205.000	20.316	6570.000	20.523	6935.000	20.718
7300.000	20.904	7665.000	21.081	8030.000	21.250	8395.000	21.411
8760.000	21.565	9125.000	21.713	9490.000	21.856	9855.000	21.993
%10220.000	22.125	%10585.000	22.252	%10950.000	22.375		

EXHIBIT B-3

LAND USE STUDY

LAND USE

INTRODUCTION

The land use study identifies potential impacts of the proposed AVEF II Project on existing and future land uses. Where necessary, mitigation measures were developed to reduce potential impacts. The land use study addresses components inventory, impact assessment, and mitigation.

Study Components

The land use analysis was divided into components to facilitate the inventory and impact analysis for the proposed Project, as described below. Seven study maps detailing the land use components have been included as follows:

- Land Ownership - Figure 1
- Existing Land Use - Figure 2
- Known Residential Structures - Figure 3
- Large Lot Subdivisions - Figure 4
- Existing Facilities and Utilities - Figure 5
- Existing Zoning - Figure 6
- Land Use Map - Figure 7

Ownership

The Project site is located on privately owned land within an unincorporated area of Maricopa County. Private land, State Trust Lands administered by the Arizona State Land Department and Bureau of Land Management land are present within the study area. See Figure 1 for land ownership information within the study area.

Existing Land Use

The study area is rural in nature and consists primarily of agricultural, vacant, scattered residential areas, the PVNGS, and the Pinnacle West (Redhawk) and Sempra (Mesquite) power plants currently under construction (see Figure 2). Descriptions of the specific types of land uses and their respective locations within the study area is provided below.

Residential -- There are approximately nine (9) occupied single-family dwelling units and a few abandoned homes within the study area (see Figure 3). There are two recorded Records of Survey for Unsubdivided Lands (Horseshoe Trails Phase I and Horseshoe Trails Phase II) within the 2-mile study area (see Figure 4).

Agriculture--Agricultural uses in the study area predominantly include irrigated farmland with alfalfa the primary crop. The majority of agricultural land being cropped within the study area is located southeast of the Project site, along Centennial Wash and the Southern Pacific Railroad. Several properties in the area that were previously used for agriculture are now out of production and are returning to vacant desert.

Industrial--Industrial uses within the study area includes portions of the PVNGS property located in the northern portion of the study area. Phase I of Duke Energy's Arlington Valley Energy Project (AVEF I) is under construction within the study area. Phase I and II of Pinnacle West's Redhawk

facility is under construction just east of the study area. Sempra's Mesquite facility, east of AVEF I and within the study area, is scheduled to begin construction in early fall 2001. Construction has also begun on the Hassayampa Switchyard that is located east and adjacent to Sempra's Mesquite facility. This facility will be located approximately 1.5 miles east of the project site and south of Elliot Road at approximately 375th Avenue (between the existing Kyrene and North Gila 500kV transmission lines). This switchyard will serve as a satellite facility for new and existing power lines and an alternative to connecting directly into the existing PVNGS switchyard.

Utilities– A network of electrical transmission lines are present in the study area (see Figure 5). Several agricultural irrigation wells and canals/ditches were identified throughout the study area. Several of these facilities were found at the Project site, but none appear to be in operation.

Transportation–The majority of the roads within the study area are unpaved, two-track roads used by local property owners. Major arterial roads within the study area that are paved include Elliot Road and Wintersburg Road (383rd Avenue).

The Southern Pacific Railroad operates one main railroad line that generally parallels the southern boundary of the Project site. One spur of this railroad serves the PVNGS site and is located approximately 1.5 miles east of the project site.

Vacant Land–A large portion of the study area is undeveloped or vacant land. These tracts of land currently have no visible structures or buildings.

Zoning

Zoning is a method of land use control that specifies the types of land uses allowed, the intensity or density of the use, and standards for development. The zoning classification for the project area was obtained from Maricopa County's Planning and Development Department. The zoning classification for the project area is shown in Figure 6.

According to the Maricopa County's *Zoning Ordinance* (1999), the project area includes the Rural-190 zoning district. The principal purpose of this zoning district is to conserve and protect farms and other open land uses, foster orderly growth in rural areas, and prevent urban and agricultural land use conflicts. Uses permitted in this zoning district typically include farm and non-farm residential uses, farms, and recreational and institutional uses. The Rural-190 zoning district requires a minimum lot size of 190,000 square feet per dwelling unit. However, more specifically, in Maricopa County a Special Use Permit ("S.U.P.") is required for a generating facility. The site (as a part of Duke's AVEF I approvals) has an approved S.U.P. To allow the construction of AVEF II, Duke Energy is in the process of applying for a Major Amendment to AVEF I's S.U.P., which will be issued by the Maricopa County Board of Supervisors upon recommendation of the County's Planning and Zoning Commission. The PVNGS is currently operated under a Special Use Permit granted by Maricopa County.

Future Land Use

The purpose of the future land use inventory was to document all planned or proposed land uses. Sources of future land use information include projected uses embodied in officially adopted general and area-wide plans. Planned land uses within the vicinity of the proposed project are described by Maricopa County's recently updated *Tonopah/Arlington Area Plan* (2000). The Existing Zoning and Land Use maps from the *Tonopah/Arlington Area Plan* follow as Figures 6 and 7.

Changes in existing, developed land uses within the study area are unlikely to occur. However, the development of vacant and agricultural lands is more likely to occur as rural-type development (e.g., residential) continues throughout the study area.

The majority of lands within the study area are currently planned for Rural Residential, High Density use. According to Maricopa County's *Tonopah/Arlington Area Plan*, the Rural Residential, High Density category denotes areas where single-family residential development is desirable but urban services (e.g., water, sewer, schools, parks, law enforcement, fire protection) are limited. Uses in this category include agricultural and single-family residential.

Several locations within the study area are designated by the County's Plan as open space. The majority of land designated as open space is located south of the project site and adjacent to the Pinnacle West and Sempra power plant sites. According to the *Tonopah/Arlington Area Plan*, this designation is prescribed for areas that would be best precluded from development except for recreational purposes.

The *Tonopah/Arlington Area Plan* designates the AVEF property as Industrial. Uses permitted in this category include general warehousing, storage, distribution activities, and general manufacturing. The PVNGS is identified as a major industrial employment center.

Inventory

The purpose of the land use inventory was to compile baseline data in an effort to assess potential land use impacts that may result from the construction, operation, and maintenance of the proposed Project. The inventory included current land jurisdiction, existing and future land uses, and zoning information within a 2-mile radius (study area) of the project site.

Base maps were generated using the Tonopah/Arlington Area Plan and aerial photography. Subsequently, land use information was inventoried within a 2-mile radius of the project site. Information compiled for the land use study was based on a review of existing maps, aerial photographs, planning agency contacts and publications, and field reconnaissance.

The Project site is located approximately 1.5 miles southwest of the Palo Verde Nuclear Generating Station ("PVNGS"), on the south side of Elliot Road between the 387th Avenue and 391st Avenue alignments. The Southern Pacific Railroad is approximately 1.5 miles to the south. The Project site is located on vacant land, and there is no indication that the property has been farmed or used for any discernable use in the past decade.

Impact Assessment

The proposed project site is located on land under private ownership. Lands adjacent to the project are primarily undeveloped. The project will not have any direct adverse impacts to existing residential or other uses.

Based on a records search at the County's Planning and Development Department, no residential developments have been proposed or approved for the area immediately surrounding the project site. Recent approvals (i.e., Duke's AVEF I, Pinnacle West, Sempra, and the Hassayampa Switchyard) indicate that other land use plans within the vicinity will be consistent with the proposed Project. Therefore, the Project would have no adverse impacts to future land use plans.

Mitigation

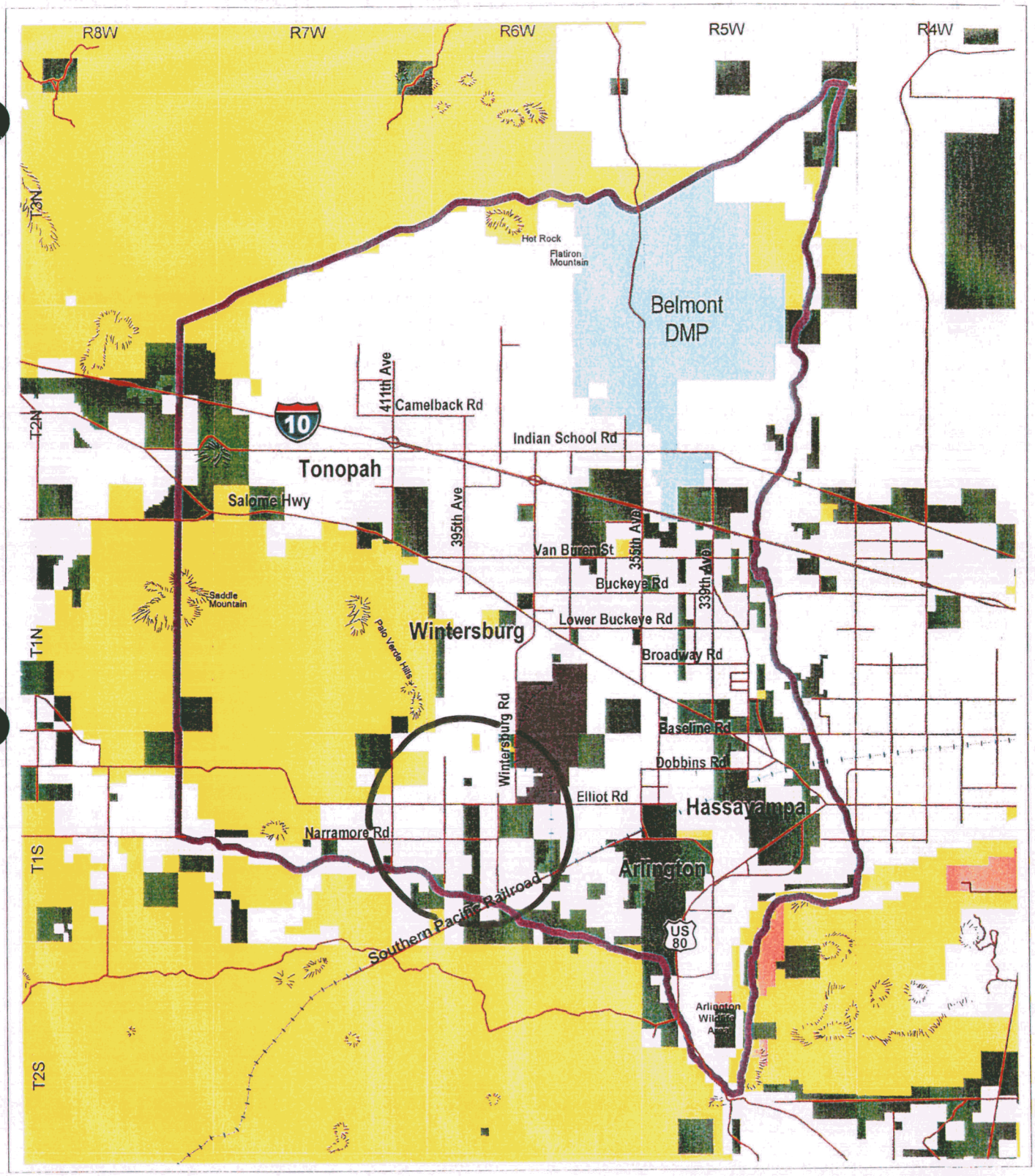
No site-specific mitigation measures have been identified at this time because no substantial impacts to existing or future land use are expected as a result of constructing and operating the proposed Project.

REFERENCES

Maricopa County. November 1999. *Zoning Ordinance*. Phoenix, Arizona.

Maricopa County. 2000. *Tonopah/Arlington Area Plan*. Phoenix, Arizona.

U.S. Geological Survey. 1984. 1:24,000 scale map - Arlington, Arizona.



Ownership

- Bureau of Land Management
- State Trust Land
- State Wildlife
- Private
- Palo Verde NGS
- Belmont DMP

- Freeway
- Arterials
- Railroad
- Area Plan Boundary

Land Ownership

Figure 1

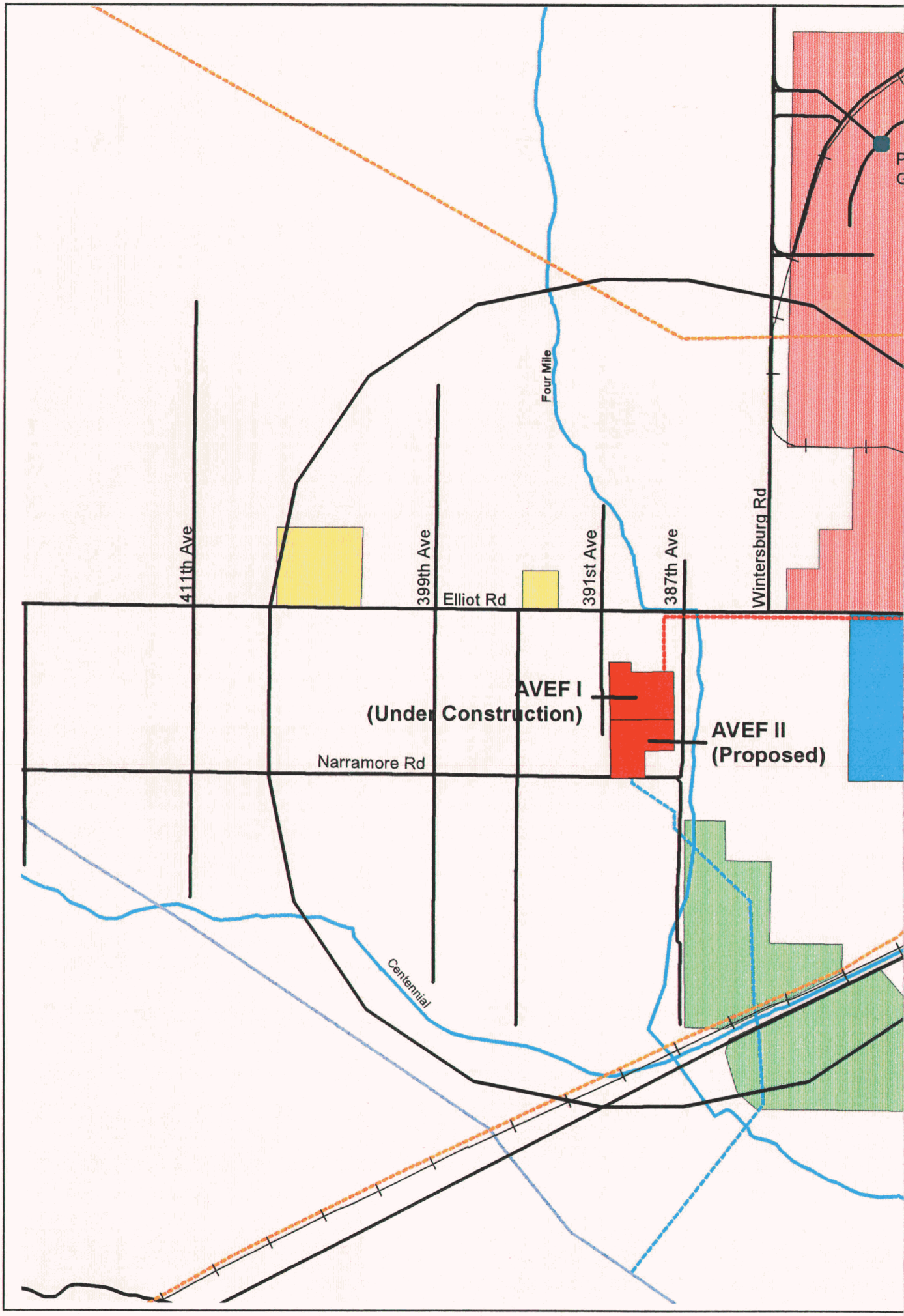
MARICOPA COUNTY 2020 Eye to the Future

MARICOPA COUNTY ARIZONA

N

Scale in Miles

0 1 2 3 4 5


411th Ave
399th Ave
Elliot Rd
391st Ave
387th Ave
Wintersburg Rd
Four Mile
AVEF I
(Under Construction)
AVEF II
(Proposed)
Narramore Rd
Centennial

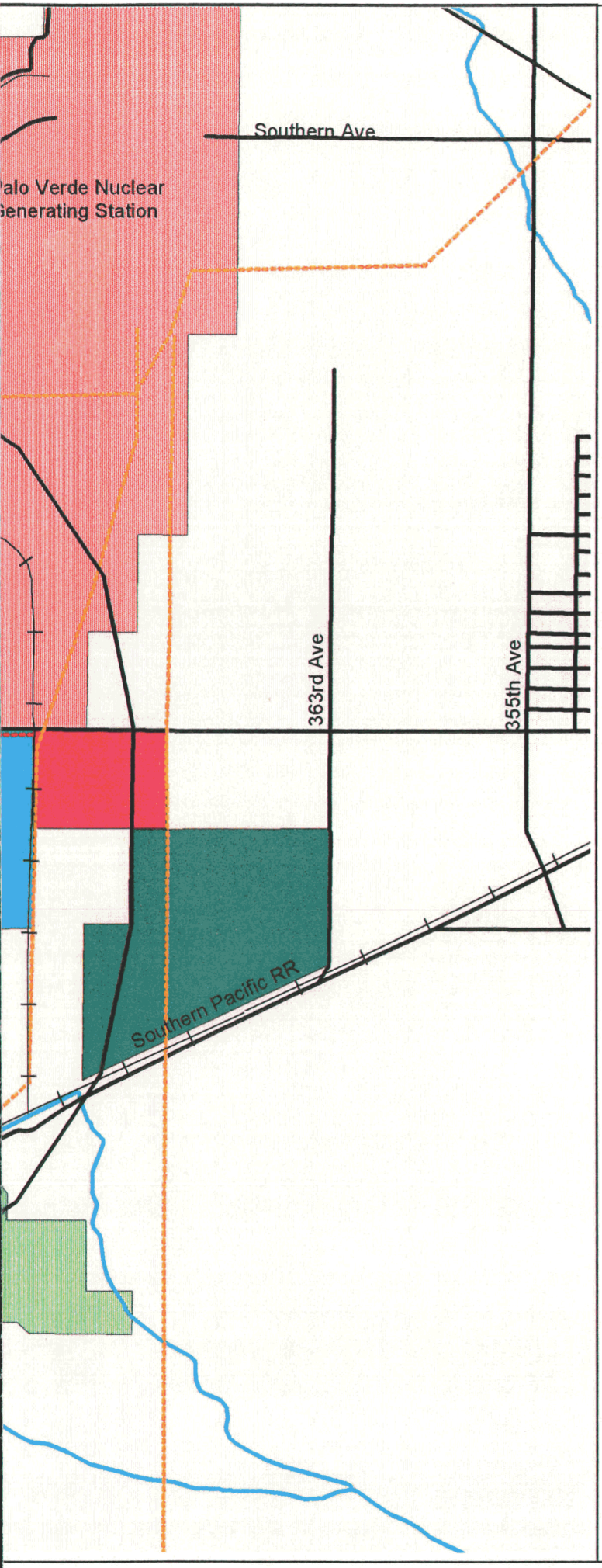


Figure 2:

Existing Land Use (2000)

Existing Land Use (2000)

- Vacant Land
- Agricultural Land
- Palo Verde Nuclear Generating Station
- Residential Land

- Arlington Valley Energy Facility
- Hassayampa Switchyard (Under Construction)
- Redhawk Generating Station (Under Construction)
- Mesquite Generating Station (Approved)
- AVEF Transmission Line (Under Construction)
- Existing Transmission Lines
- AVEF Natural Gas Line (Approved)
- Existing Natural Gas Line
- Rivers and washes
- Streets
- Railroads
- Area within 2 Miles of Project
- Palo Verde Nuclear Generating Station

0 0.5 1
Miles

Duke Energy

Palo Verde N
Generating S
Four Mile
411th Ave
399th Ave
391st Ave
387th Ave
Wintersburg Rd
Elliot Rd
AVEF I
(Under Construction)
AVEF II
(Proposed)
Narramore Rd
Centennial

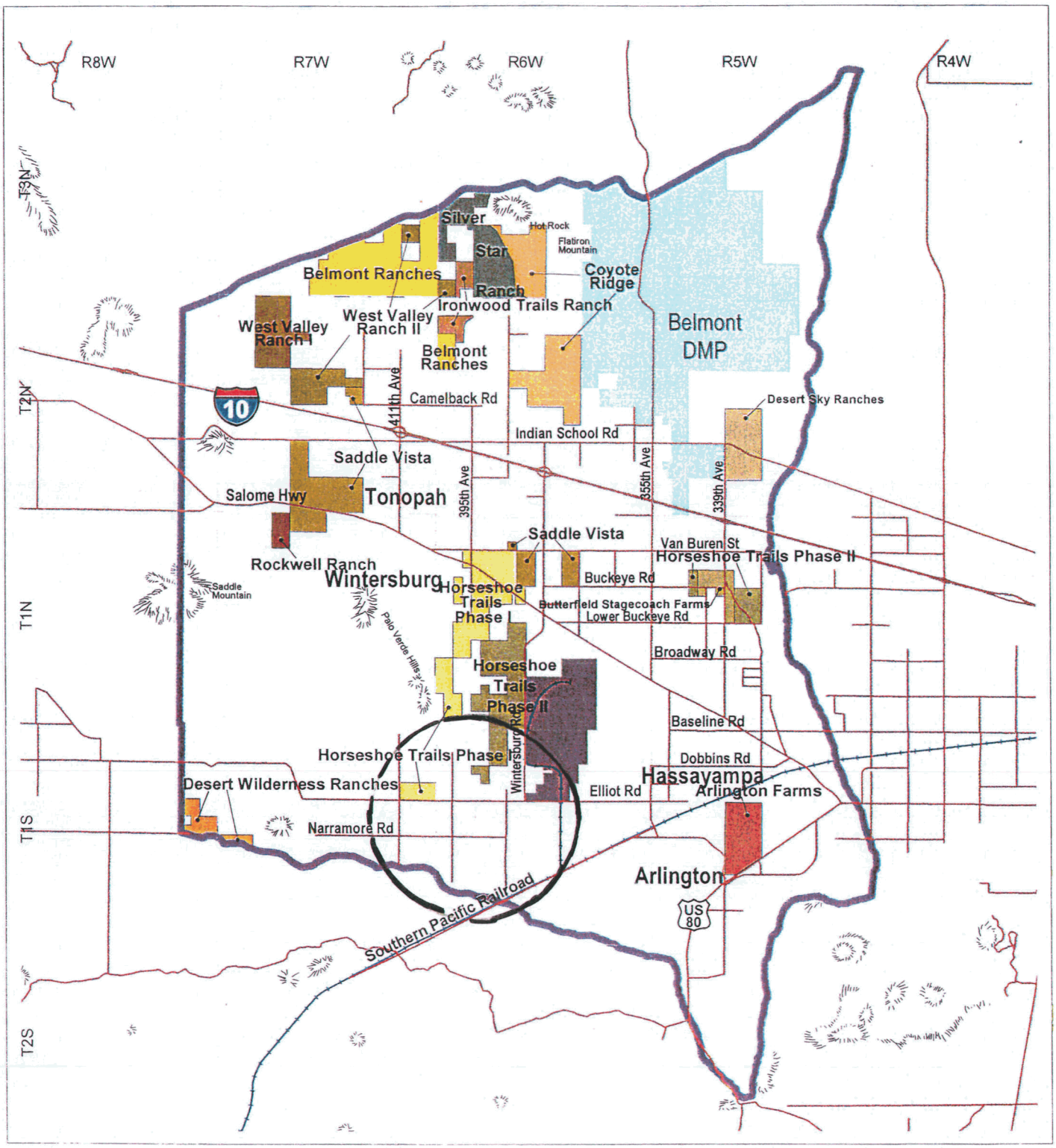
Figure 3:

Known Residential Structures

- Known Residential Structures
- Arlington Valley Energy Facility
- Hassayampa Switchyard (Under Construction)
- Redhawk Generating Station (Under Construction)
- Mesquite Generating Station (Approved)
- AVEF Transmission Line (Under Construction)
- Existing Transmission Lines
- AVEF Natural Gas Line (Approved)
- Existing Natural Gas Line
- Rivers and washes
- Streets
- Railroads
- Area within 2 Miles of Project
- Palo Verde Nuclear Generating Station

0 0.5 1
Miles

Duke Energy



Legend

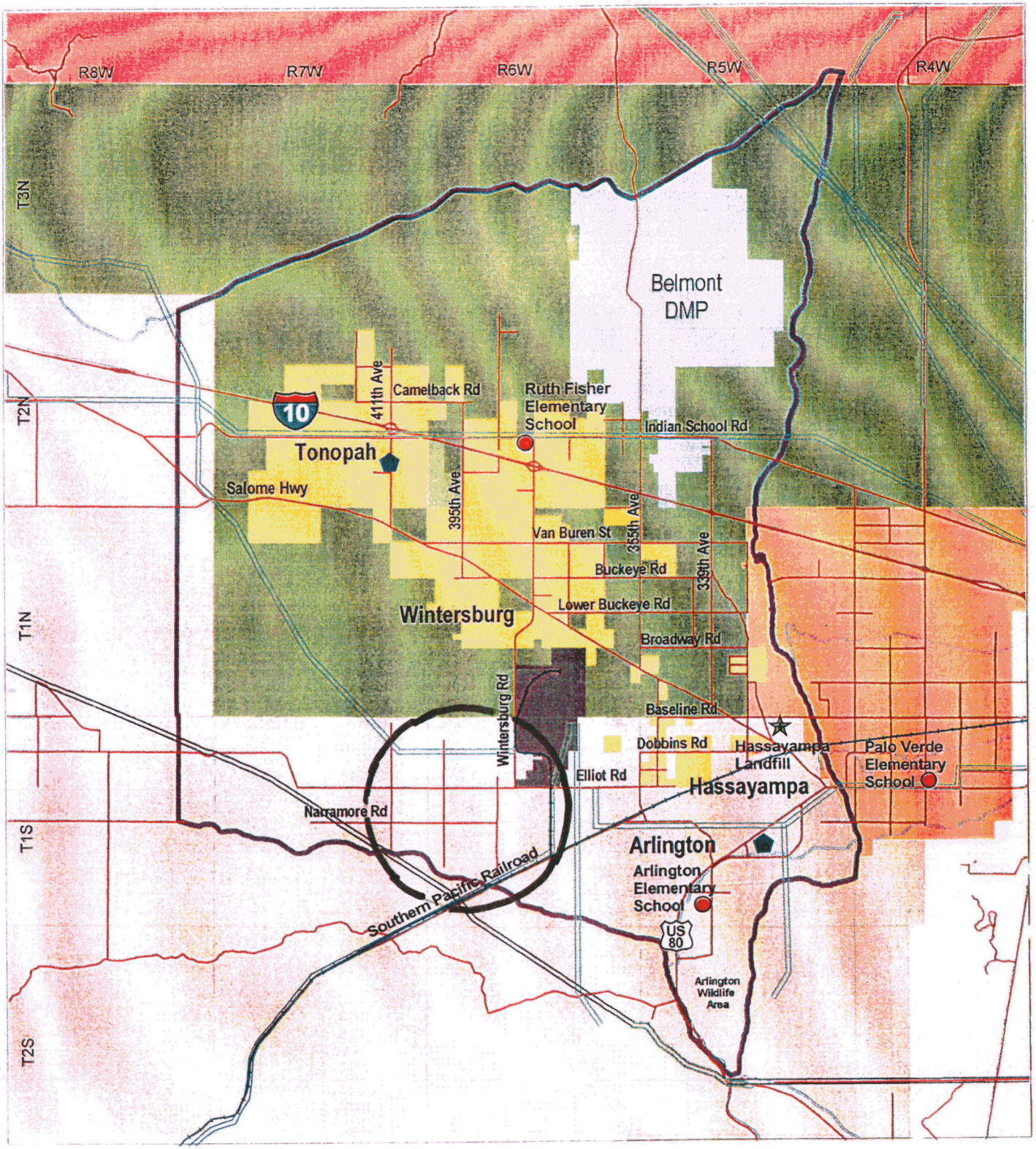
- Palo Verde NGS
- Belmont DMP
- Freeway
- Arterials
- Railroad
- Area Plan Boundary

Large Lot Subdivisions

Figure 4

Scale in Miles

0 1 2 3 4 5



Water Service Areas
- Hassyampa Water Company, Inc
- Valley View Water Company, Inc.
- Water Utility of Greater Tonopah, Inc.
- West Phoenix Water Company (Defunct)

School Districts
- Arlington Elementary
- Palo Verde
- Ruth Fisher
- Wickenburg

Utilities
- Electric
- Gas
- Oil
- Railroad
- Freeway
- Arterials
- Canals
- Planning Area Boundary
- Belmont DMP
- Palo Verde NGS

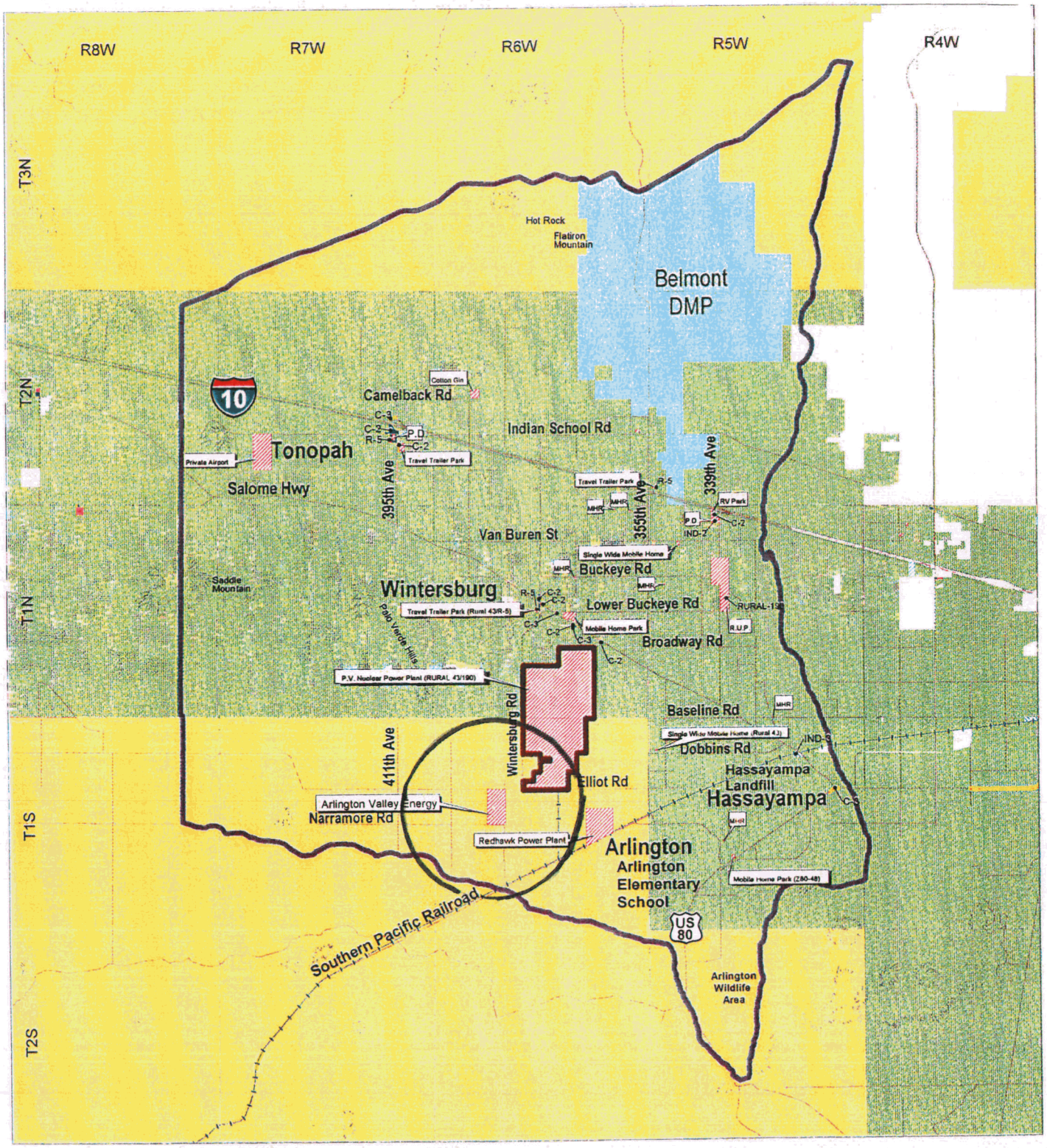
- Post Office
- School
- Landfill
- Fire Station

Existing Facilities and Utilities

Figure 5

Scale in Miles
0 1 2 3 4 5

Revised 3/17/2000



Zoning

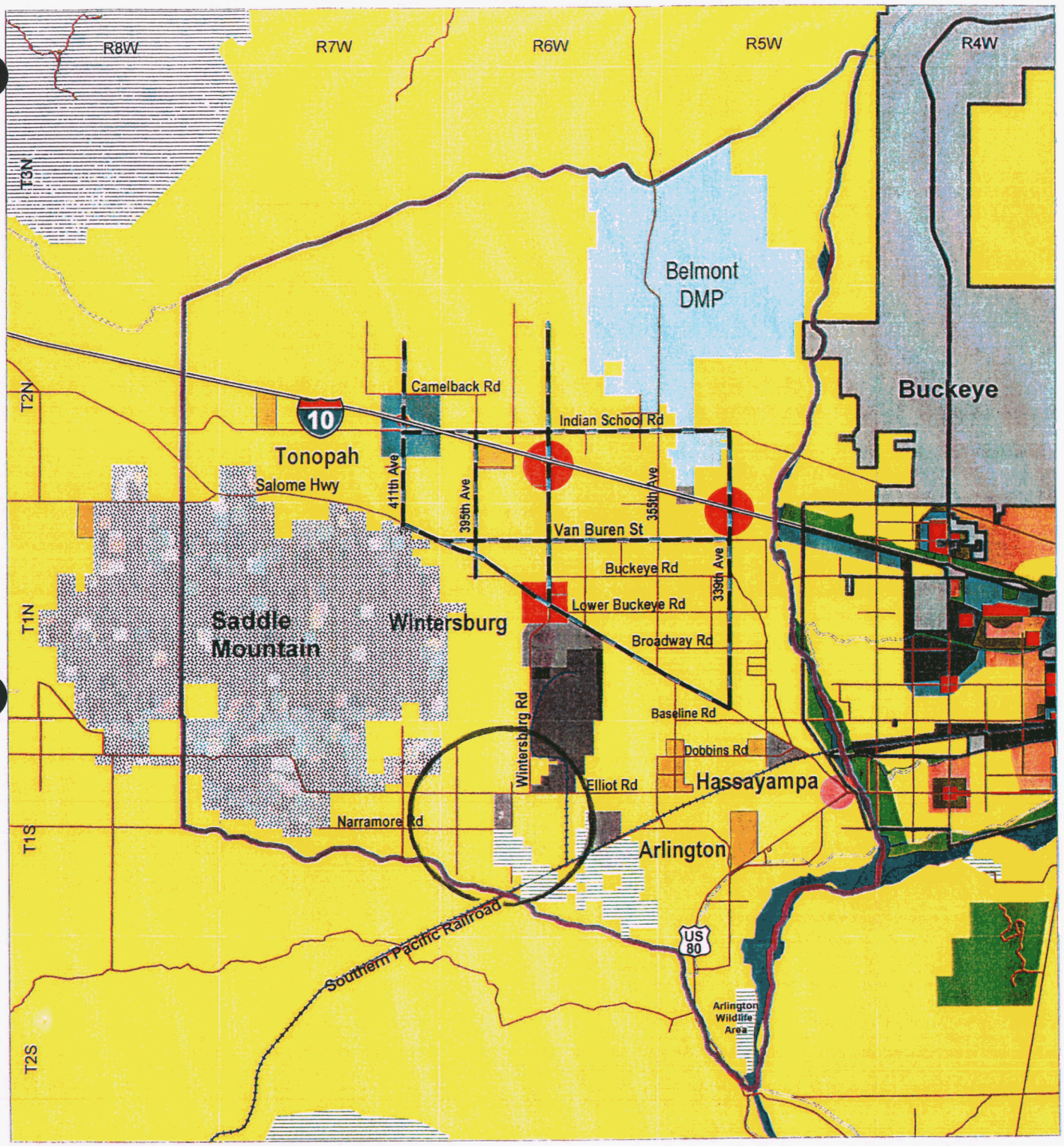
- R-5
- Rural-43
- Rural-190
- Special Use
- C-2
- C-3
- Ind-2
- Ind-3

Freeway
Arterials
Railroad
Area Plan Boundary

Existing Zoning

Figure 6

Scale in Miles
0 1 2 3 4 5



Land Use Categories

- Rural
- Large Lot Residential
- Small Lot Residential
- Neighborhood Retail Center
- Community Retail Center
- Regional Retail Center
- Proposed Open Space
- Recreation
- Open Space
- Educational
- Mixed Use
- Industrial
- Public Facility
- Palo Verde NGS
- Belmont DMP
- Freeway
- Streets
- Core Arterials
- Railroad
- Area Plan Boundary

Land Use Map

Figure 7

Scale in Miles

0 1 2 3 4 5

EXHIBIT C
AREAS OF BIOLOGICAL WEALTH

EXHIBIT C
AREAS OF BIOLOGICAL WEALTH

As stated in Arizona Corporation Commission Rules of Practice and Procedure R14-3-219:

"Describe any areas in the vicinity of the proposed site or route which are unique because of biological wealth or because they are habitats for rare and endangered species. Describe the biological wealth or species involved, and state the effects, if any, the proposed facilities will have thereon."

The proposed power plant site is located on agricultural land that has been out of production for several years. The sparsely vegetated site is dominated by Russian thistle, Johnsongrass, canarygrass, bermuda grass, annual sunflower, globemallow, and nightshade, with scattered mesquite and tamarisk. Winters Wash and Centennial Wash are located east and south of the plant site, respectively. Dominant plant species in these riparian areas include mesquite, blue palo verde, ironwood, and catclaw acacia. Other species present include fourwing saltbush, panicum, pigweed, and ragweed.

Special status wildlife and plant species documented for Maricopa County are listed in Table C-1. These include species listed as endangered or threatened by the U.S. Fish and Wildlife Service (USFWS), Wildlife of Special Concern identified by the Arizona Game and Fish Department (AGFD), and Highly Safeguarded Plants protected by the Arizona Native Plant Law per Arizona Department of Agriculture (ADA). Letters from the USFWS and AGFD that provide information on special status species that may occur in the site vicinity are presented in Attachment 1.

Only a few species (peregrine falcon, ferruginous hawk, southwestern willow flycatcher, California leaf-nosed bat, lesser long-nosed bat, and southern yellow bat) potentially could occur at or near the project site.

Neither peregrine falcons nor ferruginous hawks are expected to breed in the vicinity of the proposed project; however, they may forage in the area during spring or fall migration. Such occurrences would be very rare, as the project area does not support large numbers of prey species required by either raptor. Impacts to these species from construction and operation of the project are expected to be negligible.

Southwestern willow flycatchers breed in dense riparian areas of cottonwood, willow, and/or salt cedar in the lowlands of southern Arizona and willow thickets in montane areas, and are

Table C-1

Special Status Species of Maricopa County, Arizona

Common Name	Scientific Name	Federal Status[1]	State Status[2]	Habitat Present on Site[3]
MAMMALS				
California leaf-nosed bat	Macrotus californicus		WC	Yes, forage
Lesser long-nosed bat	*Leptonycteris curasoae yerbabuenae*	E	WC	Yes, forage
Western red bat	*Lasiurus blossevillii*		WC	No
Southern yellow bat	*Lasiurus ega*		SC	Yes, forage
Sonoran pronghorn	*Antilocapra americana sonoriensis*	E	WC	No
BIRDS				
American bittern	*Botaurus lentiginosus*		WC	No
Least bittern	*Ixobrychus exilis hesperis*		WC	No
Great egret	*Ardea alba*		WC	No
Snowy egret	*Egretta thula*		WC	No
Black-bellied whistling duck	*Dendrocygna autumnalis*		WC	No
Mississippi kite	*Ictinia mississippiensis*		WC	No
Bald eagle	*Haliaeetus leucocephalus*	T	WC	No
Common black-hawk	*Buteogallus anthracinus*		WC	No
Ferruginous hawk	*Buteo regalis*		WC	Yes, migration
American peregrine falcon	*Falco peregrinus anatum*		WC	Yes, migration
Yuma clapper rail	*Rallus longirostris yuman ensis*	E	WC	No
Snowy plover	*Charadrius alexandrinus*		WC	No
Western yellow-billed cuckoo	*Coccyzus americanus*		WC	No
Cactus ferruginous pygmy-owl	*Glaucidium brasilianum cactorum*	E	WC	No
Mexican spotted owl	*Strix occidentalis lucida*	T	WC	No
Southwestern willow flycatcher	*Empidonax trailli extimus*	E	WC	Yes, migration
REPTILES AND AMPHIBIANS				
Lowland leopard frog	*Rana yavapaiensis*		WC	No
Desert tortoise	*Gopherus agassizii*		WC	No
Arizona skink	*Eumeces gilberti arizonensis*		WC	No
FISHES				
Razorback sucker	*Xyrauchen texanus*	E	WC	No
Desert pupfish	*Cyprinodon macularius macularius*	E	WC	No
Gila topminnow	*Poeciliopsis occidentalis occidentalis*	E	WC	No

Common Name	Scientific Name	Federal Status[1]	State Status[2]	Habitat Present on Site[3]
	PLANTS			
Arizona agave	Agave arizonica	E	HS	No
Hohokam agave	Agave murpheyi		HS	No
Arizona cliffrose	Purshia subintegra	E	HS	No
Crested or Fan-top saguaro	Carnegiea gigantea	E	HS	No
Arizona hedgehog cactus	Echinocereus triglochidiatus arizonicus	E	HS	No
Acuna cactus	Echinomastus erectocentrus acunensis		HS	No
Opuntia echinocarpa	Straw-top cholla		SR	No
Lemmon fleabane	Erigeron lemmoni		HS	No

Key:

Federal Status: E = Endangered T = Threatened
WC = Wildlife of Special Concern HS = Highly Safeguarded SR = Salvage Restricted

Sources:
[1]USFWS 2001
[2]AGFD 1996, AGFD 2001, and ADA 1999
[3]Habitat assessments based on discussions with USFWS and AGFD staff specialists and field evaluations conducted in November 1999 for the AVEF I project, field evaluations conducted in June 2001, and the following sources: Kearney and Peebles 1960, Stebbins 1985, and Hoffmeister 1986.
[4]Habitat requirements for the spotted bat are not well known, but appear to include cliffs and rocks (Hoffmeister 1986).

associated with water or saturated soil conditions (Sogge et al. 1997). These habitats are not present within or adjacent to the proposed site. As a result, impacts to southwestern willow flycatchers associated with construction and operation of the project are not expected to occur.

California leaf-nosed bat, lesser long-nosed bat, and southern yellow bat could potentially forage over or near the project (AGFD 1993). No known bat roosts have been documented in or near the project area. As a result, impact to these species is expected to be negligible.

Based on the results of field evaluations conducted in 2001, AGFD Heritage Data Management System and USFWS records, a field project review meeting with AGFD staff specialists conducted in November 1999 for the approved AVEF I project, and the proposed project design, construction and operation of the power plant is not expected to impact threatened, endangered, or otherwise sensitive species of plants and animals identified by USFWS, AGFD, or ADA. Loss of habitat associated with the project is expected to be negligible for any of these species.

REFERENCES

Arizona Department of Agriculture. 1999. Protected Native Plants by Categories web site: http://agriculture.state.az.us/PSD/protplantlst.htm. Arizona Department of Agriculture. Accessed June 2001.

Arizona Game and Fish Department. 1993. Arizona Wildlife View: Bats of Arizona, August 1993. Vol. 36, No. 8.

Arizona Game and Fish Department. 1996. *Wildlife of Special Concern in Arizona* (Public Review Draft). Arizona Game and Fish Department, Phoenix, Arizona.

Arizona Game and Fish Department. 2001. Correspondence with P. Hackney, ENSR. [July 2001, AGFD #6-4-01 (07) .

Hoffmeister, D. F. 1986. *Mammals of Arizona*. University of Arizona Press, Tucson, Arizona.

Kearney, T. H. and R. H. Peebles. 1960. *Arizona flora*. University of California Press.

Stebbins, R. C. 1985. *A Field Guide to Western Reptiles and Amphibians*. Petersen Field Guides. Houghton Mifflin Co., Boston.

Sogge, et al. 1997. A Southwestern Willow Flycatcher Natural History Summary and Survey Protocol. National Park Service and Colorado Plateau Research Station at Northern Arizona University. Technical Report NPS/NAUCPRS/NRTR-97/12.

U.S. Fish and Wildlife Service. 2001. Correspondence with P. Hackney, ENSR, June 7, 2001, AESO/SE 2-21-00-I-036.

ATTACHMENT 1

USFWS and AGFD LETTERS

United States Department of the Interior

U.S. Fish and Wildlife Service
2321 West Royal Palm Road, Suite 103
Phoenix, Arizona 85021-4951
Telephone: (602) 242-0210 FAX: (602) 242-2513

In Reply Refer To:

AESO/SE
2-21-00-I-036

June 7, 2001

Mr. Phil Hackney
Project Manager
ENSR International
1601 Prospect Parkway
Fort Collins, Colorado 80525-9769

RE: Arlington Valley Energy Facility II (AVEF II), Project, Maricopa County, Arizona

Dear Mr. Hackney:

This letter responds to your June 1, 2001, request for an inventory of threatened or endangered species, or those that are proposed to be listed as such under the Endangered Species Act of 1973, as amended (Act), which may potentially occur in your project area (Maricopa County). The enclosed list may include candidate species as well. We hope the enclosed county list of species will be helpful. In future communications regarding this project, please refer to consultation number 2-21-00-I-036.

The enclosed list of the endangered, threatened, proposed, and candidate species includes all those potentially occurring anywhere in the county, or counties, where your project occurs. Please note that your project area may not necessarily include all or any of these species. The information provided includes general descriptions, habitat requirements, and other information for each species on the list. Also on the enclosed list is the Code of Federal Regulations (CFR) citation for each list and is available at most public libraries. This information should assist you in determining which species may or may not occur within your project area. Site-specific surveys could also be helpful and may be needed to verify the presence or absence of a species or its habitat as required for the evaluation of proposed project-related impacts.

Endangered and threatened species are protected by Federal law and must be considered prior to project development. If the action agency determines that listed species or critical habitat may be adversely affected by a federally funded, permitted, or authorized activity, the action agency must request formal consultation with the Service. If the action agency determines that the planned action may jeopardize a proposed species or destroy or adversely modify proposed critical habitat, the action agency must enter into a section 7 conference with the Service. Candidate species are those which are being considered for addition to the list of threatened or endangered species. Candidate species are those for which there is sufficient information to support a proposal for listing. Although candidate species have no legal protection under the Act, we

recommend that they be considered in the planning process in the event that they become listed or proposed for listing prior to project completion.

If any proposed action occurs in or near areas with trees and shrubs growing along watercourses, known as riparian habitat, the Service recommends the protection of these areas. Riparian areas are critical to biological community diversity and provide linear corridors important to migratory species. In addition, if the project will result in the deposition of dredged or fill materials into waterways or excavation in waterways, we recommend you contact the Army Corps of Engineers which regulates these activities under Section 404 of the Clean Water Act.

The State of Arizona protects some plant and animal species not protected by Federal law. We recommend you contact the Arizona Game and Fish Department and the Arizona Department of Agriculture for State-listed or sensitive species in your project area.

The Service appreciates your efforts to identify and avoid impacts to listed and sensitive species in your project area. If we may be of further assistance, please feel free to contact Tom Gatz (x240).

Sincerely,

Jacqueline Hanson

David L. Harlow
Field Supervisor

Enclosure

cc: John Kennedy, Habitat Branch, Arizona Game and Fish Department, Phoenix, AZ

LISTED, PROPOSED, AND CANDIDATE SPECIES FOR THE FOLLOWING COUNTY: **MARICOPA**

02/26/2001

1) LISTED

TOTAL= 13

NAME: **ARIZONA AGAVE** *AGAVE ARIZONICA*

STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: No CFR: 49 FR 21055, 05-18-1984

DESCRIPTION: HAS ATTRACTIVE ROSETTES OF BRIGHT GREEN LEAVES WITH DARK MAHOGANY MARGINS. FLOWER: BORNE ON SUB-UMBELLATE INFLORESCENCES.

ELEVATION RANGE: 3000-6000 FT.

COUNTIES: GILA, YAVAPAI, MARICOPA

HABITAT: TRANSITION ZONE BETWEEN OAK-JUNIPER WOODLAND & MOUNTAIN MAHOGANY-OAK SCRUB

SCATTERED CLONES IN NEW RIVER MOUNTAINS AND SIERRA ANCHA. USUALLY FOUND ON STEEP, ROCKY SLOPES. POSSIBLY MAZATAL MOUNTAINS. SHOULD BE LOOKED FOR WHEREVER THE RANGES OF Agave toumeyana var. bella AND Agave chrystantha OVERLAP.

NAME: **ARIZONA CLIFFROSE** *PURSHIA SUBINTEGRA*

STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: Yes CFR: 49 FR 22326 5-29-84

DESCRIPTION: EVERGREEN SHRUB OF THE ROSE FAMILY (ROSEACEAE). BARK PALE SHREDDY. YOUNG TWIGS WITH DENSE HAIRS. LEAVES 1-5 LOBES AND EDGES CURL DOWNWARD (REVOLUTE). FLOWERS: 5 WHITE OR YELLOW PETALS <0.5 INCH LONG.

ELEVATION RANGE: <4000 FT.

COUNTIES: GRAHAM YAVAPAI MARICOPA MOHAVE

HABITAT: CHARACTERISTIC WHITE SOILS OF TERTIARY LIMESTONE LAKEBED DEPOSITS.

WHITE SOILS OF TERITIARY LIMESTONE LAKEBED DEPOSITS CAN BE SEEN FROM A DISTANCE.

NAME: **ARIZONA HEDGEHOG CACTUS** *ECHINOCEREUS TRIGLOCHIDIATUS ARIZONICUS*

STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: No CFR: 44 FR 61556,10-15-1979

DESCRIPTION: DARK GREEN CYLINDROID 2.5-12 INCHES TALL, 2-10 INCHES IN DIAMETER, SINGLE OR IN CLUSTERS. 1-3 GRAY OR PINKISH CENTRAL SPINES LARGEST DEFLEXED AND 5-11 SHORTER RADIAL SPINES. FLOWER: BRILLIANT RED, SIDE OF STEM IN APRIL- MAY

ELEVATION RANGE: 3700-5200 FT.

COUNTIES: MARICOPA, GILA, PINAL

HABITAT: ECOTONE BETWEEN INTERIOR CHAPPARAL AND MADREAN EVERGREEN WOODLAND

OPEN SLOPES, IN NARROW CRACKS BETWEEN BOULDERS, AND IN UNDERSTORY OF SHRUBS. THIS VARIETY IS BELIEVED TO INTERGRADE AT THE EDGES OF ITS DISTRIBUTION WITH VARIETIES MELANCANTHUS AND NEOMEXICANUS CAUSING SOME CONFUSION IN IDENTIFICATION.

NAME: **LESSER LONG-NOSED BAT** *LEPTONYCTERIS CURASOAE YERBABUENAE*

STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: Yes CFR: 53 FR 38456, 09-30-88

DESCRIPTION: ELONGATED MUZZLE, SMALL LEAF NOSE, AND LONG TONGUE. YELLOWISH BROWN OR GRAY ABOVE AND CINNAMON BROWN BELOW. TAIL MINUTE AND APPEARS TO BE LACKING. EASILY DISTURBED.

ELEVATION RANGE: <6000 FT.

COUNTIES: COCHISE, PIMA, SANTA CRUZ, GRAHAM, PINAL, MARICOPA

HABITAT: DESERT SCRUB HABITAT WITH AGAVE AND COLUNMNAR CACTI PRESENT AS FOOD PLANTS

DAY ROOSTS IN CAVES AND ABANDONED TUNNELS. FORAGES AT NIGHT ON NECTAR, POLLEN, AND FRUIT OF PANICULATE AGAVES AND COLUMNAR CACTI. THIS SPECIES IS MIGRATORY AND IS PRESENT IN ARIZONA , USUALLY FROM APRIL TO SEPTMBER AND SOUTH OF THE BORDER THE REMAINDER OF THE YEAR.

NAME: **SONORAN PRONGHORN** *ANTILOCAPRA AMERICANA SONORIENSIS*

STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: Yes CFR: 32 FR 4001, 03-11-67

DESCRIPTION: BUFF ON BACK AND WHITE BELOW, HOOFED WITH SLIGHTLY CURVED BLACK HORNS HAVING A SINGLE PRONG. SMALLEST AND PALEST OF THE PRONGHORN SUBSPECIES.

ELEVATION RANGE: 2000-4000 FT.

COUNTIES: PIMA, YUMA, MARICOPA

HABITAT: BROAD, INTERMOUNTAIN ALLUVIAL VALLEYS WITH CREOSOTE-BURSAGE & PALO VERDE-MIXED CACTI ASSOCIATIONS

TYPICALLY, BAJADAS ARE USED AS FAWNING AREAS AND SANDY DUNE AREAS PROVIDE FOOD SEASONALLY. HISTORIC RANGE WAS PROBABLY LARGER THAN EXISTS TODAY. THIS SUBSPECIES ALSO OCCURS IN MEXICO.

NAME: **DESERT PUPFISH** *CYPRINODON MACULARIUS*

STATUS: ENDANGERED CRITICAL HAB Yes RECOVERY PLAN: Yes CFR: 51 FR 10842, 03-31-1986

DESCRIPTION: SMALL (2 INCHES) SMOOTHLY ROUNDED BODY SHAPE WITH NARROW VERTICAL BARS ON THE SIDES. BREEDING MALES BLUE ON HEAD AND SIDES WITH YELLOW ON TAIL. FEMALES & JUVENILES TAN TO OLIVE COLORED BACK AND SILVERY SIDES.

ELEVATION RANGE: <5000 FT.

COUNTIES: LA PAZ, PIMA, GRAHAM, MARICOPA, PINAL, YAVAPAI, SANTA CRUZ

HABITAT: SHALLOW SPRINGS, SMALL STREAMS, AND MARSHES. TOLERATES SALINE & WARM WATER

CRITICAL HABITAT INCLUDES QUITOBAQUITO SPRING, PIMA COUNTY, PORTIONS OF SAN FELIPE CREEK, CARRIZO WASH, AND FISH CREEK WASH, IMPERIAL COUNTY, CALIFORNIA. TWO SUBSPECIES ARE RECOGNIZED: DESERT PUPFISH (C. m. macularis) AND QUITOBAQUITO PUPFISH (C. m. eremus).

LISTED, PROPOSED, AND CANDIDATE SPECIES FOR THE FOLLOWING COUNTY: **MARICOPA**

02/26/2001

NAME: **GILA TOPMINNOW** *POECILIOPSIS OCCIDENTALIS OCCIDENTALIS*

STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: Yes CFR: 32 FR 4001, 03-11-1967

DESCRIPTION: SMALL (2 INCHES), GUPPY-LIKE, LIVE BEARING, LACKS DARK SPOTS ON ITS FINS. BREEDING MALES ARE JET BLACK WITH YELLOW FINS.

ELEVATION RANGE: <4500 FT.

COUNTIES: GILA, PINAL, GRAHAM, YAVAPAI, SANTA CRUZ, PIMA, MARICOPA, LA PAZ

HABITAT: SMALL STREAMS, SPRINGS, AND CIENEGAS VEGETATED SHALLOWS

SPECIES HISTORICALLY OCCURRED IN BACKWATERS OF LARGE RIVERS BUT IS CURRENTLY ISOLATED TO SMALL STREAMS AND SPRINGS

NAME: **RAZORBACK SUCKER** *XYRAUCHEN TEXANUS*

STATUS: ENDANGERED CRITICAL HAB Yes RECOVERY PLAN: Yes CFR: 55 FR 21154, 05-22-1990; 59 FR 13374, 03-21-1994

DESCRIPTION: LARGE (UP TO 3 FEET AND UP TO 16 POUNDS) LONG, HIGH SHARP-EDGED KEEL-LIKE HUMP BEHIND THE HEAD. HEAD FLATTENED ON TOP. OLIVE-BROWN ABOVE TO YELLOWISH BELOW.

ELEVATION RANGE: <6000 FT.

COUNTIES: GREENLEE, MOHAVE, PINAL, YAVAPAI, YUMA, LA PAZ, MARICOPA (REFUGIA), GILA, COCONINO, GRAHAM

HABITAT: RIVERINE & LACUSTRINE AREAS, GENERALLY NOT IN FAST MOVING WATER AND MAY USE BACKWATERS

SPECIES IS ALSO FOUND IN HORSESHOE RESERVOIR (MARICOPA COUNTY).CRITICAL HABITAT INCLUDES THE 100-YEAR FLOODPLAIN OF THE RIVER THROUGH GRAND CANYON FROM CONFLUENCE WITH PARIA RIVER TO HOOVER DAM; HOOVER DAM TO DAVIS DAM; PARKER DAM TO IMPERIAL DAM. ALSO GILA RIVER FROM AZ/NM BORDER TO COOLIDGE DAM; AND SALT RIVER FROM HWY 60/SR 77 BRIDGE TO ROOSEVELT DAM; VERDE RIVER FROM FS BOUNDARY TO HORSESHOE LAKE.

NAME: **BALD EAGLE** *HALIAEETUS LEUCOCEPHALUS*

STATUS: THREATENED CRITICAL HAB No RECOVERY PLAN: Yes CFR: 60 FR 35999, 07-12-95

DESCRIPTION: LARGE, ADULTS HAVE WHITE HEAD AND TAIL. HEIGHT 28 - 38"; WINGSPAN 66 - 96". 1-4 YRS DARK WITH VARYING DEGREES OF MOTTLED BROWN PLUMAGE. FEET BARE OF FEATHERS.

ELEVATION RANGE: VARIES FT.

COUNTIES: YUMA, LA PAZ, MOHAVE, YAVAPAI, MARICOPA, PINAL, COCONINO, NAVAJO, APACHE, SANTA CRUZ, PIMA, GILA, GRAHAM, COCHISE

HABITAT: LARGE TREES OR CLIFFS NEAR WATER (RESERVOIRS, RIVERS AND STREAMS) WITH ABUNDANT PREY

SOME BIRDS ARE NESTING RESIDENTS WHILE A LARGER NUMBER WINTERS ALONG RIVERS AND RESERVOIRS. AN ESTIMATED 200 TO 300 BIRDS WINTER IN ARIZONA. ONCE ENDANGERED (32 FR 4001, 03-11-1967; 43 FR 6233, 02-14-78) BECAUSE OF REPRODUCTIVE FAILURES FROM PESTICIDE POISONING AND LOSS OF HABITAT, THIS SPECIES WAS DOWN LISTED TO THREATENED ON AUGUST 11, 1995. ILLEGAL SHOOTING, DISTURBANCE, LOSS OF HABITAT CONTINUES TO BE A PROBLEM. SPECIES HAS BEEN PROPOSED FOR DELISTING (64 FR 36454) BUT STILL RECEIVES FULL PROTECTION UNDER ESA.

NAME: **CACTUS FERRUGINOUS PYGMY-OWL** *GLAUCIDIUM BRASILIANUM CACTORUM*

STATUS: ENDANGERED CRITICAL HAB Yes RECOVERY PLAN: No CFR: 62 FR 10730, 3-10-97

DESCRIPTION: SMALL (APPROX. 7"), DIURNAL OWL REDDISH BROWN OVERALL WITH CREAM-COLORED BELLY STREAKED WITH REDDISH BROWN. SOME INDIVIDUALS ARE GRAYISH BROWN

ELEVATION RANGE: <4000 FT.

COUNTIES: MARICOPA, YUMA, SANTA CRUZ, GRAHAM, GREENLEE, PIMA, PINAL, GILA, COCHISE

HABITAT: MATURE COTTONWOOD/WILLOW, MESQUITE BOSQUES, AND SONORAN DESERTSCRUB

RANGE LIMIT IN ARIZONA IS FROM NEW RIVER (NORTH) TO GILA BOX (EAST) TO CABEZA PRIETA MOUNTAINS (WEST). ONLY A FEW DOCUMENTED SITES WHERE THIS SPECIES PERSISTS ARE KNOWN, ADDITIONAL SURVEYS ARE NEEDED. CRITICAL HABITAT IN PIMA, COCHISE, PINAL, AND MARICOPA COUNTIES (64 FR 37419).

NAME: **MEXICAN SPOTTED OWL** *STRIX OCCIDENTALIS LUCIDA*

STATUS: THREATENED CRITICAL HAB Yes RECOVERY PLAN: Yes CFR: 56 FR 14678, 04-11-91; 66 FR 8530, 2/1/01

DESCRIPTION: MEDIUM SIZED WITH DARK EYES AND NO EAR TUFTS. BROWNISH AND HEAVILY SPOTTED WITH WHITE OR BEIGE.

ELEVATION RANGE: 4100-9000 FT.

COUNTIES: MOHAVE, COCONINO, NAVAJO, APACHE, YAVAPAI, GRAHAM, GREENLEE, COCHISE, SANTA CRUZ, PIMA, PINAL, GILA, MARICOPA

HABITAT: NESTS IN CANYONS AND DENSE FORESTS WITH MULTI-LAYERED FOLIAGE STRUCTURE

GENERALLY NESTS IN OLDER FORESTS OF MIXED CONIFER OR PONDERSA PINE/GAMBEL OAK TYPE, IN CANYONS, AND USE VARIETY OF HABITATS FOR FORAGING. SITES WITH COOL MICROCLIMATES APPEAR TO BE OF IMPORTANCE OR ARE PREFERED. CRITICAL HABITAT WAS REMOVED IN 1998 BUT RE-PROPOSED IN JULY 2000 AND FINALIZED IN FEB 2001 FOR APACHE, COCHISE, COCONINO, GRAHAM, MOHAVE, PIMA COUNTIES; ALSO IN NEW MEXICO, UTAH, AND COLORADO.

NAME: **SOUTHWESTERN WILLOW FLYCATCHER** *EMPIDONAX TRAILLII EXTIMUS*

STATUS: ENDANGERED CRITICAL HAB Yes RECOVERY PLAN: No CFR: 60 FR 10694, 02-27-95

DESCRIPTION: SMALL PASSERINE (ABOUT 6") GRAYISH-GREEN BACK AND WINGS, WHITISH THROAT, LIGHT OLIVE-GRAY BREAST AND PALE YELLOWISH BELLY. TWO WINGBARS VISIBLE. EYE-RING FAINT OR ABSENT.

ELEVATION RANGE: <8500 FT.

COUNTIES: YAVAPAI, GILA, MARICOPA, MOHAVE, COCONINO, NAVAJO, APACHE, PINAL, LA PAZ, GREENLEE, GRAHAM, YUMA, PIMA, COCHISE, SANTA CRUZ

HABITAT: COTTONWOOD/WILLOW & TAMARISK VEGETATION COMMUNITIES ALONG RIVERS & STREAMS

MIGRATORY RIPARIAN OBLIGATE SPECIES THAT OCCUPIES BREEDING HABITAT FROM LATE APRIL TO SEPTEMBER. DISTRIBUTION WITHIN ITS RANGE IS RESTRICTED TO RIPARIAN CORRIDORS. DIFFICULT TO DISTINGUISH FROM OTHER MEMBERS OF THE EMPIDONAX COMPLEX BY SIGHT ALONE. TRAINING SEMINAR REQUIRED FOR THOSE CONDUCTING FLYCATCHER SURVEYS. CRITICAL HABITAT ON PORTIONS OF THE 100-YEAR FLOODPLAIN ON SAN PEDRO AND VERDE RIVERS; WET BEAVER AND WEST CLEAR CREEKS, INCLUDING TAVASCI MARSH AND ISTER FLAT; THE COLORADO RIVER, THE LITTLE COLORADO RIVER, AND THE WEST, EAST, AND SOUTH FORKS OF THE LITTLE COLORADO RIVER, REFERENCE 60 CFR:62 FR 39129, 7/22/97.

LISTED, PROPOSED, AND CANDIDATE SPECIES FOR THE FOLLOWING COUNTY: **MARICOPA**

02/26/2001

NAME: **YUMA CLAPPER RAIL** *RALLUS LONGIROSTRIS YUMANENSIS*

STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: Yes CFR: 32 FR 4001, 03-11-67; 48 FR 34182, 07-27-83

DESCRIPTION: WATER BIRD WITH LONG LEGS AND SHORT TAIL. LONG SLENDER DECURVED BILL. MOTTLED BROWN ON GRAY ON ITS RUMP. FLANKS AND UNDERSIDES ARE DARK GRAY WITH NARROW VERTICAL STRIPES PRODUCING A BARRING EFFECT.

ELEVATION RANGE: <4500 FT.

COUNTIES: YUMA, LA PAZ, MARICOPA, PINAL, MOHAVE

HABITAT: FRESH WATER AND BRACKISH MARSHES

SPECIES IS ASSOCIATED WITH DENSE EMERGENT RIPARIAN VEGETATION. REQUIRES WET SUBSTRATE (MUDFLAT, SANDBAR) WITH DENSE HERBACEOUS OR WOODY VEGETATION FOR NESTING AND FORAGING. CHANNELIZATION AND MARSH DEVELOPMENT ARE PRIMARY SOURCES OF HABITAT LOSS.

THE STATE OF ARIZONA
GAME AND FISH DEPARTMENT
2221 WEST GREENWAY ROAD, PHOENIX, AZ 85023-4399
(602) 942-3000 • WWW.AZGFD.COM

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DEPUTY DIRECTOR
STEVE K. FERRELL

June 19, 2001

Mr. Phil Hackney
ENSR International
1601 Prospect Parkway
Fort Collins, CO 80525-9769

Re: Special Status Species Information for **Township 1 South, Range 6 West, Section 17; Arlington Valley Energy Facility II (AVEF II) Project, Maricopa County.**

Dear Mr. Hackney:

The Arizona Game and Fish Department (Department) has reviewed your request, dated June 1, 2001, regarding special status species information associated with the above-referenced project area. The Department's Heritage Data Management System (HDMS) has been accessed and current records show that the special status species listed on the attachment have been documented as occurring in the project area. In addition, this project does not occur in the vicinity of any proposed or designated Critical Habitats.

The Department's HDMS data are not intended to include potential distribution of special status species. Arizona is large and diverse with plants, animals, and environmental conditions that are ever changing. Consequently, many areas may contain species that biologists do not know about or species previously noted in a particular area may no longer occur there. Not all of Arizona has been surveyed for special status species, and surveys that have been conducted have varied greatly in scope and intensity.

Making available this information does not substitute for the Department's review of project proposals, and should not decrease our opportunities to review and evaluate new project proposals and sites. The Department is also concerned about other resource values, such as other wildlife, including game species, and wildlife-related recreation. The Department would appreciate the opportunity to provide an evaluation of impacts to wildlife or wildlife habitats associated with project activities occurring in the subject area, when specific details become available.

If you have any questions regarding the attached species list, please contact me at (602) 789-3618. General status information and county distribution lists for special status species are also available on our web site at http://www.azgfd.com/frames/fishwild/hdms_site/Home.htm.

Sincerely,

Sabra S. Schwartz
Heritage Data Management System, Coordinator

SSS:ss

Attachment

cc: Bob Broscheid, Project Evaluation Program Supervisor
Russ Haughey, Habitat Program Manager, Region VI

AGFD #6-4-01(07)

Special Status Species within 5 Miles of T1S,R6W Sec 17

Arizona Game and Fish Department, Heritage Data Management System

June 19, 2001

Scientific Name	Common Name	ESA	USFS	BLM	WSCA	NPL
OPUNTIA ECHINOCARPA	STRAW-TOP CHOLLA					SR

No Critical Habitats in project area; AGFD # 6-4-01(07); Arlington Valley Energy Facility II (AVEF II) Project, Maricopa

STATUS DEFINITIONS

ARIZONA GAME AND FISH DEPARTMENT (AGFD)
HERITAGE DATA MANAGEMENT SYSTEM (HDMS)

FEDERAL US STATUS

ESA **Endangered Species Act** (1973 as amended)
US Department of Interior, Fish and Wildlife Service (http://arizonaes.fws.gov)

Listed

- LE Listed Endangered: imminent jeopardy of extinction.
- LT Listed Threatened: imminent jeopardy of becoming Endangered.
- XN Experimental Nonessential population.

Proposed for Listing

- PE Proposed Endangered.
- PT Proposed Threatened.

Candidate (Notice of Review: 1999)

- C Candidate. Species for which USFWS has sufficient information on biological vulnerability and threats to support proposals to list as Endangered or Threatened under ESA. However, proposed rules have not yet been issued because such actions are precluded at present by other listing activity.
- SC Species of Concern. The terms "Species of Concern" or "Species at Risk" should be considered as terms-of-art that describe the entire realm of taxa whose conservation status may be of concern to the US Fish and Wildlife Service, but neither term has official status (currently all former C2 species).

Critical Habitat (check with state or regional USFWS office for location details)

- Y Yes: Critical Habitat has been designated.
- P Proposed: Critical Habitat has been proposed.

[\N No Status: certain populations of this taxon do not have designated status (check with state or regional USFWS office for details about which populations have designated status)].

USFS **US Forest Service** (1999 Animals, 1999 Plants)
US Department of Agriculture, Forest Service, Region 3 (http://www.fs.fed.us/r3/)

- S Sensitive: those taxa occurring on National Forests in Arizona which are considered sensitive by the Regional Forester.

BLM **US Bureau of Land Management** (2000 Animals, 2000 Plants)
US Department of Interior, Bureau of Land Management, Arizona State Office (http://azwww.az.blm.gov)

- S Sensitive: those taxa occurring on BLM Field Office Lands in Arizona which are considered sensitive by the Arizona State Office.
- P Population: only those populations of Banded Gila monster (*Heloderma suspectum cinctum*) that occur north and west of the Colorado River, are considered sensitive by the Arizona State Office.

TRIBAL STATUS

NESL **Navajo Endangered Species List** (1997)
Navajo Nation, Navajo Fish and Wildlife Department
(http://www.heritage.tnc.org/nhp/us/navajo/esl.html)

The Navajo Endangered Species List contains taxa with status from the entire Navajo Nation which includes parts of Arizona, Utah, and New Mexico. In this notebook we provide NESL status for only those taxa whose distribution includes part or all of the Arizona portion of the Navajo Nation.

Groups

1 Those species or subspecies that no longer occur on the Navajo Nation.

2 Any species or subspecies which is in danger of being eliminated from all or a significant portion of its range on the Navajo Nation.

3 Any species or subspecies which is likely to become an endangered species, within the foreseeable future, throughout all or a significant portion of its range on the Navajo Nation.

4 Any species or subspecies for which the Navajo Fish and Wildlife Department (NF&WD) does not currently have sufficient information to support their being listed in Group 2 or Group 3 but has reason to consider them. The NF&WD will actively seek information on these species to determine if they warrant inclusion in a different group or removal from the list.

MEXICAN STATUS

MEX **Mexican Federal Endangered Species List** (May 16, 1994)
Secretarí a de Desarollo Social, NORMA Oficial Mexicana NOM-059-ECOL-1994

The Mexican Federal Endangered Species List contains taxa with status from the entire Mexican Republic and waters under its jurisdiction. In this notebook we provide MEX designations for only those taxa occurring in Arizona and also in Mexico.

P En Peligro de Extinción(Determined Endangered in Mexico): in danger of extinction.

A Amenazada (Determined Threatened in Mexico): could become endangered if factors causing habitat deterioration or population decline continue.

R Rara (Determined Rare in Mexico): populations viable but naturally scarce or restricted to an area of reduced distribution or very specific habitats.

Pr Sujeta a ProtecciónEspecial (Determined Subject to Special Protection in Mexico): utilization limited due to reduced populations, restricted distribution, or to favor recovery and conservation of the taxon or associated taxa.

[| = One or more subspecies of this species has status in Mexico, but the HDMS does not track it at the subspecies level (most of these subspecies are endemic to Mexico). Please consult the NORMA Oficial Mexicana NOM-059-ECOL-1994 for details.]

STATE STATUS

NPL **Arizona Native Plant Law** (1993)
Arizona Department of Agriculture (http://agriculture.state.az.us/PSD/nativeplants.htm)

- **HS** Highly Safeguarded: no collection allowed.
- **SR** Salvage Restricted: collection only with permit.
- **ER** Export Restricted: transport out of State prohibited.
- **SA** Salvage Assessed: permits required to remove live trees.
- **HR** Harvest Restricted: permits required to remove plant by-products.

WSCA **Wildlife of Special Concern in Arizona** (1996 in prep)
Arizona Game and Fish Department (http://www.azgfd.com)

- **WC** Wildlife of Special Concern in Arizona. Species whose occurrence in Arizona is or may be in jeopardy, or with known or perceived threats or population declines, as described by the Arizona Game and Fish Department's listing of Wildlife of Special Concern in Arizona (WSCA, in prep). Species indicated on printouts as WC are currently the same as those in **Threatened Native Wildlife in Arizona** (1988).

EXHIBIT D
BIOLOGICAL RESOURCES

EXHIBIT D

As stated in Arizona Corporation Commission Rules of Practice and Procedure R14-3-219:

"List the fish, wildlife, plant life, and associated forms of life in the vicinity of the proposed site or route and describe the effects, if any, other proposed facilities will have thereon."

BIOLOGICAL RESOURCES

Tables D-1, D-2, D-3, and D-4 list the mammal, bird, reptiles and amphibians, and plant species, potentially occurring within the vicinity of the project. Because no flowing streams are present within the project area, fish species have not been listed.

Construction of the project is expected to have negligible impacts to native vegetation since the plant site is characterized by sparse, primarily non-native plant species. Agricultural lands and creosote bush flats are common in the region.

Impacts to wildlife populations in the vicinity of the project are expected to be minimal due to the low quality habitat of the agricultural lands affected. Additionally, construction will not impact unique vegetation or wildlife species, habitat, or movement corridors for wildlife.

REFERENCES

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National Geographic Society. 1999. *Field guide to the birds of North America*. Third edition. National Geographic Society, Washington, D.C.

Stebbins, R. C. 1985. *A field guide to western reptiles and amphibians.* Petersen Field Guides. Houghton Mifflin Co., Boston.

Witzeman, J., S. Demaree and E. Radke. 1997. *Birds of Phoenix and Maricopa County, Arizona.* Maricopa Audubon Society, Phoenix, Arizona.

Table D-1

Mammals Potentially Present in the Project Area

Common Name	Scientific Name[1]	Habitat Type[1]
Desert shrew	*Notiosorex crawfordi*	Desert with adequate hiding/nest cover
Western pipistrelle	*Pipistrellus hesperus*	Desert with nearby cliffs or rock outcrops; summer only
Big brown bat	*Eptesicus fuscus*	Pine forests to desert with caves, mine shafts, or saguaro cavities for roosting; summer only
Pallid bat	*Antrozous pallidus*	Desert with buildings, bridges, mine shafts, or cliffs for roosting
Brazilian free-tailed bat	*Tadarida brasiliensis*	Desert with caves or mine shafts
Desert cottontail	*Sylvilagus audubonii*	Desert to juniper woodlands in areas with dense shrub cover
Black-tailed jackrabbit	*Lepus californicus*	Desert to juniper woodlands
Harris' antelope squirrel	*Ammospermophilus harrisii*	Saltbush-creosote bush-bursage desert
Round-tailed ground squirrel	*Spermophilus tereticaudus*	Creosote-bush-saltbush desert
Botta's pocket gopher	*Thomomys bottae*	All environments with adequate plant cover
Arizona pocket mouse	*Perognathus amplus*	Sonoran, and Mojave deserts
Little pocket mouse	*Perognathus longimembris*	Sandy creosote bush desert
Desert pocket mouse	*Perognathus penicillatus*	Sonoran desert
Rock pocket mouse	*Chaetodipus intermedius*	Rocky areas of Sonoran desert
Desert kangaroo rat	*Dipodomys deserti*	Sandy areas of Sonoran desert
Merriam's kangaroo rat	*Dipodomys merriami*	Creosote bush-mesquite desert
Western harvest mouse	*Reithrodontomys megalotis*	Wide variety of environments with grassy or weedy areas
Cactus mouse	*Peromyscus eremicus*	Variety of desert environments
Southern grasshopper mouse	*Onychomys torridus*	Desert with mesquite and cacti
Arizona cotton rat	*Sigmodon arizonae*	Desert with mesquite
White-throated wood rat	*Neotoma albigula*	Wide variety of desert environments
Desert wood rat	*Neotoma lepida*	Variety of environments from creosote bush to pine
Coyote	*Canis latrans*	All environments
Kit fox	*Vulpes macrotis*	Desert with sandy or diggable clay soils
Gray fox	*Urocyon cinereoargenteus*	Wide variety of environments including open desert
Collared peccary	*Tayassu tajacu*	Sonoran desert with shrub and tree thickets and cactus patches
Mule deer	*Odocoileus hemionus*	Variety of environments from desert to pine forests

Source:
[1]Hoffmeister 1986

Table D-2

Common Bird Species Potentially Present in the Project Area[1]

Common Name	Scientific Name[2]	Habitat Type[3]
Red-tailed hawk	*Buteo jamaicensis*	Habitat variable
American kestrel	*Falco sparverius*	Open country
Gambel's quail	*Callipepla gambelii*	Desert scrublands and thickets
White-winged dove	*Zenaida asiatica*	Dense mesquite, mature citrus groves, riparian woodlands, saguaro-paloverde desert
Mourning dove	*Zenaida macroura*	Wide variety of habitats; often near drainages
Greater roadrunner	*Geococcyx californianus*	Scrub desert, mesquite groves
Great horned owl	*Bubo virginianus*	Habitat variable
Burrowing owl	*Athene cunicularia*	Open country
Lesser nighthawk	*Chordeiles acutipennis*	Dry open country, scrubland, desert
Common poorwill	*Phalaenoptilus nuttali*	Sagebrush and chaparral slopes
Costa's hummingbird	*Calypte costae*	Desert washes, dry chaparral
Gila woodpecker	*Melanerpes uropygialis*	Scrub desert, cactus country, streamside woods
Gilded flicker	*Colaptes chrysoides*	Low desert woodlands, saguaros
Ash-throated flycatcher	*Myiarchus cinerascens*	Wide variety of habitats
Western kingbird	*Tyrannus verticalis*	Dry open country
Loggerhead shrike	*Lanius ludovicianus*	Open or brushy areas
Common raven	*Corvus corax*	Variety of habitats
Verdin	*Aurilparus flaviceps*	Mesquite and other dense thorny shrubs or southwestern desert
Cactus wren	*Campylorhynchus brunneicapillus*	Cactus country and arid hillsides and valleys
Black-tailed gnatcatcher	*Polioptila melanura*	Desert resident, partial to washes
Northern mockingbird	*Mimus polyglottos*	Variety of habitats
European starling	*Sturnis vulgaris*	Wide variety of habitats
Curve-billed thrasher	*Toxostoma curvirostre*	Canyons, semiarid brushland
Phainopepla	*Phainopepla nitens*	Mesquite brushland
Lucy's warbler	*Vermivora luciae*	Mesquite and cottonwoods along watercourses
Black-throated sparrow	*Amphispiza bilineata*	Desert, especially rock slopes
Northern cardinal	*Cardinalis cardinalis*	Taller and denser Lower Sonoran brush[4]
Brown-headed cowbird	*Molothrus ater*	Woodlands, farmlands, suburbs
House finch	*Carpodacus mexicanus*	Habitat variable
Turkey vulture	*Cathartes aura*	Habitat variable
Northern harrier	*Circus cyaneus*	Habitat variable

Sources:
[1]Potential for occurrence based on Monson and Phillips 1981 and Witzeman et al. 1997
[2]American Ornithological Union 1998
[3]National Geographic Society 1999
[4]Monson and Phillips 1981

Table D-3

Reptile and Amphibian Species Potentially Present in the Project Area[1]

Common Name	Scientific Name	Habitat Type[2]
TOADS		
Couch spadefoot	*Scaphiopus couchi*	Shortgrass plains, mesquite savannah, creosote bush desert, and other areas of low rainfall
Western spadefoot	*Scaphiopus hammondii*	Washes, floodplains, alluvial fans, playas, alkali flats
Red-spotted toad	*Bufo punctatus*	Desert streams, open grassland and scrubland, oak woodland, rocky canyons
LIZARDS		
Western banded gecko	*Coleonyx variegatus*	Variety of habitats, from creosote bush flats to pinon-juniper belt
Desert iguana	*Dipsosaurus dorsalis*	Creosote bush desert
Zebratail lizard	*Callisaurus draconoides*	Washes, desert pavement, hardpan
Desert spiny lizard	*Sceloporus magister*	Arid/semiarid plains and lower mountain slopes
Side-blotched lizard	*Uta stansburiana*	Sand, rock, hardpan or loam with grass, shrubs, and scattered trees
Desert horned lizard	*Phrynosoma platyrhinos*	Sandy flats, alluvial fans, washes, dune edges
Western whiptail	*Cnemidophorus tigris*	Desert and semiarid areas with sparse vegetation
SNAKES		
Spotted leaf-nosed snake	*Phyllorhynchus decurtatus*	Open desert plains
Coachwhip	*Masticophis flagellum*	Variety of habitats
Western patch-nosed snake	*Salvadora hexalepis*	Grasslands, chaparral, sagebrush plains, pinon-juniper woodland, desert scrub
Glossy snake	*Arizona elegans*	Variety of open desert and grassland areas
Gopher snake	*Pituophis melanoleucus*	Variety of habitats
Common kingsnake	*Lampropeltis getulus*	Variety of habitats
Long-nosed snake	*Rhinocheilus lecontei*	Desert, prairies, shrubland
Ground snake	*Sonora semiannulata*	Arid and semiarid regions; river bottoms, desert flats, sand hummocks, rocky hillsides
Western shovel-nosed snake	*Chionactus occipitalis*	Washes, dunes, sandy flats, loose soils, rocky hillsides
Night snake	*Hypsiglena torquata*	Variety of habitats
Arizona coral snake	*Micruroides euryxanthus*	Arid and semiarid thornscrub, brushland, woodland, grassland, farmland
Western diamondback rattlesnake	*Crotalus atrox*	Variety of habitats in arid and semiarid regions
Sidewinder	*Crotalus cerastes*	Sand hummocks topped with creosote bushes, mesquite, or other desert plants; also windswept flats, barren dunes, hardpan, rocky hillsides

Sources:
[1]Potential for occurrence based on Stebbins 1985
[2]Stebbins 1985

Table D-4

Plant Species Potentially Present in the Project Area

Common Name	Scientific Name[1]	Habitat Type[2]
Red brome	*Bromus rubens*	Roadside and waste places
Arabian grass	*Schismus arabicus*	Sandy soil
Mediterranean grass	*Schismus barbatus*	Open desert
Wingscale	*Atriplex canescens*	Sandy, sometimes saline soil
Quail brush	*Atriplex lentiformes*	Moist or dry saline soil
All scale	*Atriplex polycarpa*	Moderately saline to nonsaline soil
Russian thistle[3]	*Salsola iberica*	Roadsides, overgrazed ranges
Yellow tansy mustard	*Descurainia pinnata*	Open ground
London rocket	*Sisymbrium irio*	Abundant in irrigated areas
Catclaw acacia	*Acacia greggi*	Along streams and washes
Velvet mesquite[3]	*Prosopis velutina*	Along watercourses, on grasslands and lower mountain slopes
Blue paloverde	*Cercidium floridum*	Along washes, on floodplains
Filaree	*Erodium cicutarium*	Common on plains and mesas
Creosote bush	*Larrea tridentata*	Dry plains and mesas
Corona de Cristo	*Castela emoryi*	Desert plains
Graythorn	*Ziziphus obtusifolia*	Dry mesa, plains, slopes
Alkali pink, globemallow[3]	*Sphaeralcea parviflora*	Roadsides, fields, edges of sandy washes, well-drained slopes
Tamarisk, salt cedar[3]	*Tamarix pentandra*	Along streams and disturbed sites
Wolfberry	*Lycium* spp.	Washes and dry slopes in desert or semidesert areas
Desert willow	*Chilopsis linearis*	Along washes in deserts and foothills
Triangle-leaf bursage	*Ambrosia deltoidea*	Plains and mesas
White bursage	*Ambrosia dumosa*	Dry plains and mesas
Desert broom	*Baccharis sarothroides*	Hillsides and bottomlands, sometimes in saline soil
Alkali goldenbush	*Isocoma acradenius*	Various habitats, often in saline soils
Jimmy weed	*Isocoma heterophyllus*	Mesas and plains, often in saline soil and on overgrazed rangeland
Prickly lettuce	*Lactuca serriola*	Waste land and roadsides
Bermuda grass[3]	*Cynodon dactylon*	Fields, washes, disturbed sites
Pigweed	*Amaranthus sp.*	Disturbed sites
Cholla cactus	*Opvutia* sp.	Creosote bush flats, washes
Brittle bush	*Encelia farinosa*	Creosote bush flats, washes
Nightshade[3]	*Solanum* sp.	Disturbed sites, fields
Purslane	*Portulaca* sp.	Disturbed sites, fields
Annual sunflower[3]	*Helianthus annuus*	Disturbed sites, fields, roadsides
Canarygrass[3]	*Phalaris canariensis*	Disturbed sites, fields, roadsides
Johnsongrass[3]	*Sorghum halepense*	Disturbed sites, fields, roadsides
Ragweed	*Ambrosia* sp.	Disturbed sites, fields, washes

Sources:
[1]Lehr 1978
[2]Kearney and Peebles 1960
[3]Observed during June 2001 site visit

EXHIBIT E
SCENIC AREAS, HISTORIC SITES AND STRUCTURES, AND ARCHAEOLOGICAL SITES

EXHIBIT E
SCENIC AREAS, HISTORIC SITES AND STRUCTURES, ARCHAEOLOGICAL SITES

As stated in Arizona Corporation Commission Rules of Practice and Procedure R14-3-219:

"Describe any existing scenic areas, historic sites and structures or archaeological sites in the vicinity of the proposed facilities and state the effects, if any, the proposed facilities will have thereon."

SCENIC AREAS AND VISUAL RESOURCES

The visual resource study addressed the inherent aesthetics of the landscape, public value of viewing the landscape, and sensitivity to visual effects from the proposed AVEF II project. The visual analysis was conducted by Duke Energy-Flour Daniel in June 2001 and included an evaluation of the existing visual conditions, scenic quality, and visual sensitivity.

The project area is located within the Basin and Range physiographic province in southwest Arizona (USDA 1989). More specifically it is within the Sonoran Desertscrub – Lower Colorado Subdivision (Lowe 1964). The topographic features within and surrounding the project area can be characterized as flat, with isolated hills occurring within 1 to 2 miles of the proposed project. The Palo Verde Hills and Yellow Medicine Hills are located 5 to 7 miles northwest and southwest of the project, respectively. The White Tank Mountains and Gila Bend Mountains are 12 to 15 miles northeast and south of the project, respectively. The average elevation above mean sea level is approximately 875 feet in the project area.

The vegetation in the project vicinity is dominated by agricultural land. Along Winters Wash and Centennial Wash, located east and south of the plant site, respectively, mesquite, salt cedar, ironwood, and acacia dominate the landscape. The proposed project site is located on vacant agricultural land.

At present, the most dominant man-made features within the project area include the PVNGS, the AVEF I and Redhawk power plants, and Hassayampa switchyard currently under construction, high-voltage transmission line corridors, numerous aboveground electrical subtransmission and distribution lines, a distribution substation, the Union Pacific Railroad, a few occupied residences and unoccupied structures, concrete irrigation canals, abandoned structures, paved and unpaved road surfaces, range gates, signs, as well as other man-made elements (e.g., abandoned water tanks) that have significantly altered the natural setting.

Visual Quality

The scenic value or visual quality of the landscape is a function of the attributes or amenities that naturally occur within that setting (land forms, rock formations, topography, presence of water, vegetation patterns) which add to or diminish its value. Within the project area, the landscape is lacking in natural amenities and could be described as common or non-distinctive. Exhibit E-1 provides a photosimulation of the proposed AVEF II site looking south from Elliot Road. This photosimulation includes the approved AVEF I as it is expected to appear during operation in 2002.

Sensitive Viewpoints

The sensitivity of a viewpoint reflects the degree of public concern for change in the scenic quality of the landscape visible from that location. Sensitivity is measured by evaluating the type of viewpoint and viewer concern for change in the landscape, volume of use, viewing duration, public concerns, and influence of adjacent land use. Sensitive viewpoints that were identified within the project area include residences and the old U.S. 80. Exhibit E-2 presents a photosimulation of the proposed AVEF II (with the approved AVEF I in the foreground) looking south from Elliot Road. Exhibit E-3 presents a photosimulation of the proposed AVEF II (with the approved AVEF I) looking southeast, approximately 1.5 miles down Elliot Road.

Residences - Residences are considered high sensitivity viewpoints since their occupants have a high concern for change in the landscape and have long-term viewing conditions. There are two ranch residents located approximately 0.7 to 0.8 mile northwest of the proposed project site. It is anticipated that residential views of the proposed project would be unobstructed due to insufficient topographic variances to effectively screen the site. However, the presence of existing high-voltage transmission lines between these viewers and the proposed project site has already altered the landscape setting.

Another 2 ranch residences are located approximately 1.0 to 1.5 miles west and northwest of the proposed project site. A residential area is located approximately 1.8 miles west-northwest of the project site. Variation in topography between the proposed project and these residences will partially screen the majority of the power plant. It is anticipated that portions of the stacks will be visible from these residences.

Large-scale residential and supporting infrastructure (schools, regional parks, churches, retail services) developments are not expected to occur in the reasonable foreseeable future within the project area. The majority of lands within the immediate vicinity of the proposed project are currently planned for Rural Residential High-Density use. According to Maricopa County's

EXHIBIT E-1. PHOTOSIMULATION OF PROPOSED PROJECT SITE (AVEF I AFTER CONSTRUCTION)

EXHIBIT E-2. PHOTOSIMULATION OF PROPOSED AVEF II (WITH AVEF I) FROM ELLIOT RD

EXHIBIT E-3. PHOTOSIMULATION OF PROPOSED AVEF II (WITH AVEF I) 1.5 MILES DOWN ELLIOT RD

Tonopah Area Land Use Plan, this residential category denotes areas where single-family residential development is desirable but urban services (e.g., water, sewer, schools, parks, law enforcement, fire protection) are limited. The County recently updated its *Tonopah/Arlington Area Plan* (2000) (see Exhibit B-3, Land Use Study).

Travel Routes – The old U.S. 80 alignment has not been designated by the State Historic Preservation Office as being eligible as a listed historic property. Further, the distance from this road to the proposed project site is in excess of 2 miles. It is not anticipated that the proposed project will significantly affect this road.

Mitigation

In an effort to blend with the background landscape setting, dark hues of browns, greens, and grays will be utilized to the extent feasible in the painting of the proposed project facility.

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HISTORIC SITES AND STRUCTURES AND ARCHAEOLOGICAL SITES

Methods

In November 1999, a comprehensive literature search and records review was conducted by the Arizona State Museum and through the Arizona State Historic Preservation Office. The file search identified previously completed cultural resources surveys, all previously recorded archaeological sites and historic properties listed on the National Register of Historic Places (NRHP), and previously recorded standing structures situated within a 2-mile radius of the proposed project site. The goal of the review was to determine whether the construction and operation of the proposed project might affect archaeological or historic cultural resources.

Findings

The review of agency and museum files documented 8 cultural resource surveys previously conducted within a 2-mile radius of the project site (Table E-1). The earliest of these surveys was conducted in 1972 and 1973 at geotechnical boring locations associated with the PVNGS. The plant site and buffer zone were intensively surveyed and the results were summarized in a report (Trott 1974). This report does not document the full extent and methods of this survey work, but a large block encompassing approximately 8,360 acres apparently was surveyed intensively (Stein 1981). At least 31 archaeological and historical sites were identified and recorded within this block, and 22 additional sites were recorded in adjacent areas. These sites include aboriginal archaeological sites containing approximately 20 lithic scatters, 10 trails, 2 petroglyphs, 5 rock enclosures, and 16 historic sites consisting primarily of 1920's-1930's homestead remnants. Five of these sites, designated AZ T:9:25, 27, 29, 37, and 49 (MNA), are located within a 2-mile radius of the proposed project site, but not within the project site.

In 1975, studies were conducted at 13 sites to mitigate the impacts of construction of the PVNGS (Stein 1981). Two of these sites, AZ T:9:25 (MNA) and AZ T:9:29 (MNA), are aboriginal archaeological sites recorded by Trott (1974) and are located within a 2-mile radius of the proposed project site, but not within the project site. Site AZ T:9:25 (MNA) consists of seven rock enclosures ranging from circular to rectangular in form; no artifacts or other cultural remains were found in association with these rock enclosures. Site AZ T:9:29 (MNA) consists of a trail leading up the southwestern side of a basalt hill; one plainware sherd was located at the base of the trail. The function of the trail is interpreted as an intaglio art-form rather than a transportation route.

In 1976, the Museum of Northern Arizona surveyed two alternate transmission line corridors that extend from the PVNGS to the Colorado River (Berry 1978). Of the 73 recorded sites, only two (AZ T:9:21 and 22[ASM]) are located within a 2-mile radius of the proposed project site; neither of these lie within the project site. Both sites are identified as temporary camps of Patayan cultural affiliation. The sites contain numerous basalt lithics, millingstone fragments, flakes, and ceramics. Neither of the sites is recommended as eligible to the NRHP due to off-road vehicle and cattle grazing disturbance.

Several studies were conducted for the transmission lines that were constructed to connect the PVNGS to the regional power grid. Surveys for the Palo Verde-Kyrene line (Powers et al. 1978) covered a 200-foot-wide corridor that falls within a 2-mile radius of the proposed project site, but not within the project site. The survey documented a single site, AZ T:9:5 (ASM), located on the south side of Centennial Wash. The site is a scatter of fewer than 50 artifacts including a few pieces of flaked stone and six types of ceramic sherds, including both Hohokam and Patayan varieties.

Table E-1

Previous Cultural Resource Surveys

Project Name and Number	Scope	Sites	Reference
All American pipeline survey	145 miles x 200 feet (3,515 acres)	No sites within 2-mile radius of project site	Batcho 1985
Palo Verde-Devers transmission line survey	190 miles x 400 feet (9,212 acres)	AZ T:9:21 and 22 (ASM) within 2-mile radius but not within project site	Berry 1978
Yuma 500kV transmission line	119.8 miles x 200 feet (2,904 acres)	AZ T:9:1, 2, and 3 (ASM) within 2-mile radius but not within project site	Effland and Green 1982
All American pipeline survey	95 miles x 200 feet (2,303 acres)	No sites within 2-mile radius of the project site	Higgins and Brunson 1985
Palo Verde to Kyrene transmission line	73.3 miles x 100-330 feet (~1,777 acres)	AZ T:9:5 (ASM) - within 2-mile radius but not within the project site	Powers et al 1978
PacifiCorp turbine pipeline survey	6.8 miles x 200 feet (165 acres)	No sites within 2-mile radius of the project site	Rogge and Darrington 1994
Devers-Palo Verde transmission line No. 2 survey	385 acres	AZ R:8:61 (ASM), AZ S:6:20 and 21 (ASM) - not within 2-mile radius of project site	Swartz and Dongoske 1987
Palo Verde plant survey	9,300 acres	AZ T:9:25, 27, 29, 37, and 49 (MNA) within 2-mile radius but not within project site	Trott 1974
Arlington Valley Energy Project survey	94 acres	No sites within the project site	Ellis and Copeland 2000
Arlington Valley Energy Project survey	285 acres	No sites within the project site	Copeland and Breternitz 2000

In 1981, twenty-three cultural resources were inventoried during the intensive 100 percent survey of the Yuma 500 kV transmission line (Effland and Green 1982). Three sites (AZ T:9:1, 2, and 3) are located within a 2-mile radius of the proposed project site; none of these sites lie within the project site. Site AZ T:9:1 (ACS) is an historic homestead circa 1920's - 1930's and includes structures in various stages of disrepair, irrigation canals, and domestic debris. AZ T:9:2 (ACS) is the site of the Crag railroad station building complex (dismantled) and associated debris. The

remaining site, AZ T:9:3 (ACS) is an aboriginal lithic scatter consisting of cores, flakes, and angular waste occurring in low densities. None of the sites is recommended as eligible to the NRHP.

Two pedestrian surveys were conducted by New Mexico State University for the All American Pipeline right-of-way. The first survey was conducted in the spring of 1985 between Oracle, Arizona and a point 145 miles to the west (Batcho 1985). The survey resulted in the documentation of 13 sites, 9 low-density artifact scatters, and 49 isolated occurrences. None of the recorded sites is located within a 2-mile radius of the proposed project site. Between March and August 1985, the second cultural resources survey was conducted between Ward Road and a point 95 miles to the west (Higgins and Brunson 1985). The inventory identified 20 sites and 25 isolated occurrences. Aboriginal lithic debris, rock rings, and trails without artifacts characterize nineteen of the 20 sites. The remaining site is the La Paz Pumping Station in which 3 small modern rock cairns were discovered. None of the sites is situated within a 2-mile radius of the project site.

The Institute for American Research conducted a non-collection survey for the Devers-Palo Verde No. 2 Transmission Line in May to June of 1987 (Swartz and Dongoske 1987). Thirty-four previously recorded sites were located and three additional sites were recorded. The 3 newly recorded sites (AZ R:8:61, AZ S:6:20 and 21[ASM]) are characterized by prehistoric lithic scatter of unknown cultural affiliation and a single trail segment with no artifacts or additional features. None of the 37 sites lies within a 2-mile radius of the project site.

In 1994, a Class III cultural resource survey was conducted for the Pacificorp Turbine Pipeline Project Wintersburg Alternatives (Rogge and Darrington 1994). No archaeological sites, isolated finds, or other types of cultural resources were encountered during the survey.

A Class III cultural resources survey of approximately 94 acres of state and private land scheduled for development as part of AVEF I was conducted in January 2000 (Ellis and Copeland 2000). Six isolated occurrences of prehistoric artifacts were found. No archaeological sites were located. An additional 285 acres of private land surrounding the project area was surveyed in August 2000 (Copeland and Breternitz 2000). A single isolated occurrence consisting of a basalt slab metate was found. No archaeological sites were located. The area surveyed in 2000 for the AVEF I project included the proposed AVEF II project site.

Conclusion

A total of 11 archaeological and historic sties have been discovered within a 2-mile radius of the proposed project site, but not within the project site. Nine of these are aboriginal sites, consisting

of lithic scatters, or features such as trails, intaglios, rock enclosures, and hearths. One site appears to be the remnants of a homestead dating to the first half of the twentieth century, and the remaining site is the historic Crag railroad station. No traditional cultural properties were identified.

Today, the significance of archaeological, historical, and traditional cultural properties commonly is evaluated by using the criteria (36 CFR 60.4 [a-d]) for inclusion on the National Register of Historic Places and the counterpart Arizona Register of Historic Places. Criteria for both of these registers are essentially the same. When the PVNGS studies were conducted in the late 70s, the use of register criteria to evaluate significance was not standard procedure. However, field recommendations for further study in order to mitigate project impacts or protect resources in place are a good indication of resource significance.

Of the 11 sites located within a 2-mile radius of the project, mitigation studies were conducted on 5 of them, 5 sites were recommended as not eligible for inclusion to the NRHP, and the remaining site was not recommended for further study.

Many of the aboriginal archaeological sites were found along major washes or clustered around the volcanic hills scattered throughout the area. The proposed project site lacks both of these topographic features. In addition, no aboriginal sites were found within those portions of the proposed project area that had been farmed.

In summary, little potential exists for the proposed project to affect archaeological or historical sites. No additional Class III surveys are required.

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EXHIBIT F
RECREATIONAL PURPOSES AND ASPECTS

EXHIBIT F
RECREATIONAL PURPOSES AND ASPECTS

As stipulated in Arizona Corporation Commission Rules of Practice and Procedure R14-3-219:

"State the extent, if any, the proposed site or route will be available to the public for recreational purposes, consistent with safety considerations and regulations and attach any plans the applicant may have concerning the development of the recreational aspects of the proposed site or route."

RECREATIONAL PURPOSES AND ASPECTS

Duke is unaware of any officially approved plans for the development of recreational facilities within the vicinity of the proposed project. The construction, operation, and maintenance of proposed project facilities will be consistent with safety considerations, and will not be open to public access.

EXHIBIT G
CONCEPT OF PROJECT FACILITIES

EXHIBIT G
CONCEPT OF PROJECT FACILITIES

As stated in Arizona Corporation Commission Rules of Practice and Procedure R14-3-219:

"Attach any artist's or architect's conception of the proposed plant or transmission line structures and switchyards which applicant believes may be informative to the committee."

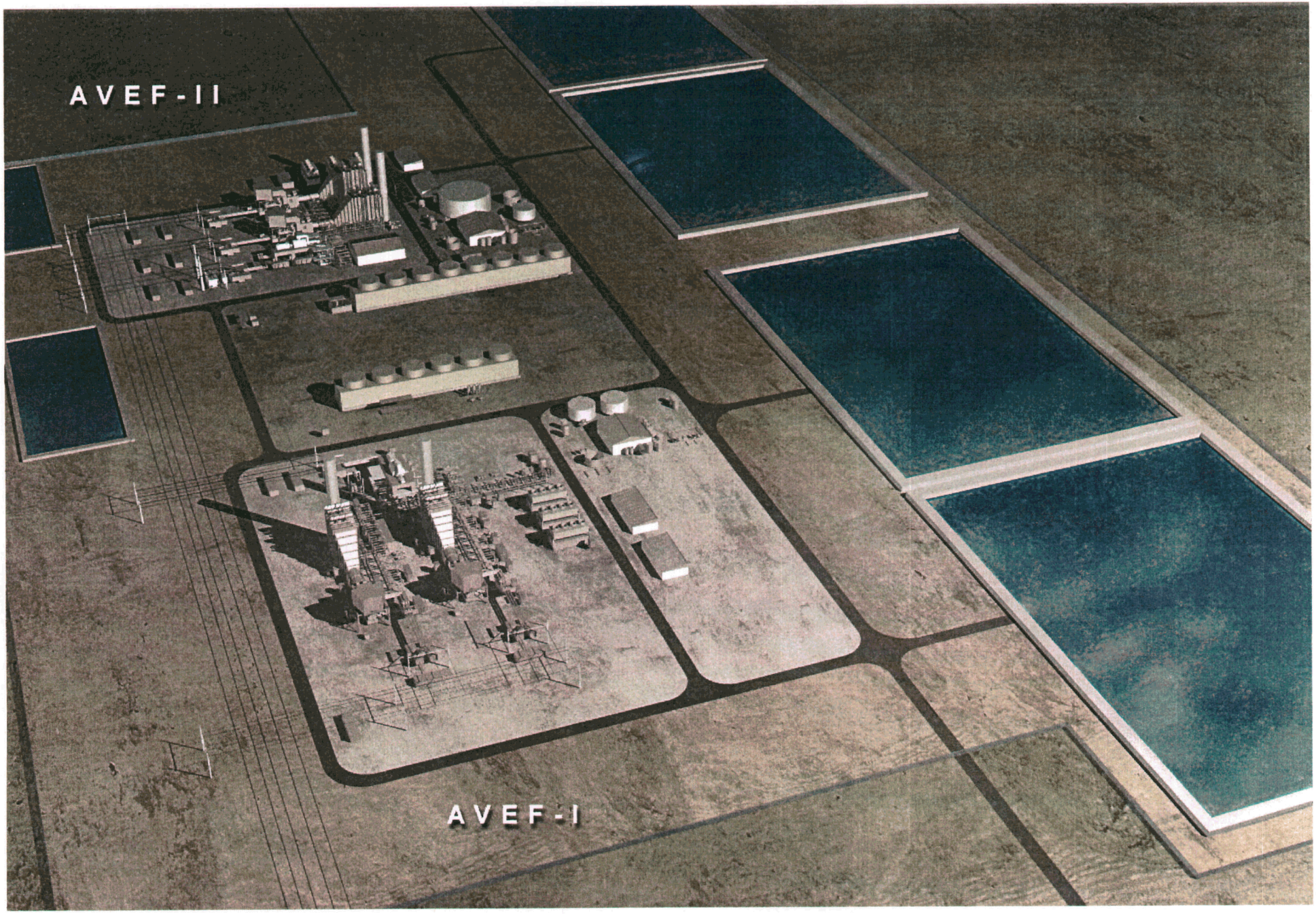

EXHIBIT G-1. PHOTOSIMULATION OF AVEF II LAYOUT (WITH AVEF I IN FOREGROUND)

EXHIBIT H
EXISTING PLANS

EXHIBIT H
EXISTING PLANS

As stated in Arizona Corporation Commission Rules of Practice R-14-3-219:

"To the extent applicant is able to determine, state the existing plans of the state, local government and private entities for other developments at or in the vicinity of the proposed site or route."

Existing and future land uses are described in Exhibits A and B-3. A record search conducted at Maricopa County's Planning and Development Department revealed that no residential subdivisions have been approved for the area immediately surrounding the proposed project. Only two residential subdivisions (Horseshoe Trails and Horseshoe Trails Phase II) have been approved within a two-mile radius of the project site.

A satellite switchyard (Hassayampa) is currently under construction and is located approximately 1.5 miles east of the proposed AVEF II, immediately south of Elliot Road (near the intersection of Elliot Road and 375th Avenue). This switchyard will be flanked by the existing Kyrene and North Gila 500kV transmission lines. The Hassayampa switchyard will provide interconnections for new and existing transmission lines as an alternative to direct connections with the existing PVNGS switchyard. In addition, the Pinnacle West (Redhawk) facility (under construction) and the approved Sempra (Mesquite) power plant are located within the 2-mile radius of the proposed project.

Based on information received to date, Duke is unaware of any other planned developments within the vicinity of the proposed project.

EXHIBIT I
ANTICIPATED NOISE/INTERFERENCE WITH COMMUNICATION FACILITIES

EXHIBIT I
ANTICIPATED NOISE/INTERFERENCE WITH COMMUNICATION FACILITIES

As stated in Arizona Corporation Commission Rules of Practice and Procedures R14-3-219:

"Describe the anticipated noise emission levels and any interference with communication signals which will emanate from the proposed facilities."

ANTICIPATED NOISE

The expected noise levels generated during full load operation of AVEF I and AVEF II at the nearest residences have been evaluated by means of a detailed analytical noise model. The model results indicate that plant noise will be insignificant at all of the residential locations within 2 miles of the project site (see attached Sound Impact Assessment report).

There are 3 private residences located outside the project site and within a 2-mile radius of the site. Plant noise emissions were modeled for each of these locations. The locations of the nearest occupied residences and the expected noise levels from the facility operating at base load are provided below.

Table I-1
Anticipated Facility Noise Emissions
at the Nearest Residences

	Potential Sensitive Noise Receptor Location	Expected Plant Noise Level During Full Load Operation in Decibels (dBA)
1	Single residence approximately 5,200 feet northwest from center of the facility	43
2	Single residence approximately 6,000 feet north-northwest from center of the facility	41
3	Single residence approximately 6,500 feet north from center of the facility	40

The low noise levels are basically attributable to the large distances between the project facilities and the receptor points. Despite the remote location of the site and the strong likelihood that current background sound levels are quite low, the probability of disturbance from facility sound levels is minimal. Under normal circumstances plant noise should be negligible regardless of the existing ambient sound level and no adverse impact is expected at any of the residences evaluated.

INTERFERENCE WITH COMMUNICATION SIGNALS

No interference with communication signals will be caused by the project.

Arlington Valley Energy Facility I & II
Maricopa County, AZ

Sound Impact Assessment

May 31, 2001

CAVANAUGH TOCCI ASSOCIATES, INC.

CONSULTANTS IN ACOUSTICS

Architectural ■ Structural ■ Mechanical ■ Environmental

INTRODUCTION

Duke Energy Maricopa, LLC is proposing to construct and operate a baseload, combined-cycle power plant adjacent to the Arlington Valley Energy Facility I power plant, in Maricopa County, Arizona. The proposed facility, the Arlington Valley Energy Facility II (the Project) is located approximately 5 miles south of Wintersburg, Arizona. The proposed power plant will consist of two combustion turbine generators (CTGs) in series with dedicated heat recovery steam generators (HRSGs). Steam from the HRSGs will drive a steam turbine generator (STG). The facility will use air inlet chilling and duct firing to augment power output. Natural gas will serve as the primary source of fuel for the Project. The facility will have a nominal electrical capacity of 620 megawatts (MW). The Arlington Valley Energy Facility I is a similar sized power plant using the same combined-cycle technology.

The Project area is bordered on the north by Elliot Road and on the south by Narramore Road. The east and west sides of the site are bounded by 387th Avenue and 391st Avenue respectively. The site is located in a desert region on clear flat ground with minor topographic relief. The base elevation of the power plant will be approximately 880 feet above mean sea level.

Land use near the Project site is primarily agricultural with some residential properties. The nearest residence is located approximately 1 mile from the center of the power plants. There are two other residential properties located within 8000 feet of the Project site. The Palo Verde Nuclear Generating Station is approximately 2 miles northeast of the project site.

This sound impact assessment evaluates the acoustic impact of the combined operation of the Arlington Valley Energy I & II facilities. This report includes basic sound measurement terminology and a brief discussion of noise regulatory criteria. This report also identifies significant project related sound sources and describes computer modeling techniques used to estimate facility sound levels in the surrounding community.

SOUND MEASUREMENT TERMINOLOGY

In order to quantify the amplitude, frequency, and temporal characteristics of sound, various acoustical descriptors are used. The following is an introduction to acoustic terminology that is used in this report.

Sound Level

Sound levels are typically quantified using a logarithmic decibel (dB) scale. Generally, the sensitivity of human hearing is restricted to the frequency range of 20 Hz to 20,000 Hz. However, the human ear is most sensitive to sound in the 500 Hz to 5,000 Hz frequency range. Above and below this range, the ear becomes progressively less sensitive. To account for this feature of human hearing, sound level meters incorporate filtering of acoustic signals that corresponds to the varying sensitivity of the human ear to sound at different frequencies. This filtering is called A-weighting. Sound level measurements that are obtained using this filtering are referred to as A-weighted sound levels and are signified by the identifier, dBA. A-weighted sound levels are widely used for evaluating human exposure to environmental sounds. To help place A-weighted sound levels in perspective, Figure 1 contains a scale showing typical sound levels for common interior and environmental sound sources.

Octave Band Sound Levels

To characterize a sound, it is often necessary to evaluate the frequency distribution of the sound energy. As mentioned before, the frequencies of most interest where human exposure is concerned range between 20 Hz and 20,000 Hz. This frequency range is commonly divided into octave bands, where an octave band is a range of frequencies. Each octave band is referred to by its center frequency and has a bandwidth of one octave (a doubling of frequency). For example, the 125 Hz octave band encompasses the range of frequencies from 89 Hz to 178 Hz. Note that the upper limit of an octave band is twice the value of the lower limit. To cover the full range of human hearing, it is necessary to measure sound in 10 separate octave bands. Typically, the lowest frequency band measured has a center frequency of 31.5 Hz. The next frequency band has a center frequency of 63 Hz. This geometric series continues to the highest frequency band that has a center frequency of 16,000 Hz. A set of octave band sound levels to describe a particular sound is called an octave band spectrum. Covering the full range of hearing, an octave band spectrum would have 10 values, one for each band.

Environmental Noise Descriptors

Sound levels in the environment are continuously fluctuating and it is difficult to quantify these time-varying levels with single number descriptors. Statistical approaches, which use *percentile* sound levels and *equivalent* sound levels, are often used to quantify the temporal characteristics of environmental sound.

Percentile sound levels (L_n) are the A-weighted sound levels that are exceeded for specific percentages of time within a noise measurement interval. For example if a measurement interval is one hour long, the 50th percentile sound level (L_{50}) is the A-weighted sound level that is exceeded for 30 minutes of that interval. Similarly, the 90th percentile sound level (L_{90}) is the A-weighted sound level that is exceeded for 54 minutes of the same one-hour long interval. The 90th percentile sound level represents the nominally lowest level reached during the monitoring interval and is typically influenced by sound of relatively low level, but nearly constant duration, such as distant traffic or continuously operating industrial equipment. The L_{90} is often used in standards to quantify the existing background or residual sound level. Conversely, the L_{10} represents the nominally highest sound levels reached during a monitoring interval. The L_{10} is typically influenced by sound of high level, but short duration, such as that produced by vehicles passing on a nearby road. The L_{10} is sometimes called the intrusive sound level. By using percentile sound levels, it is possible to characterize the sound environment in terms of the steady-state background sound (L_{90}) and occasional transient sound (L_{10}).

The *equivalent sound level* (L_{eq}) is the energy average of the A-weighted sound level for the measurement interval. Sounds of low level and long duration, as well as sounds of high level and short duration influence this sound level descriptor.

The *day-night average sound level* (L_{dn}) is a 24-hour average A-weighted sound level where a 10-dB "penalty" is applied to sound occurring between the hours of 10:00 p.m. and 7:00 a.m. The 10-dB penalty accounts for the heightened sensitivity of a community to noise occurring at night.

Because of their sensitivity to the temporal characteristics of sound, the L_{eq} and L_{dn} descriptors have become widely accepted for use in environmental noise regulations and criteria. Among the federal agencies using energy average sound levels are the U.S Environmental Protection Agency, the Federal Highway Administration, the U.S Department of Housing and Urban Development, the Federal Aviation Administration and the Department of Defense.

NOISE REGULATIONS AND GUIDELINES

County & State

There are no County or State noise regulations that define limits for environmental sound produced by an electric power plant at the proposed Project site.

Federal

There are no federal regulations that define limits for environmental sound produced by an electric power plant. However, the U.S. Environmental Protection Agency (EPA) has taken the lead among federal agencies in studying the general impact of environmental noise, and has issued guidelines that identify yearly L_{dn} sound levels sufficient to protect public health and welfare from the effects of environmental noise. The EPA carefully guards against the misuse of these guidelines by stating:

> *On the basis of available scientific information, EPA has identified a range of yearly day-night sound levels sufficient to protect public health and welfare from the effects of environmental noise. It is very important that these noise levels summarized in Table VIII not be misconstrued. Since protective levels were derived without concern for technical or economic feasibility and contain a margin of safety to ensure the protective value, they must not be viewed as standards, criteria, regulations or goals. Rather, they should be viewed as levels below which there is no reason to suspect that the general population will be at risk from any of the identified effects of noise.*

Table 1 presents EPA's suggested levels to protect public health and welfare. Of these levels, the most widely cited is the day-night average sound level (L_{dn}) of 55 dB for outdoors in residential areas. Based on extensive review of available data, EPA has concluded that a L_{dn} of 55 dB (outdoors) will not interfere with speech intelligibility (outdoors or indoors) and should in most cases protect against sleep interference. Because the plant is expected to operate continuously over any 24-hour period, a continuous average sound level (L_{eq}) of 49 dBA is required to produce a day-night average (L_{dn}) of 55 dB.

TABLE 1

Yearly Ldn Values That Protect Public Health and Welfare with a Margin of Safety

Effect	L_{dn}	L_{eq}(24hrs)	Area
Hearing		≤ 70 dBA	All areas (at the ear)
Outdoor activity	≤ 55 dB		Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places where quiet is a basis for use
		≤ 55 dBA	Outdoor areas where people spend a limited amounts of time such as schoolyards, playgrounds, etc.
Indoor activity	≤ 45 dB		Indoor residential areas
		≤ 45 dBA	Other indoor areas with human activities such as schools, etc.

Source: Table VIII, Protective Noise Levels – Condensed Version of EPA Levels Document, EPA 500/9-79-100 November 1978

PROJECT OPERATIONAL SOUND LEVELS

Operational noise impacts will be associated with sound from several individual noise sources. The total noise impact is the result of the combined impact of each individual noise source located on-site. Environmental sound modeling was conducted for each significant noise source at the plant assuming full operation (100% load). These individual impacts were then combined to determine overall sound levels as a result of the Project. The modeling requires information on equipment noise emission levels, the location of the source relative to the receiver, and information on how the noise may propagate from the source to the receiver.

The primary Project noise sources used to model facility sound impact include:

Arlington Valley I

- Combustion turbine exhaust sound transmitted out HRSG stack (2 stacks),
- Heat recovery steam generator (2 HRSGs),
- Combustion turbine air inlets (2 inlets),
- Mechanical draft cooling tower (6 cells),
- Transformers (2 CTG,1 STG),
- Turbine inlet air chillers (3 units),
- Combustion Turbine Package (2 units),

    Generator compartment,

    Load compartment,

    Air inlet plenum,

    Combustion turbine compartment,

    Exhaust diffuser,

    Accessory compartment,

- Steam Turbine Package (1 unit).

Arlington Valley II

- Combustion turbine exhaust sound transmitted out HRSG stack (2 stacks),
- Heat recovery steam generators (2 HRSGs),
- Combustion turbine air inlets (2 inlets),
- Mechanical draft cooling tower (8 cells),
- Transformers (2 CTG,1 STG),
- Turbine inlet air chillers (3 units),
- Combustion Turbine Package (2 units),

    Generator compartment,

    Load compartment,

    Air inlet plenum,

    Combustion turbine compartment,

    Exhaust diffuser,

    Accessory compartment,

- Steam Turbine Package (1 unit).

Operational sound levels produced by the power plant have been calculated using SoundPlan® Wins Version 5.0 environmental sound modeling software. For this project, the CONCAWE method was used to calculate facility A-weighted sound levels in an area of 20-square-miles surrounding the Project site. In addition, specific calculations of facility sound levels were performed for the three nearest residential receptor locations that surround the Project. As a worst case noise impact scenario, all facility equipment was assumed to be operating simultaneously at full load. Receptor sound levels for each of the sources listed above were calculated using the following data and corrections:

- Source sound power level (in octave bands),
- Source directivity,
- Distance between source and receptor,
- Air absorption (15°C and 70% relative humidity),
- Ground effect,
- Reflections from building and tank structures,
- Barrier attenuation (from earth contours and or man-made structures).

The equipment sound levels are based on noise data provided by the equipment vendor or the design engineer when available. For equipment where vendor data were not available, the noise levels were either calculated from the procedures described in the Electric Power Plant Environmental Noise Guide (Edison Electric Institute (EEI) 1984) using site-specific ratings and specifications, or from consultants' data collected on other similar projects. The noise methodology contained in the EEI Guide is derived from extensive measurement programs at a variety of electric generation facilities.

The acoustic modeling of the facility was performed with standard acoustic treatment. Inherent in the standard facility design are several noise control features. These include enclosing significant sources of sound (the combustion turbines, steam turbine and generators) in sound attenuating enclosures. These enclosures are designed to reduce emitted sound levels to less than 90 dBA immediately adjacent to the enclosure. The gas turbine exhaust sound will be reduced by the sound absorptive properties of the HRSG, and gas turbine inlets will include sound absorptive parallel baffle silencers. In addition, facility orientation and plant layout have been optimized to minimize sound impact at residential properties.

Table 2 provides a summary of the A-weighted sound levels generated by each individual piece of equipment used to model facility sound impact.

Figure 2 graphically presents estimated isopleths of facility operational sound levels in the area surrounding the Project. Table 3 presents estimates of facility sound levels at the three nearest residential receptors. Appendix A contains listings of the sound modeling results.

TABLE 2
Source Sound Level (dBA) at 400 feet with an Unobstructed View

Sound Source	Description	Sound Level (dBA)
Cooling Tower (AV II)	8 cell tower	62
Cooling Tower (AV I)	6 cell tower	61
Combustion Turbine Package	per CT package	62
Steam Turbine Package	per ST package	61
HRSG Stack	per stack	59
HRSG Walls	per HRSG unit	58
Inlet Air Chillers	per chiller unit	55
Transformers	NEMA Sound Rating77	51
Combustion Turbine Inlet	per CT air inlet	41

TABLE 3
Estimates of Facility Sound Levels (dBA) at Nearest Residential/Recreational Receptors

Location	Approximate Distance and Direction from Center of Facility	Sound Level (dBA)
Location R-1	5,200 feet Northwest	43
Location R-2	6,000 feet West Northwest	41
Location R-3	6,500 feet North	40

The maximum sound level from worst-case operation of the plant is estimated to be 43 dBA at the nearest residential receptor that is located northwest of the facility. This sound level corresponds to a day-night average sound level (L_{dn}) for a continuously operating facility of 49 dB. Facility sound levels at all other residential receptors surrounding the Project are expected to be lower. As such, facility sound impact will be well below the EPA's guidelines for outdoors sound exposure at all surrounding residences. The low noise levels are attributable to the large distances between the Project and the receptor points. Despite the remote location of the site and the strong likelihood that current background sound levels are quite low, the probability of disturbance from facility sound is minimal.

Figures

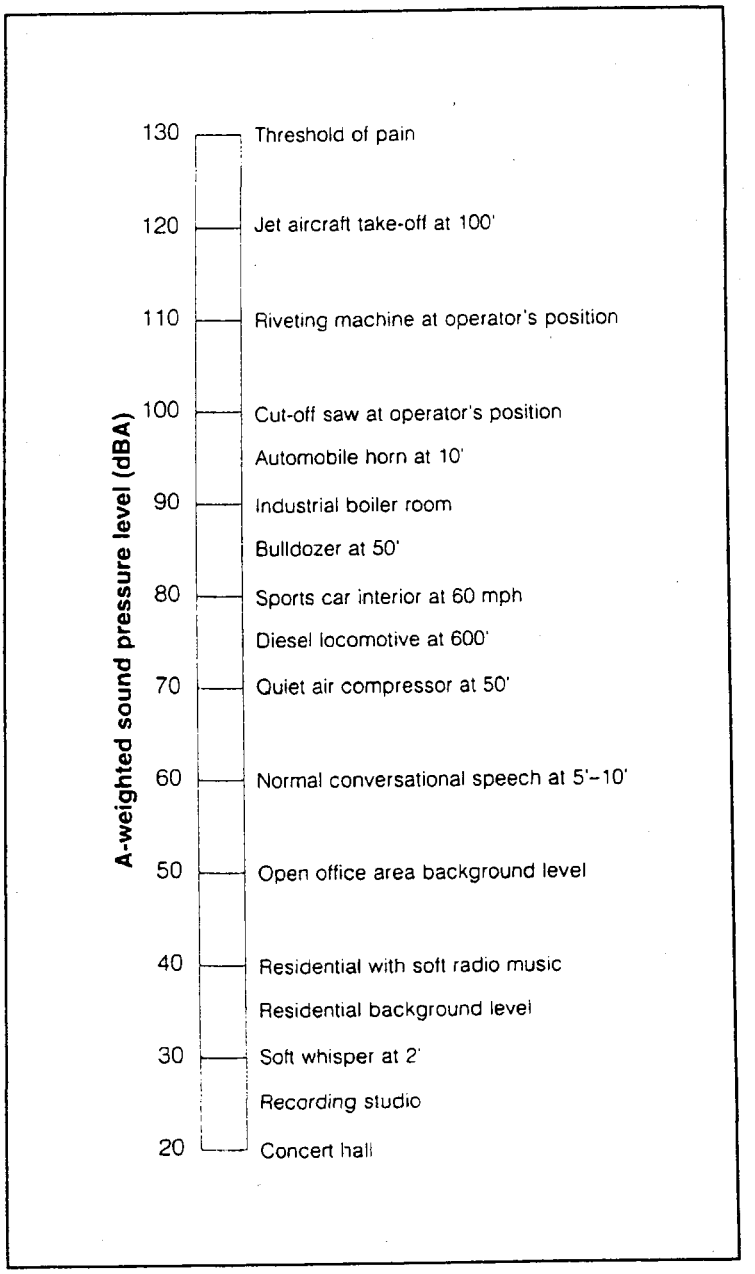

Figure 1

Typical Sound Levels for Common Interior and Environmental Sources

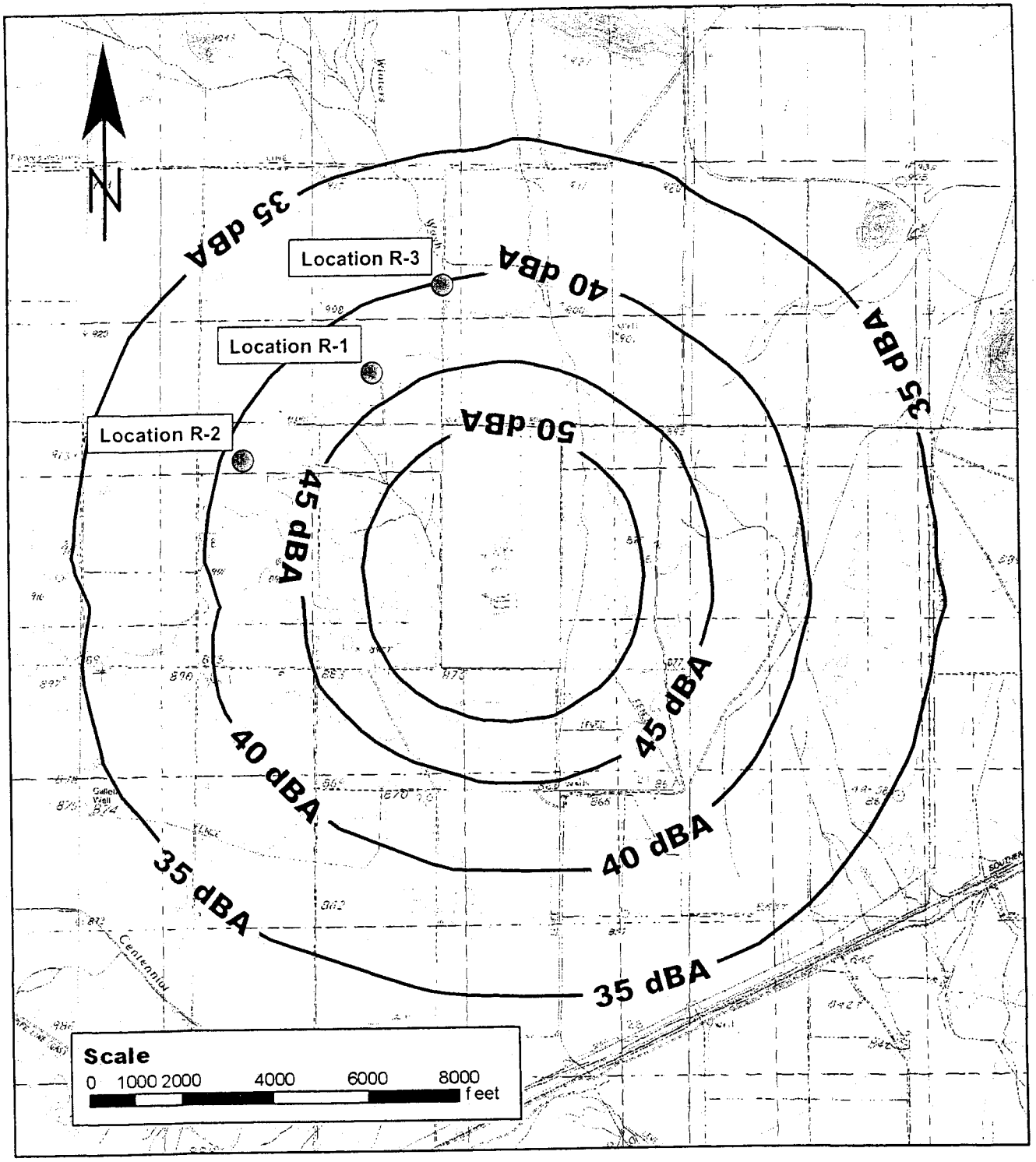

Figure 2

Calculated Estimates of Facility Sound Levels (dBA)

Arlington Valley Energy Facilities I & II

Appendix A

Facility Operational Sound Model

Arlington Valley Energy Facility
Mean propagation - SPS AV1 + AV2

Source	Lw dB(A)	Lw' dB(A)	s m	Adiv dB	Agr dB	Abar dB	Aatm dB	DI dB	Re dB(A)	Ls dB(A)
R1 Leq 43.3	dB(A)									
AV1 West Stack	114.6	114.6	1461.95	74.3	-1.0		1.7	6.2		33.4
AV1 East Stack	114.6	114.6	1488.53	74.5	-0.9		1.7	6.2		33.1
AV1 West HRSG W	107.6	80.2	1444.61	74.2	1.7		2.1	0.0	9.5	32.6
AV1 East HRSG W	107.6	80.2	1472.00	74.4	1.7		2.1	0.0	10.3	32.4
AV1 ST Generator Comp	112.1	112.1	1495.31	74.5	0.8		5.7	0.0	21.7	31.6
AV2 Cooling Tower Inlet N	115.1	88.4	1601.11	75.1	0.8	0.3	10.4	0.0	7.0	31.6
AV2 South Stack	114.6	114.6	1750.00	75.9	-0.3		2.0	6.1		30.9
AV1 Cooling Tower Inlet N	113.9	88.5	1536.84	74.7	0.8		10.6	0.0	1.2	30.9
AV2 North HRSG N	107.6	79.2	1718.47	75.7	2.1	0.8	2.5	0.0		29.5
AV1 West Exhaust Diffuser	108.2	108.2	1429.71	74.1	0.8		6.3	0.0	5.8	27.1
AV1 East Exhaust Diffuser	108.2	108.2	1457.59	74.3	0.8		6.3	0.0	9.9	26.9
AV2 South HRSG N	107.6	79.3	1755.81	75.9	2.1	3.3	2.5	0.0		26.8
AV1 North Inlet Chiller	105.1	105.1	1395.29	73.9	0.9		3.6	0.0		26.8
AV1 Center Inlet Chiller	105.1	105.1	1408.93	74.0	0.9		3.6	0.0		26.6
AV2 North Stack	114.6	114.6	1713.32	75.7	3.9		2.1	6.2		26.6
AV1 South Inlet Chiller	105.1	105.1	1422.38	74.1	0.9		3.6	0.0		26.5
AV1 West Turbine Comp	107.2	107.2	1425.85	74.1	0.4		8.4	0.0	7.8	24.5
AV1 East Turbine Comp	107.2	107.2	1453.84	74.3	0.4		8.5	0.0	11.9	24.3
AV2 North Exhaust Diffuser	108.2	108.2	1734.88	75.8	1.0	0.2	7.5	0.0	2.1	23.8
AV2 West Inlet Chiller	105.1	105.1	1780.97	76.0	1.3		4.3	0.0		23.5
AV2 Center Inlet Chiller	105.1	105.1	1789.40	76.1	1.3	0.0	4.4	0.0		23.5
AV1 West CT Generator	104.0	104.0	1413.64	74.0	0.5		6.2	0.0	2.6	23.3
AV1 East CT Generator	104.0	104.0	1441.77	74.2	0.5		6.3	0.0	6.7	23.1
AV1 ST Transformer	102.4	102.4	1525.08	74.7	1.6		3.8	0.0	15.6	23.1
AV1 Cooling Tower Inlet S	113.9	88.4	1553.40	74.8	0.8	20.0	10.5	0.0	21.4	21.8
AV1 West CT Transformer	100.4	100.4	1380.31	73.8	1.6		3.5	0.0	-10.1	21.5
AV2 ST Generator Comp	112.1	112.1	1711.20	75.7	0.9	9.5	4.8	0.0		21.3
AV1 East CT Transformer	100.4	100.4	1409.40	74.0	1.6		3.6	0.0		21.2
AV2 North Turbine Comp	107.2	107.2	1736.78	75.8	0.6	0.0	9.8	0.0	-2.0	21.0
AV2 ST Transformer	102.4	102.4	1720.75	75.7	1.7	0.0	4.3	0.0	-9.3	20.6
AV1 West CT Acc Comp	102.2	102.2	1412.88	74.0	0.4		7.5	0.0		20.4
AV1 East CT Acc Comp	102.2	102.2	1441.61	74.2	0.4		7.6	0.0	6.8	20.3
AV2 North CT Generator	104.0	104.0	1744.10	75.8	0.7	0.0	7.3	0.0		20.1
AV2 South CT Generator	104.0	104.0	1780.76	76.0	0.7	0.0	7.3	0.0		19.9
AV1 West Load Comp	101.4	101.4	1419.78	74.0	0.7		6.9	0.0	0.7	19.9
AV1 East Load Comp	101.4	101.4	1447.46	74.2	0.7		7.0	0.0	4.8	19.7
AV2 South CT Transformer	100.4	100.4	1788.94	76.1	1.8	0.1	4.5	0.0		17.9
AV2 North CT Acc Comp	102.2	102.2	1733.77	75.8	0.6	0.1	8.9	0.0	-6.2	16.9
AV1 Cooling Tower Discharge	102.9	102.9	1522.84	74.7	0.7		3.8	7.3		16.5
AV1 Cooling Tower Discharge 5	102.9	102.9	1532.11	74.7	0.7		3.8	7.3		16.4
AV1 Cooling Tower Discharge 4	102.9	102.9	1540.68	74.8	0.7		3.8	7.3		16.3
AV2 North Load Comp	101.4	101.4	1741.50	75.8	0.9	0.1	8.3	0.0	-5.3	16.3
AV1 Cooling Tower Discharge 3	102.9	102.9	1549.72	74.8	0.7		3.8	7.3		16.2
AV1 Cooling Tower Discharge 2	102.9	102.9	1558.39	74.9	0.7		3.8	7.3		16.2
AV1 Cooling Tower Discharge	102.9	102.9	1567.56	74.9	0.7		3.9	7.3		16.1
AV2 Cooling Tower Discharge	102.9	102.9	1582.74	75.0	0.7		3.9	7.3		16.0

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Arlington Valley Energy Facility
Mean propagation - SPS AV1 + AV2

Source	Lw dB(A)	Lw' dB(A)	s m	Adiv dB	Agr dB	Abar dB	Aatm dB	DI dB	Re dB(A)	Ls dB(A)
AV2 Cooling Tower Discharge 7	102.9	102.9	1589.50	75.0	0.7		3.9	7.3		15.9
AV2 Cooling Tower Discharge 6	102.9	102.9	1596.62	75.1	0.7		3.9	7.3		15.8
AV2 Cooling Tower Discharge 5	102.9	102.9	1604.68	75.1	0.8		3.9	7.3		15.8
AV2 Cooling Tower Discharge 4	102.9	102.9	1613.38	75.2	0.8		4.0	7.3		15.7
AV2 Cooling Tower Discharge 3	102.9	102.9	1621.13	75.2	0.8		4.0	7.3		15.6
AV2 Cooling Tower Discharge 2	102.9	102.9	1629.09	75.2	0.8		4.0	7.3		15.6
AV2 Cooling Tower Discharge	102.9	102.9	1638.16	75.3	0.8	0.0	4.0	7.4		15.4
AV1 West Inlet Plenum	99.2	99.2	1422.17	74.1	0.1		9.9	0.0	1.7	15.3
AV1 East Inlet Plenum	99.2	99.2	1449.86	74.2	0.1		10.0	0.0	5.8	15.3
AV1 West HRSG E	107.6	80.1	1450.02	74.2	1.7	19.7	1.9	0.0		13.0
AV1 East HRSG E	107.6	80.3	1477.42	74.4	1.8	19.7	2.0	0.0		12.7
AV1 West CT Inlet	90.7	90.7	1398.76	73.9	1.5		3.1	0.0	-24.6	12.1
AV1 East CT Inlet	90.7	90.7	1427.91	74.1	1.6		3.1	0.0	-21.8	11.8
AV2 Cooling Tower Inlet S	115.1	88.7	1617.64	75.2	0.8	20.0	10.3	0.0	-21.7	11.8
AV2 North Inlet Plenum	99.2	99.2	1738.88	75.8	0.3	0.0	11.7	0.0	-13.8	11.3
AV2 North CT Transformer	100.4	100.4	1752.76	75.9	1.7	8.2	3.4	0.0	-20.7	11.1
AV2 North HRSG S	107.6	79.5	1726.44	75.7	2.1	19.8	2.3	0.0		10.7
AV2 South HRSG S	107.6	79.2	1762.42	75.9	2.1	19.7	2.3	0.0		10.5
AV2 South CT Inlet	90.7	90.7	1787.88	76.0	2.0	0.2	3.8	0.0		8.6
AV2 North CT Inlet	90.7	90.7	1751.53	75.9	2.0	0.6	4.1	0.0		8.1
AV2 East Inlet Chiller	105.1	105.1	1796.12	76.1	1.3	17.4	2.8	0.0		7.5
AV2 South Exhaust Diffuser	108.2	108.2	1772.12	76.0	1.1	19.6	5.9	0.0		5.7
AV2 South Turbine Comp	107.2	107.2	1773.13	76.0	0.6	19.9	8.8	0.0		2.0
AV2 South Load Comp	101.4	101.4	1777.20	76.0	0.9	19.7	6.7	0.0		-1.9
AV2 South CT Acc Comp	102.2	102.2	1768.38	76.0	0.6	19.9	8.1	0.0		-2.3
AV2 South Inlet Plenum	99.2	99.2	1776.04	76.0	0.4	20.0	11.7	0.0		-8.9
R2 Leq 41.4	dB(A)									
AV1 West Stack	114.6	114.6	1783.45	76.0	-0.3		2.0	6.1		30.6
AV1 East Stack	114.6	114.6	1826.27	76.2	-0.2		2.1	6.1		30.3
AV2 Cooling Tower Inlet N	115.1	88.4	1782.87	76.0	0.9		10.9	0.0		30.3
AV1 West HRSG W	107.6	80.2	1773.84	76.0	2.1		2.5	0.0		30.0
AV2 South Stack	114.6	114.6	1874.36	76.5	-0.1		2.1	6.1		29.9
AV2 North HRSG N	107.6	79.2	1870.33	76.4	2.2		2.6	0.0		29.2
AV2 South HRSG N	107.6	79.3	1890.14	76.5	2.2		2.7	0.0		29.1
AV2 ST Generator Comp	112.1	112.1	1891.23	76.5	1.0	0.0	6.7	0.0	22.5	29.0
AV1 Cooling Tower Inlet N	113.9	88.5	1787.89	76.0	0.9		11.2	0.0		28.7
AV1 ST Generator Comp	112.1	112.1	1800.69	76.1	0.9		6.5	0.0		28.6
AV2 North Stack	114.6	114.6	1855.34	76.4	4.0		2.3	6.1		25.8
AV1 South Inlet Chiller	105.1	105.1	1726.96	75.7	1.2		4.2	0.0	18.2	25.0
AV1 West Exhaust Diffuser	108.2	108.2	1772.00	76.0	1.1		7.0	0.0		24.1
AV1 North Inlet Chiller	105.1	105.1	1717.01	75.7	1.2		4.2	0.0		24.0
AV1 Center Inlet Chiller	105.1	105.1	1722.11	75.7	1.2		4.2	0.0		24.0
AV1 East Exhaust Diffuser	108.2	108.2	1815.35	76.2	1.1		7.1	0.0		23.8
AV2 North Exhaust Diffuser	108.2	108.2	1896.00	76.6	1.1		7.3	0.0		23.2
AV2 South Exhaust Diffuser	108.2	108.2	1915.70	76.6	1.1		7.3	0.0		23.1
AV2 West Inlet Chiller	105.1	105.1	1889.10	76.5	1.3		4.5	0.0		22.7
AV2 Center Inlet Chiller	105.1	105.1	1904.43	76.6	1.4		4.6	0.0		22.6

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Arlington Valley Energy Facility
Mean propagation - SPS AV1 + AV2

Source	Lw dB(A)	Lw' dB(A)	s m	Adiv dB	Agr dB	Abar dB	Aatm dB	DI dB	Re dB(A)	Ls dB(A)
AV2 East Inlet Chiller	105.1	105.1	1917.72	76.7	1.4		4.6	0.0		22.5
AV1 West Turbine Comp	107.2	107.2	1771.01	76.0	0.6		9.6	0.0		21.1
AV1 East HRSG W	107.6	80.2	1816.70	76.2	2.1	9.5	2.1	0.0	4.3	20.7
AV1 East Turbine Comp	107.2	107.2	1814.40	76.2	0.7		9.7	0.0		20.7
AV1 West CT Generator	104.0	104.0	1766.57	75.9	0.7		7.2	0.0		20.1
AV2 North Turbine Comp	107.2	107.2	1899.09	76.6	0.7		10.0	0.0		20.0
AV1 ST Transformer	102.4	102.4	1829.41	76.2	1.8		4.5	0.0		19.9
AV2 South Turbine Comp	107.2	107.2	1918.84	76.7	0.7		10.0	0.0		19.8
AV1 East CT Generator	104.0	104.0	1810.36	76.2	0.7		7.4	0.0		19.7
AV2 North CT Generator	104.0	104.0	1911.59	76.6	0.8		7.6	0.0		18.9
AV2 South CT Generator	104.0	104.0	1931.18	76.7	0.8		7.7	0.0		18.8
AV1 West CT Transformer	100.4	100.4	1746.49	75.8	1.7		4.3	0.0		18.5
AV1 East CT Transformer	100.4	100.4	1790.69	76.1	1.8		4.4	0.0		18.2
AV2 North CT Transformer	100.4	100.4	1937.43	76.7	1.8	0.0	4.7	0.0		17.1
AV1 West CT Acc Comp	102.2	102.2	1760.73	75.9	0.6		8.6	0.0		17.1
AV1 West Load Comp	101.4	101.4	1768.63	76.0	0.9		7.8	0.0		16.7
AV1 East CT Acc Comp	102.2	102.2	1805.72	76.1	0.6		8.8	0.0		16.7
AV2 ST Transformer	102.4	102.4	1921.84	76.7	1.8	6.4	4.1	0.0	13.3	16.4
AV1 East Load Comp	101.4	101.4	1812.25	76.2	0.9		7.9	0.0		16.4
AV2 North CT Acc Comp	102.2	102.2	1900.74	76.6	0.7		9.1	0.0		15.9
AV2 South CT Acc Comp	102.2	102.2	1918.92	76.7	0.7		9.1	0.0		15.7
AV2 North Load Comp	101.4	101.4	1906.95	76.6	1.0		8.1	0.0		15.7
AV2 South Load Comp	101.4	101.4	1925.24	76.7	1.0		8.2	0.0		15.5
AV1 West HRSG E	107.6	80.1	1782.05	76.0	2.1	19.7	2.4	0.0	12.9	14.8
AV2 Cooling Tower Discharge	102.9	102.9	1737.25	75.8	0.9		4.2	7.3		14.7
AV2 Cooling Tower Discharge 7	102.9	102.9	1751.06	75.9	0.9	0.0	4.2	7.3		14.6
AV1 Cooling Tower Discharge	102.9	102.9	1753.92	75.9	0.9		4.3	7.3		14.6
AV2 Cooling Tower Discharge 6	102.9	102.9	1764.62	75.9	0.9	0.0	4.3	7.3		14.5
AV1 Cooling Tower Discharge 5	102.9	102.9	1769.79	76.0	0.9	0.0	4.3	7.3		14.5
AV2 Cooling Tower Discharge 5	102.9	102.9	1779.77	76.0	0.9	0.0	4.3	7.3		14.4
AV1 Cooling Tower Discharge 4	102.9	102.9	1784.70	76.0	0.9	0.0	4.3	7.3		14.4
AV2 Cooling Tower Discharge 4	102.9	102.9	1795.20	76.1	0.9	0.0	4.3	7.3		14.3
AV1 Cooling Tower Discharge 3	102.9	102.9	1799.79	76.1	0.9	0.0	4.3	7.3		14.3
AV2 Cooling Tower Discharge 3	102.9	102.9	1809.35	76.2	0.9	0.0	4.4	7.3		14.2
AV1 Cooling Tower Discharge 2	102.9	102.9	1814.98	76.2	0.9	0.0	4.4	7.3		14.2
AV2 Cooling Tower Discharge 2	102.9	102.9	1824.35	76.2	0.9	0.0	4.4	7.2		14.1
AV1 Cooling Tower Discharge	102.9	102.9	1830.35	76.3	0.9	0.0	4.4	7.2		14.1
AV2 Cooling Tower Discharge	102.9	102.9	1839.84	76.3	0.9	0.0	4.4	7.2		14.0
AV1 West Inlet Plenum	99.2	99.2	1769.43	76.0	0.4		11.8	0.0		11.1
AV1 East Inlet Plenum	99.2	99.2	1812.73	76.2	0.4		12.0	0.0		10.6
AV2 Cooling Tower Inlet S	115.1	88.7	1791.05	76.1	0.9	20.0	10.8	0.0		10.3
AV1 East HRSG E	107.6	80.3	1825.18	76.2	2.2	19.7	2.4	0.0		10.1
AV2 North Inlet Plenum	99.2	99.2	1903.21	76.6	0.4		12.5	0.0		9.7
AV2 North HRSG S	107.6	79.5	1874.66	76.5	2.2	19.8	2.5	0.0		9.6
AV2 South HRSG S	107.6	79.2	1893.45	76.5	2.2	19.8	2.5	0.0		9.5
AV2 South Inlet Plenum	99.2	99.2	1922.83	76.7	0.5		12.6	0.0		9.5
AV1 West CT Inlet	90.7	90.7	1761.37	75.9	2.0		3.5	0.0		9.3

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Arlington Valley Energy Facility
Mean propagation - SPS AV1 + AV2

Source	Lw dB(A)	Lw' dB(A)	s m	Adiv dB	Agr dB	Abar dB	Aatm dB	DI dB	Re dB(A)	Ls dB(A)
AV1 East CT Inlet	90.7	90.7	1805.18	76.1	2.0		3.5	0.0		9.0
AV1 Cooling Tower Inlet S	113.9	88.4	1795.82	76.1	0.9	20.0	11.2	0.0		8.8
AV2 North CT Inlet	90.7	90.7	1924.74	76.7	2.1		3.7	0.0		8.2
AV2 South CT Transformer	100.4	100.4	1955.99	76.8	1.8	19.4	4.0	0.0		-1.6
AV2 South CT Inlet	90.7	90.7	1944.40	76.8	2.1	15.9	1.7	0.0		-5.8
R3 Leq 40.2	dB(A)									
AV1 West Stack	114.6	114.6	1799.80	76.1	-0.2		2.1	6.1		30.5
AV1 East Stack	114.6	114.6	1809.92	76.2	-0.2		2.1	6.1		30.4
AV1 West HRSG W	107.6	80.2	1781.07	76.0	2.1		2.5	0.0	7.0	29.9
AV1 East HRSG W	107.6	80.2	1792.18	76.1	2.1		2.5	0.0	6.9	29.8
AV2 South Stack	114.6	114.6	2157.69	77.7	0.4		2.5	6.0		28.0
AV1 Cooling Tower Inlet N	113.9	88.5	1905.05	76.6	1.0		11.5	0.0	2.7	27.8
AV2 Cooling Tower Inlet N	115.1	88.4	1999.28	77.0	1.0	1.7	11.2	0.0	9.7	27.1
AV2 North HRSG N	107.6	79.2	2115.26	77.5	2.4	0.8	3.0	0.0	-15.5	26.8
AV1 West Exhaust Diffuser	108.2	108.2	1760.60	75.9	1.0		7.0	0.0	18.8	25.3
AV2 North Stack	114.6	114.6	2116.44	77.5	4.1		2.6	6.1		24.3
AV1 East Exhaust Diffuser	108.2	108.2	1771.81	76.0	1.1		7.0	0.0		24.1
AV1 North Inlet Chiller	105.1	105.1	1747.54	75.8	1.2		4.3	0.0		23.8
AV1 Center Inlet Chiller	105.1	105.1	1763.72	75.9	1.3		4.3	0.0		23.7
AV1 South Inlet Chiller	105.1	105.1	1779.83	76.0	1.3		4.3	0.0		23.5
AV1 ST Generator Comp	112.1	112.1	1837.02	76.3	1.0	19.9	6.3	0.0	22.3	22.5
AV1 West Turbine Comp	107.2	107.2	1755.65	75.9	0.6		9.5	0.0	15.5	22.2
AV2 South Exhaust Diffuser	108.2	108.2	2165.81	77.7	1.3	0.0	8.0	0.0	-2.3	21.1
AV1 East Turbine Comp	107.2	107.2	1766.92	75.9	0.6		9.5	0.0		21.1
AV2 West Inlet Chiller	105.1	105.1	2193.39	77.8	1.6	0.0	5.1	0.0		20.7
AV2 North Exhaust Diffuser	108.2	108.2	2123.88	77.5	1.3	0.2	8.6	0.0	4.6	20.6
AV1 West CT Generator	104.0	104.0	1740.85	75.8	0.7		7.2	0.0	0.1	20.3
AV1 East CT Generator	104.0	104.0	1751.88	75.9	0.7		7.2	0.0	0.0	20.2
AV1 ST Transformer	102.4	102.4	1861.56	76.4	1.8		4.5	0.0		19.7
AV2 ST Generator Comp	112.1	112.1	2092.71	77.4	1.1	8.2	5.9	0.0		19.6
AV1 East CT Transformer	100.4	100.4	1717.79	75.7	1.7		4.2	0.0	7.8	19.1
AV1 West CT Transformer	100.4	100.4	1706.00	75.6	1.7		4.2	0.0	-7.4	18.8
AV2 ST Transformer	102.4	102.4	2088.22	77.4	1.9	0.1	5.1	0.0		17.9
AV2 South Turbine Comp	107.2	107.2	2165.45	77.7	0.9	0.0	10.8	0.0	-3.0	17.8
AV2 North Turbine Comp	107.2	107.2	2124.80	77.5	0.8	0.1	11.2	0.0	4.0	17.8
AV1 West CT Acc Comp	102.2	102.2	1743.72	75.8	0.6		8.6	0.0	0.2	17.3
AV1 East CT Acc Comp	102.2	102.2	1754.89	75.9	0.6		8.6	0.0	0.0	17.2
AV1 Cooling Tower Inlet S	113.9	88.4	1923.91	76.7	1.0	20.0	11.5	0.0	16.6	17.2
AV2 South CT Generator	104.0	104.0	2169.27	77.7	0.9	0.0	8.4	0.0	2.5	17.1
AV2 North CT Generator	104.0	104.0	2128.02	77.6	0.9	0.0	8.4	0.0		17.1
AV2 South HRSG N	107.6	79.3	2157.11	77.7	2.4	11.4	2.6	0.0	6.7	16.9
AV1 West Load Comp	101.4	101.4	1748.41	75.9	0.9		7.8	0.0		16.9
AV1 East Load Comp	101.4	101.4	1758.98	75.9	0.9		7.8	0.0		16.8
AV2 North CT Transformer	100.4	100.4	2125.23	77.5	1.9	0.0	5.0	0.0	-19.1	15.9
AV2 South CT Transformer	100.4	100.4	2166.59	77.7	1.9	0.0	5.1	0.0	-15.1	15.7
AV1 Cooling Tower Discharge 2	102.9	102.9	1919.18	76.7	1.0		4.6	7.2	5.7	14.1
AV1 Cooling Tower Discharge	102.9	102.9	1922.75	76.7	1.0		4.6	7.2	5.6	14.1

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Arlington Valley Energy Facility
Mean propagation - SPS AV1 + AV2

Source	Lw dB(A)	Lw' dB(A)	s m	Adiv dB	Agr dB	Abar dB	Aatm dB	DI dB	Re dB(A)	Ls dB(A)
AV2 South CT Acc Comp	102.2	102.2	2158.61	77.7	0.8	0.0	10.0	0.0	-0.1	13.9
AV2 South Load Comp	101.4	101.4	2167.60	77.7	1.1	0.0	8.9	0.0	-2.2	13.7
AV2 Cooling Tower Discharge	102.9	102.9	2018.51	77.1	1.1	0.0	4.8	7.2	6.6	13.7
AV1 Cooling Tower Discharge	102.9	102.9	1905.93	76.6	1.0		4.6	7.2		13.6
AV1 Cooling Tower Discharge 5	102.9	102.9	1909.47	76.6	1.0		4.6	7.2		13.5
AV1 Cooling Tower Discharge 4	102.9	102.9	1912.55	76.6	1.0		4.6	7.2		13.5
AV1 Cooling Tower Discharge 3	102.9	102.9	1916.18	76.6	1.0		4.6	7.2		13.5
AV2 North CT Acc Comp	102.2	102.2	2119.53	77.5	0.8	0.3	10.9	0.0	-0.6	13.0
AV2 North HRSG S	107.6	79.5	2124.13	77.5	2.4	19.7	2.7	0.0	11.2	12.9
AV2 Cooling Tower Discharge	102.9	102.9	1999.66	77.0	1.1		4.7	7.2		12.9
AV2 North Load Comp	101.4	101.4	2127.00	77.6	1.1	0.2	9.6	0.0		12.9
AV2 Cooling Tower Discharge 7	102.9	102.9	2001.31	77.0	1.1		4.8	7.2		12.9
AV2 Cooling Tower Discharge 6	102.9	102.9	2003.57	77.0	1.1		4.8	7.2		12.9
AV2 Cooling Tower Discharge 5	102.9	102.9	2006.22	77.0	1.1		4.8	7.2		12.9
AV2 Cooling Tower Discharge 4	102.9	102.9	2009.57	77.1	1.1		4.8	7.2		12.9
AV2 Cooling Tower Discharge 3	102.9	102.9	2012.28	77.1	1.1	0.0	4.8	7.2		12.8
AV2 Cooling Tower Discharge 2	102.9	102.9	2014.76	77.1	1.1	0.0	4.8	7.2		12.8
AV2 Cooling Tower Inlet S	115.1	88.7	2017.83	77.1	1.1	20.0	11.3	0.0	10.7	12.8
AV1 West Inlet Plenum	99.2	99.2	1751.35	75.9	0.4		11.7	0.0		11.2
AV1 East Inlet Plenum	99.2	99.2	1762.20	75.9	0.4		11.7	0.0		11.1
AV1 West HRSG E	107.6	80.1	1783.46	76.0	2.1	19.8	2.4	0.0		10.2
AV1 East HRSG E	107.6	80.3	1794.34	76.1	2.1	19.8	2.4	0.0		10.2
AV1 West CT Inlet	90.7	90.7	1722.68	75.7	1.9		3.5	0.0	-24.1	9.6
AV1 East CT Inlet	90.7	90.7	1734.96	75.8	1.9		3.5	0.0	-24.2	9.5
AV2 South HRSG S	107.6	79.2	2164.64	77.7	2.5	19.7	2.8	0.0		7.9
AV2 North Inlet Plenum	99.2	99.2	2125.42	77.5	0.6	0.0	13.7	0.0	-5.6	7.5
AV2 South Inlet Plenum	99.2	99.2	2167.33	77.7	0.6	0.0	13.7	0.0	-4.2	7.4
AV2 North CT Inlet	90.7	90.7	2130.98	77.6	2.3	0.1	4.0	0.0	-29.6	6.8
AV2 South CT Inlet	90.7	90.7	2171.84	77.7	2.3	0.0	3.9	0.0	-32.0	6.7
AV2 Center Inlet Chiller	105.1	105.1	2196.82	77.8	1.6	17.7	3.4	0.0		4.6
AV2 East Inlet Chiller	105.1	105.1	2198.93	77.8	1.6	17.7	3.4	0.0		4.6

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Arlington Valley Energy Facility
Contribution Spectra - SPS AV1 + AV2

Name	*Sum	31Hz	63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz
		dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
R1 Leq 43.3	dB(A)									
AV1 West Stack	33.36	4.25	19.22	27.96	30.12	26.16	11.61	-15.52	-43.29	
AV1 East Stack	33.11	4.04	19.02	27.74	29.86	25.91	11.32	-15.92	-44.06	
AV1 West HRSG W	32.60	13.95	23.00	26.32	27.47	26.80	20.31	13.37	-16.42	
AV1 East HRSG W	32.35	13.73	22.77	26.08	27.21	26.55	20.11	13.08	-17.16	
AV1 ST Generator Comp	31.63	-1.77	11.27	15.25	18.11	27.78	28.06	20.16	-3.66	-55.05
AV2 Cooling Tower Inlet N	31.57	0.99	15.01	21.75	21.37	25.28	27.64	22.94	3.18	-48.97
AV2 South Stack	30.89	2.17	17.13	25.69	27.53	23.62	8.70	-19.71	-51.40	
AV1 Cooling Tower Inlet N	30.87	-0.35	13.69	20.41	21.06	24.98	26.44	23.06	4.16	-46.00
AV2 North HRSG N	29.49	8.12	18.91	23.42	24.54	23.92	16.76	8.48	-24.91	
AV1 West Exhaust Diffuser	27.05	1.75	14.80	17.77	18.67	22.31	20.76	17.22	-3.45	-54.33
AV1 East Exhaust Diffuser	26.85	1.53	14.57	17.54	18.43	22.08	20.49	17.35	-3.98	-55.97
AV2 South HRSG N	26.78	6.50	16.75	20.80	21.72	21.07	13.79	5.32	-28.53	
AV1 North Inlet Chiller	26.78	-4.56	11.48	15.90	21.14	22.38	20.60	6.87	-9.06	-58.76
AV1 Center Inlet Chiller	26.65	-4.68	11.37	15.78	21.01	22.26	20.46	6.67	-9.45	-59.59
AV2 North Stack	26.64	0.19	15.15	21.78	22.20	20.29	6.72	-21.52	-52.86	
AV1 South Inlet Chiller	26.52	-4.79	11.26	15.67	20.88	22.14	20.33	6.47	-9.84	-60.40
AV1 West Turbine Comp	24.48	-5.22	9.83	10.80	14.70	18.34	18.80	19.26	-4.34	-57.10
AV1 East Turbine Comp	24.34	-5.44	9.60	10.57	14.46	18.11	18.52	19.38	-4.89	-58.75
AV2 North Exhaust Diffuser	23.77	-4.56	8.63	12.32	15.14	19.99	17.96	12.62	-12.00	
AV2 West Inlet Chiller	23.52	-7.42	8.59	12.97	17.92	19.29	16.96	1.40	-19.83	
AV2 Center Inlet Chiller	23.46	-10.42	8.53	12.92	17.86	19.23	16.89	1.29	-20.06	
AV1 West CT Generator	23.29	-11.12	1.93	7.90	9.81	18.44	19.92	14.42	-10.01	
AV1 East CT Generator	23.07	-11.34	1.70	7.67	9.56	18.21	19.64	14.49	-10.59	
AV1 ST Transformer	23.07	-15.10	3.93	12.81	12.57	20.38	16.94	6.49	-19.56	
AV1 Cooling Tower Inlet S	21.75	-14.64	-3.43	0.54	0.92	4.85	20.15	16.01	-5.03	-59.86
AV1 West CT Transformer	21.46	-15.95	3.10	11.95	11.79	18.52	15.11	5.61	-18.22	
AV2 ST Generator Comp	21.33	-8.34	4.45	8.07	10.09	18.66	16.01	4.64	-24.15	
AV1 East CT Transformer	21.20	-16.19	2.86	11.71	11.54	18.27	14.83	5.06	-19.08	
AV2 North Turbine Comp	21.03	-11.57	3.63	5.34	11.23	15.98	15.95	14.60	-13.06	
AV2 ST Transformer	20.61	-20.55	-0.61	10.99	11.10	17.91	13.96	2.96	-25.58	
AV1 West CT Acc Comp	20.35	-10.11	5.94	5.90	8.81	14.45	15.92	14.14	-11.05	
AV1 East CT Acc Comp	20.26	-10.34	5.70	5.67	8.56	14.21	15.64	14.51	-11.58	
AV2 North CT Generator	20.13	-18.00	-4.61	2.26	6.41	15.92	16.87	9.49	-19.26	
AV2 South CT Generator	19.95	-17.71	-3.56	5.24	6.94	15.66	16.56	9.00	-20.26	
AV1 West Load Comp	19.86	-10.17	4.88	11.85	11.75	13.39	13.86	12.34	-10.17	
AV1 East Load Comp	19.68	-10.39	4.65	11.62	11.51	13.16	13.59	12.44	-10.73	
AV2 South CT Transformer	17.88	-23.36	-3.91	6.05	8.62	15.44	11.38	-0.22	-29.59	
AV2 North CT Acc Comp	16.92	-17.04	-0.52	-0.07	3.92	12.00	12.97	9.64	-19.97	
AV1 Cooling Tower	16.47	-8.49	4.48	10.85	10.00	11.28	7.55	-7.79	-33.46	
AV1 Cooling Tower	16.39	-8.56	4.41	10.78	9.92	11.20	7.46	-7.93	-33.73	
AV1 Cooling Tower	16.32	-8.63	4.34	10.71	9.84	11.13	7.37	-8.06	-33.97	
AV2 North Load Comp	16.28	-16.99	-1.37	6.37	8.41	10.95	10.91	7.53	-19.18	
AV1 Cooling Tower	16.24	-8.69	4.27	10.64	9.76	11.05	7.28	-8.20	-34.23	
AV1 Cooling Tower	16.17	-8.76	4.21	10.57	9.69	10.98	7.19	-8.33	-34.48	
AV1 Cooling Tower	16.09	-8.83	4.14	10.50	9.61	10.91	7.10	-8.46	-34.74	

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Arlington Valley Energy Facility
Contribution Spectra - SPS AV1 + AV2

Name	*Sum	31Hz	63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz
		dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
AV2 Cooling Tower	15.96	-8.94	4.02	10.38	9.48	10.78	6.95	-8.69	-35.17	
AV2 Cooling Tower	15.91	-8.99	3.97	10.32	9.42	10.72	6.88	-8.79	-35.36	
AV2 Cooling Tower	15.85	-9.04	3.92	10.27	9.36	10.67	6.81	-8.89	-35.57	
AV2 Cooling Tower	15.78	-9.10	3.86	10.21	9.29	10.60	6.73	-9.01	-35.80	
AV2 Cooling Tower	15.71	-9.16	3.79	10.14	9.22	10.53	6.64	-9.14	-36.04	
AV2 Cooling Tower	15.65	-9.22	3.74	10.08	9.15	10.47	6.56	-9.25	-36.26	
AV2 Cooling Tower	15.58	-9.28	3.68	10.02	9.09	10.41	6.49	-9.37	-36.49	
AV2 Cooling Tower	15.43	-12.70	2.44	9.95	9.01	10.33	6.40	-9.50	-36.74	
AV1 West Inlet Plenum	15.28	-27.19	-11.14	-7.17	-0.27	5.37	8.83	13.31	-16.24	
AV1 East Inlet Plenum	15.26	-27.41	-11.37	-7.40	-0.51	5.14	8.56	13.42	-16.79	
AV1 West HRSG E	13.00	-1.17	5.09	6.66	7.36	6.71	-0.08	-7.06	-36.75	
AV1 East HRSG E	12.66	-1.54	4.64	6.09	7.14	6.50	-0.33	-7.45	-37.51	
AV1 West CT Inlet	12.09	-10.94	6.11	6.13	6.09	4.67	-0.87	-9.46	-20.54	
AV1 East CT Inlet	11.85	-11.18	5.87	5.89	5.83	4.43	-1.16	-9.75	-21.36	
AV2 Cooling Tower Inlet S	11.75	-13.17	-1.97	2.03	1.43	5.37	7.69	2.92	-17.09	
AV2 North Inlet Plenum	11.33	-33.98	-17.38	-12.68	-3.82	2.97	5.93	8.57	-25.11	
AV2 North CT Transformer	11.12	-23.73	-4.94	3.61	2.55	8.22	2.57	-10.54	-42.05	
AV2 North HRSG S	10.66	-3.44	2.71	4.18	5.10	4.53	-2.66	-10.96	-44.45	
AV2 South HRSG S	10.55	-3.45	2.78	4.32	4.84	4.27	-2.98	-11.45	-45.43	
AV2 South CT Inlet	8.60	-17.54	0.89	3.29	3.01	1.69	-4.45	-15.04	-31.39	
AV2 North CT Inlet	8.14	-17.80	-0.15	1.51	3.27	1.95	-4.14	-14.56	-30.41	
AV2 East Inlet Chiller	7.55	-15.64	-1.55	0.54	2.87	1.45	-3.17	-18.80	-40.24	
AV2 South Exhaust Diffuser	5.71	-11.89	-1.42	-1.07	-3.22	-0.28	-2.37	-7.89	-33.02	
AV2 South Turbine Comp	1.96	-18.97	-6.51	-8.15	-7.32	-4.29	-4.38	-5.90	-34.05	
AV2 South Load Comp	-1.86	-23.88	-11.40	-7.04	-10.20	-9.32	-9.41	-12.95	-40.16	
AV2 South CT Acc Comp	-2.30	-24.30	-10.88	-13.56	-13.73	-8.25	-7.34	-10.84	-40.92	
AV2 South Inlet Plenum	-8.88	-40.87	-27.39	-26.03	-22.19	-17.31	-14.40	-11.94	-46.13	
R2 Leq 41.4	dB(A)									
AV1 West Stack	30.63	1.95	16.90	25.45	27.26	23.35	8.39	-20.17	-52.32	
AV1 East Stack	30.31	1.67	16.62	25.15	26.92	23.01	7.99	-20.77	-53.50	
AV2 Cooling Tower Inlet N	30.26	-0.08	13.92	20.76	20.30	24.24	26.28	20.72	-1.53	-59.34
AV1 West HRSG W	29.97	11.55	20.56	23.88	24.78	24.21	16.94	8.42	-25.72	
AV2 South Stack	29.95	1.35	16.30	24.82	26.54	22.64	7.54	-21.42	-54.81	
AV2 North HRSG N	29.24	10.89	19.89	23.20	24.03	23.49	16.08	7.10	-28.36	
AV2 South HRSG N	29.15	10.79	19.78	23.12	23.94	23.39	15.93	6.87	-28.87	
AV2 ST Generator Comp	29.00	-8.61	5.23	11.68	16.34	26.06	24.77	14.66	-14.20	
AV1 Cooling Tower Inlet N	28.71	-2.12	11.89	18.73	19.26	23.21	24.24	19.65	-2.69	-60.78
AV1 ST Generator Comp	28.62	-3.94	9.06	13.11	15.80	25.52	24.39	14.73	-12.80	
AV2 North Stack	25.75	-0.76	14.19	20.94	21.30	19.36	5.52	-23.40	-56.69	
AV1 South Inlet Chiller	24.96	-7.05	10.00	14.38	19.35	20.71	18.43	3.04	-17.68	
AV1 West Exhaust Diffuser	24.14	-0.75	12.25	15.30	16.00	19.72	17.63	12.12	-13.02	
AV1 North Inlet Chiller	24.02	-6.98	9.03	13.41	18.40	19.76	17.52	2.27	-18.08	
AV1 Center Inlet Chiller	23.98	-7.02	9.00	13.37	18.36	19.72	17.48	2.20	-18.22	
AV1 East Exhaust Diffuser	23.81	-1.04	11.96	15.02	15.70	19.42	17.26	11.54	-14.19	
AV2 North Exhaust Diffuser	23.22	-1.56	11.44	14.53	15.15	18.88	16.59	10.49	-16.35	
AV2 South Exhaust Diffuser	23.08	-1.68	11.31	14.41	15.02	18.75	16.43	10.23	-16.88	

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Arlington Valley Energy Facility
Contribution Spectra - SPS AV1 + AV2

Name	*Sum	31Hz	63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz
		dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
AV2 West Inlet Chiller	22.72	-8.12	7.88	12.27	17.14	18.52	16.03	-0.03	-22.75	
AV2 Center Inlet Chiller	22.61	-8.22	7.78	12.18	17.04	18.42	15.90	-0.23	-23.16	
AV2 East Inlet Chiller	22.52	-8.30	7.69	12.09	16.94	18.33	15.79	-0.41	-23.51	
AV1 West Turbine Comp	21.07	-7.75	7.26	8.30	12.00	15.73	15.64	14.13	-13.99	
AV1 East HRSG W	20.73	4.56	12.70	15.31	15.34	13.87	5.90	-3.19	-38.10	
AV1 East Turbine Comp	20.70	-8.03	6.97	8.03	11.70	15.43	15.27	13.55	-15.16	
AV1 West CT Generator	20.08	-13.72	-0.71	5.33	7.04	15.76	16.68	9.19	-19.87	
AV2 North Turbine Comp	20.00	-8.58	6.42	7.51	11.13	14.86	14.56	12.45	-17.43	
AV1 ST Transformer	19.90	-17.24	1.76	10.75	10.35	17.16	13.04	1.25	-28.68	
AV2 South Turbine Comp	19.84	-8.70	6.29	7.39	11.00	14.73	14.40	12.19	-17.96	
AV1 East CT Generator	19.72	-14.01	-1.01	5.05	6.73	15.46	16.30	8.61	-21.06	
AV2 North CT Generator	18.93	-14.66	-1.66	4.44	6.05	14.78	15.46	7.29	-23.77	
AV2 South CT Generator	18.78	-14.78	-1.79	4.32	5.92	14.65	15.30	7.03	-24.29	
AV1 West CT Transformer	18.50	-18.69	0.32	9.27	8.92	15.73	11.74	0.35	-28.44	
AV1 East CT Transformer	18.18	-18.98	0.02	8.99	8.61	15.43	11.37	-0.24	-29.64	
AV2 North CT Transformer	17.13	-23.73	-3.45	8.10	7.64	14.46	10.15	-2.15	-33.56	
AV1 West CT Acc Comp	17.05	-12.68	3.33	3.37	6.08	11.80	12.73	9.27	-20.71	
AV1 West Load Comp	16.72	-12.73	2.28	9.32	9.02	10.74	10.66	7.16	-19.93	
AV1 East CT Acc Comp	16.67	-12.98	3.03	3.08	5.76	11.49	12.34	8.67	-21.93	
AV2 ST Transformer	16.40	-22.67	-3.75	5.13	7.46	14.04	9.35	-3.51	-35.66	
AV1 East Load Comp	16.38	-13.02	1.98	9.04	8.72	10.44	10.29	6.58	-21.11	
AV2 North CT Acc Comp	15.89	-13.59	2.41	2.50	5.12	10.85	11.55	7.43	-24.48	
AV2 South CT Acc Comp	15.74	-13.70	2.29	2.39	5.00	10.73	11.40	7.19	-24.96	
AV2 North Load Comp	15.65	-13.63	1.37	8.46	8.08	9.81	9.50	5.35	-23.64	
AV2 South Load Comp	15.52	-13.74	1.25	8.35	7.96	9.69	9.35	5.11	-24.13	
AV1 West HRSG E	14.83	-3.75	6.69	8.97	9.41	8.50	1.34	-5.61	-40.59	
AV2 Cooling Tower	14.75	-10.05	2.90	9.26	8.25	9.57	5.47	-10.89	-39.49	
AV2 Cooling Tower	14.64	-10.90	2.80	9.17	8.14	9.47	5.35	-11.08	-39.87	
AV1 Cooling Tower	14.62	-10.16	2.78	9.15	8.12	9.45	5.32	-11.11	-39.95	
AV2 Cooling Tower	14.54	-11.04	2.71	9.08	8.04	9.37	5.22	-11.26	-40.24	
AV1 Cooling Tower	14.50	-11.83	2.67	9.04	8.01	9.33	5.18	-11.33	-40.38	
AV2 Cooling Tower	14.43	-11.18	2.60	8.98	7.93	9.26	5.09	-11.47	-40.66	
AV1 Cooling Tower	14.39	-12.03	2.57	8.95	7.90	9.23	5.04	-11.53	-40.79	
AV2 Cooling Tower	14.32	-11.66	2.50	8.88	7.82	9.15	4.95	-11.68	-41.08	
AV1 Cooling Tower	14.29	-12.38	2.47	8.85	7.79	9.12	4.91	-11.74	-41.20	
AV2 Cooling Tower	14.22	-11.80	2.40	8.79	7.72	9.05	4.83	-11.87	-41.46	
AV1 Cooling Tower	14.18	-12.40	2.36	8.75	7.68	9.01	4.78	-11.94	-41.62	
AV2 Cooling Tower	14.11	-11.62	2.30	8.69	7.62	8.94	4.69	-12.07	-41.87	
AV1 Cooling Tower	14.07	-12.58	2.26	8.65	7.57	8.90	4.64	-12.15	-42.03	
AV2 Cooling Tower	14.00	-12.07	2.20	8.59	7.51	8.83	4.56	-12.28	-42.29	
AV1 West Inlet Plenum	11.05	-29.74	-13.73	-9.69	-2.98	2.74	5.65	8.15	-25.95	
AV1 East Inlet Plenum	10.59	-30.02	-14.02	-9.96	-3.29	2.44	5.28	7.58	-27.12	
AV2 Cooling Tower Inlet S	10.30	-14.37	-3.18	0.90	0.21	4.17	6.20	0.59	-21.79	
AV1 East HRSG E	10.07	-3.92	2.24	3.82	4.38	3.83	-3.52	-12.28	-47.13	
AV2 North Inlet Plenum	9.66	-30.60	-14.61	-10.51	-3.89	1.83	4.53	6.39	-29.54	
AV2 North HRSG S	9.60	-4.44	1.69	3.19	4.02	3.48	-3.94	-12.94	-48.46	

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Arlington Valley Energy Facility
Contribution Spectra - SPS AV1 + AV2

Name	*Sum	31Hz	63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz
		dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
AV2 South HRSG S	9.49	-4.52	1.61	3.10	3.89	3.35	-4.10	-13.19	-48.96	
AV2 South Inlet Plenum	9.47	-30.73	-14.74	-10.63	-4.02	1.70	4.37	6.14	-30.07	
AV1 West CT Inlet	9.28	-13.63	3.38	3.46	3.20	1.88	-4.23	-14.69	-30.68	
AV1 East CT Inlet	8.98	-13.92	3.08	3.18	2.89	1.57	-4.60	-15.27	-31.86	
AV1 Cooling Tower Inlet S	8.76	-16.34	-5.16	-1.08	-0.81	3.14	4.16	-0.47	-22.93	
AV2 North CT Inlet	8.19	-14.69	2.30	2.45	2.09	0.77	-5.60	-16.83	-35.06	
AV2 South CT Transformer	-1.64	-30.41	-13.85	-7.43	-10.72	-5.66	-10.00	-22.38	-54.06	
AV2 South CT Inlet	-5.80	-23.76	-8.91	-11.20	-14.29	-18.46	-25.76	-37.09	-55.59	
R3 Leq 40.2	dB(A)									
AV1 West Stack	30.51	1.84	16.79	25.33	27.13	23.22	8.23	-20.40	-52.77	
AV1 East Stack	30.43	1.77	16.73	25.26	27.05	23.14	8.14	-20.54	-53.05	
AV1 West HRSG W	29.94	11.50	20.51	23.83	24.73	24.16	17.26	8.62	-25.78	
AV1 East HRSG W	29.85	11.42	20.43	23.74	24.63	24.07	17.16	8.45	-26.10	
AV2 South Stack	28.00	-0.37	14.57	23.04	24.50	20.59	5.08	-25.17	-62.41	
AV1 Cooling Tower Inlet N	27.79	-2.87	11.12	18.02	18.49	22.44	23.27	18.22	-5.77	
AV2 Cooling Tower Inlet N	27.14	-2.62	11.29	18.17	17.51	21.31	23.06	16.41	-8.90	
AV2 North HRSG N	26.77	5.82	16.60	20.77	21.77	21.22	13.34	3.25	-35.60	
AV1 West Exhaust Diffuser	25.32	-0.68	12.33	16.54	17.24	20.97	18.89	13.41	-11.62	
AV2 North Stack	24.27	-2.37	12.57	19.57	19.81	17.77	3.43	-26.71		
AV1 East Exhaust Diffuser	24.14	-0.75	12.25	15.30	16.00	19.72	17.63	12.12	-13.02	
AV1 North Inlet Chiller	23.78	-7.19	8.82	13.20	18.17	19.53	17.25	1.85	-18.92	
AV1 Center Inlet Chiller	23.66	-7.30	8.71	13.09	18.05	19.41	17.11	1.64	-19.36	
AV1 South Inlet Chiller	23.53	-7.41	8.60	12.98	17.93	19.30	16.97	1.42	-19.80	
AV1 ST Generator Comp	22.51	-15.40	-4.95	-3.57	2.85	20.01	18.41	7.68	-22.48	
AV1 West Turbine Comp	22.25	-7.64	7.36	8.40	13.26	16.98	16.91	15.44	-12.55	
AV2 South Exhaust Diffuser	21.15	-7.22	6.64	12.39	13.50	17.19	14.45	7.35	-23.29	
AV1 East Turbine Comp	21.11	-7.72	7.29	8.33	12.03	15.76	15.67	14.18	-13.88	
AV2 West Inlet Chiller	20.66	-13.00	5.91	10.51	15.17	16.54	13.57	-3.90	-30.78	
AV2 North Exhaust Diffuser	20.61	-7.52	5.65	9.24	10.66	17.20	15.08	8.10	-22.07	
AV1 West CT Generator	20.33	-13.54	-0.53	5.50	7.22	15.94	16.90	10.00	-19.01	
AV1 East CT Generator	20.24	-13.62	-0.61	5.43	7.14	15.86	16.80	9.85	-19.31	
AV1 ST Transformer	19.68	-17.44	1.55	10.55	10.13	16.95	12.77	0.83	-29.54	
AV2 ST Generator Comp	19.63	-10.65	2.19	6.13	8.19	17.11	14.25	1.47	-32.28	
AV1 East CT Transformer	19.05	-18.49	0.52	9.46	9.55	16.34	12.29	1.24	-27.54	
AV1 West CT Transformer	18.81	-18.41	0.60	9.53	9.20	16.01	12.09	1.49	-27.20	
AV2 ST Transformer	17.90	-23.09	-3.52	7.04	8.72	15.51	10.96	-2.05	-35.53	
AV2 South Turbine Comp	17.84	-14.23	1.61	5.25	9.49	13.19	12.45	9.35	-24.29	
AV2 North Turbine Comp	17.78	-14.52	0.65	2.26	6.71	13.41	13.07	10.09	-23.09	
AV1 West CT Acc Comp	17.29	-12.56	3.45	3.48	6.20	11.92	12.87	9.97	-20.08	
AV1 East CT Acc Comp	17.19	-12.64	3.37	3.41	6.12	11.84	12.78	9.83	-20.38	
AV1 Cooling Tower Inlet S	17.16	-17.16	-5.98	0.79	0.48	3.80	15.74	9.75	-16.49	
AV2 South CT Generator	17.14	-20.23	-6.37	2.39	4.47	13.17	13.73	4.30	-30.40	
AV2 North CT Generator	17.13	-20.43	-7.15	-0.27	3.04	13.41	13.74	4.55	-29.47	
AV2 South HRSG N	16.92	1.14	8.89	11.64	11.40	9.92	2.44	-7.84	-47.46	
AV1 West Load Comp	16.88	-12.60	2.41	9.45	9.16	10.89	10.83	7.43	-19.38	
AV1 East Load Comp	16.80	-12.67	2.34	9.38	9.09	10.81	10.74	7.29	-19.67	

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Arlington Valley Energy Facility
Contribution Spectra - SPS AV1 + AV2

Name	*Sum	31Hz	63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz
		dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
AV2 North CT Transformer	15.91	-24.82	-4.54	7.07	6.50	13.29	8.67	-4.36	-38.45	
AV2 South CT Transformer	15.67	-24.55	-3.21	6.86	6.26	13.04	8.35	-4.61	-39.37	
AV1 Cooling Tower	14.13	-11.26	1.68	8.87	7.68	8.98	4.47	-12.93	-44.32	
AV1 Cooling Tower	14.10	-11.28	1.65	8.85	7.66	8.95	4.44	-12.98	-44.41	
AV2 South CT Acc Comp	13.91	-19.28	-2.58	-0.44	3.53	9.23	9.81	4.68	-30.97	
AV2 South Load Comp	13.72	-19.23	-3.38	6.34	6.48	8.18	7.74	2.57	-30.20	
AV2 Cooling Tower	13.67	-15.24	1.06	8.48	7.25	8.53	3.89	-13.92	-45.76	
AV1 Cooling Tower	13.55	-11.17	1.76	8.18	7.05	8.37	3.98	-13.16	-44.08	
AV1 Cooling Tower	13.53	-11.20	1.74	8.16	7.03	8.34	3.95	-13.20	-44.17	
AV1 Cooling Tower	13.51	-11.22	1.72	8.14	7.01	8.32	3.93	-13.25	-44.26	
AV1 Cooling Tower	13.48	-11.24	1.70	8.12	6.98	8.30	3.90	-13.29	-44.35	
AV2 North CT Acc Comp	12.96	-19.57	-3.50	-3.11	-0.19	6.54	10.11	4.91	-30.10	
AV2 North HRSG S	12.95	-1.96	5.36	7.57	7.31	5.88	-2.05	-12.65	-52.29	
AV2 Cooling Tower	12.93	-11.77	1.17	7.63	6.44	7.73	3.19	-14.38	-46.59	
AV2 North Load Comp	12.93	-19.52	-4.34	3.29	3.81	8.42	7.75	2.56	-29.44	
AV2 Cooling Tower	12.92	-11.78	1.16	7.62	6.43	7.72	3.18	-14.41	-46.63	
AV2 Cooling Tower	12.90	-11.79	1.14	7.61	6.41	7.71	3.16	-14.43	-46.69	
AV2 Cooling Tower	12.89	-11.81	1.13	7.59	6.40	7.69	3.14	-14.47	-46.76	
AV2 Cooling Tower	12.87	-11.83	1.11	7.57	6.37	7.67	3.11	-14.51	-46.85	
AV2 Cooling Tower	12.77	-15.21	-0.10	7.56	6.36	7.65	3.09	-14.55	-46.92	
AV2 Cooling Tower	12.75	-15.22	-0.12	7.55	6.34	7.63	3.07	-14.58	-46.99	
AV2 Cooling Tower Inlet S	12.75	-15.79	-3.07	3.27	3.19	7.21	8.72	1.49	-24.94	
AV1 West Inlet Plenum	11.25	-29.62	-13.61	-9.57	-2.86	2.86	5.81	8.39	-25.46	
AV1 East Inlet Plenum	11.13	-29.69	-13.68	-9.64	-2.93	2.79	5.71	8.25	-25.75	
AV1 West HRSG E	10.24	-3.82	2.32	3.81	4.66	4.11	-3.17	-11.74	-46.01	
AV1 East HRSG E	10.21	-3.80	2.34	3.79	4.61	4.05	-3.25	-11.87	-46.28	
AV1 West CT Inlet	9.56	-13.37	3.64	3.72	3.48	2.15	-3.89	-13.75	-29.49	
AV1 East CT Inlet	9.47	-13.45	3.56	3.64	3.39	2.06	-4.00	-13.91	-29.82	
AV2 South HRSG S	7.91	-5.95	0.21	1.81	2.21	1.59	-6.29	-16.64	-56.13	
AV2 North Inlet Plenum	7.55	-36.52	-20.36	-15.76	-8.33	0.25	3.07	3.84	-35.26	
AV2 South Inlet Plenum	7.44	-36.22	-19.37	-12.63	-5.52	0.18	2.74	3.57	-36.20	
AV2 North CT Inlet	6.77	-19.12	0.44	1.29	0.80	-0.54	-7.24	-19.04	-40.30	
AV2 South CT Inlet	6.69	-18.88	0.82	1.08	0.56	-0.78	-7.55	-19.68	-41.40	
AV2 Center Inlet Chiller	4.63	-18.26	-4.28	-2.13	-0.11	-1.55	-6.45	-23.94	-50.87	
AV2 East Inlet Chiller	4.59	-18.30	-4.32	-2.17	-0.16	-1.60	-6.47	-23.97	-50.92	

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Arlington Valley Energy Facility
Assessed receiver spectra in dB(A) - SPS AV1 + AV2

Time Slice	31 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
R1 Leq 43.3	dB(A)								
Leq	19.1	30.3	35.8	37.5	37.7	35.7	30.7	9.1	-42.4
R2 Leq 41.4	dB(A)								
Leq	17.5	28.6	34.0	35.4	36.2	33.9	27.2	2.4	-56.5
R3 Leq 40.2	dB(A)								
Leq	16.5	27.6	33.2	34.6	34.8	31.9	25.7	-1.0	

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EXHIBIT J
SPECIAL FACTORS

EXHIBIT J
SPECIAL FACTORS

Prior to constructing AVEF I, Duke conducted an extensive public involvement program to introduce Duke and the project to the community. Subsequently, the community has been notified of Duke's plans to expand its Arlington Valley Energy Facility (AVEF II) (see Notice at Exhibit J-1). Elected officials and community leaders have indicated their support for the AVEF II as demonstrated in the letters attached at Exhibit J-2.

Duke has made significant investments in the community and has continued its public involvement as AVEF I is being built. A list of Duke charitable contributions to the community is attached as Exhibit J-3.

In December 1999, Duke commissioned a study showing the fiscal and economic benefits to the community of AVEF I. In June 2001, Duke commissioned an update of that study to include the additional fiscal and economic benefits of AVEF II. A copy of the original study and the June 2001 update is attached as Exhibit J-4.

EXHIBIT J-1

COMMUNITY NOTICE LETTERS

Duke Energy®
Arlington Valley Energy

Duke Energy Maricopa, LLC
P.O. Box 26
Arlington, Arizona 85322
623/327-1314 OFFICE
623/327-1315 FAX

June, 2001

Dear Neighbor,

Let me begin with saying that with each passing month Duke Energy North America and the Kellam family in particular, are reminded how pleased we are that we chose to locate in Arizona. The community has been very supportive and we hope that you feel we have responded in kind.

Since the last letter to the community, we have had several positive developments regarding the progress of our Arlington Valley Energy project.

First of all, construction continues on schedule and activity has increased recently. We now have approximately 150 workers on site, and the number will continue to grow to a peak of 600 this fall. Two construction milestones are coming up shortly. In the next few weeks you will be able to see steel erected as the plant begins to go up from the foundation work we have been doing. Also, specialized transport will begin to deliver the heavy components for the plant. These include the gas and steam turbines and the steam boiler.

Secondly, our very positive experience in Arizona has prompted us to commit to an expansion of the capacity of the Arlington facility. The critical power needs of metropolitan Phoenix, and the west in general will remain for some time. Duke has the ability to construct and deliver additional power quickly. For those reasons and others, expanding the capacity of Arlington Valley Energy seems to be the right thing to do. Our current construction will be able to provide 570 MW of power in the summer of 2002. The expansion will double the overall output and we plan to have it all on-line by the summer of 2003. This additional construction, we believe, will further enhance the economy in Arizona with additional jobs and investment and at the same time, insure that there is sufficient power produced in Arizona for future needs.

Finally, we are pleased to announce that Arlington Valley Energy now has its own website dedicated to providing the community with up-to-date news and information about Duke Energy and Arlington Valley in particular. We invite you to visit the site and check it in the future for progress reports and photos of construction and our re-vegetation project with the University of Arizona. The address is:

http://dena.duke-energy.com//arlington/

In closing, let me just restate that my wife Kathy and I are proud to be your neighbors and I hope that you will contact me with any questions or comments you may have regarding the Arlington Energy project.

Sincerely,

Rufus

Rufus Kellam
Director

EXHIBIT J-2

SUPPORT LETTERS

Buckeye Union High School District No. 201

902 Eason Avenue
Buckeye, Arizona 85326
Phone 623-386-4423 Fax 623-386-9705

Mr. Marty Arambel
Governing Board Member

Mr. Phillip Echeverria
Governing Board Member

Mrs. Jeanine Guy
Governing Board Member

Mr. Jerry Kerr
Governing Board Member

Mr. Gary Mayfield
Governing Board Member

June 21, 2001

Mary Rose Wilcox
Maricopa County Board of Supervisors
301 W. Jefferson
Phoenix, AZ 85003

Dear Supervisor Wilcox,

It is my understanding that Duke Energy is seeking approval from Maricopa County to expand their generating facility in Western Maricopa County, i.e., Arlington, Arizona.

Buckeye Union High School District receives students from the three Elementary School Districts surrounding the Duke plant. Serving a composite community as we do, we have a partnership interest in a good neighbor policy for the whole of Buckeye Valley.

When Duke Energy first arrived, they confidently announced that they would be good neighbors, keep us informed, and try to respond to our concerns and community needs. Even before they had even filed a permit application, company personnel made a genuine and credible effort to communicate with and support our communities. They also said they would be "straight" with us. Well, not all of us believed them.

It is my pleasure to report that this company has been true to its word. In particular, Rufus Kellam, the Project Director for Duke, has been very active in the communities.

While their first phase is still under construction, based on their record so far, I would like to voice support for their expansion. I believe the power plant and its employees are, and will continue to be, an asset to the Buckeye Valley.

Sincerely,

Dr. Henry E. Schmitt

Dr. Henry E. Schmitt
Superintendent

HES/ph

Dr. Henry Schmitt
Superintendent

Dr. Danny Hernandez
Principal

Ms Mary Ann Sphar
Assistant Principal

Mrs. Marquel L. Wheeler
Business Manager

Ruth Fisher School District #90

38201 West Indian School Road
Tonopah, AZ 85354

Phone 623-386-5688
Fax 623-386-3364

June 20, 2001

Honorable, Mary Rose Wilcox
301 W. Jefferson 10th floor
Phoenix, Arizona 85003

Dear Supervisor Wilcox:

Let me begin by thanking you for the representation and support you have given the Tonopah Community as a member of the Board of Supervisors. Your commitment to the entire district is greatly appreciated.

It is my understanding that Duke Energy of the Arlington Valley is applying for expansion of their electrical generating plant. To that end, I feel that Duke's track record in support of Ruth Fisher School and the Tonopah Community should be noted. I find it very refreshing to work with a company who is committed to the formation of a lasting partnership. As you are aware, rural Western Maricopa County has not had the luxury of many opportunities to establish working partnerships with industry. Duke has "Stepped up to the plate". Our school has, in a short time , reaped the benefits of a good neighbor.

Duke has contributed in excess of $15,000 over two years in funding a teacher vanpool, which has made the recruitment and retention of teachers much easier. They have also provided several pieces of equipment to assist us in exposing our students to new technology.

Sincerely,

Ruben S. Jimenez
Superintendent

cc:Rip Wilson, SRW Consulting

Buckeye Water Conservation & Drainage District

205 ROOSEVELT AVENUE
P.O. BOX 1726
BUCKEYE, ARIZONA 85326-0160
PH: (623) 386-2196
FAX (623) 386-7789

July 10, 2001

Arizona Corporation Commission
Commissioner Jim Irvin
1200 West Washington
Phoenix, Arizona 85007

Re' Duke Energy-Arlington Facility
Arlington, Arizona

Dear Commissioner Irvin:

We have been notified that Duke Energy is planning on expanding their Arlington Plant. This letter is in complete support of Duke's planned expansion. Since Duke has arrived in this community, they have joined in community affairs both as individuals and as financial Corporate sponsors. They have made every effort to keep our communities informed as to their plans and have bent over backwards in order to be a "good neighbor."

They are very conscience of the environment and their technology is state of the art. They are in the process of planting the 2000 acres of prior farmland back into its original desert landscape.

Again we are in complete support of Duke Energy, Max Shilstone and Rufus Kellam. I stand ready to stand up and speak on behalf of my community.

Sincerely,

Jackie A. Meck, General Manager

EXHIBIT J-3

CHARITABLE CONTRIBUTIONS

EXHIBIT J-3
CHARITABLE CONTRIBUTIONS SUMMARY

CHAMBERS OF COMMERCE	
Arizona Chamber of Commerce	Table Sponsorship
Arizona Chamber of Commerce	Senatorial Sponsorship
Arizona Chamber of Commerce	Annual Membership Dues
Arizona Chamber of Commerce	The Classic Golf Tournament
Arizona Hispanic Chamber of Commerce	Table Sponsorship
Buckeye Valley Chamber of Commerce	Rodeo Ticket Sponsorship
Buckeye Valley Chamber of Commerce	Bluegrass Sponsorship
Buckeye Valley Chamber of Commerce	Demolition Derby Sponsorship
Buckeye Valley Chamber of Commerce	Chamber Luncheon Dues
Buckeye Valley Chamber of Commerce	Annual Sweat Golf Tournament
Greater Phoenix Chamber of Commerce	Annual Membership Dues
Phoenix Chamber of Commerce	Fundraising Event Contribution
Tonopah Valley Association	Community Fireworks Display
SCHOOLS	
Arlington Elementary School	Desks and Chairs
Arlington Elementary School	New Computer Lab
Buckeye Union High School	Music Program Donation
Buckeye Union High School	Student Eye Glass Fundraiser
Buckeye Union High School	Band Booster - Uniforms
Ruth Fisher Elementary School	Van Pool Project
Ruth Fisher Elementary School	Van Pool Project
FIRE AND POLICE DEPARTMENTS	
Avondale Professional Firefighters	Sponsorship 2001 World Police and Fire Games
Buckeye Valley Fire Department	Fire Suppression Agreement
Buckeye Valley Fire Department	Buckeye Pioneer Days-Parade Candy
Buckeye Valley Fire Department	Parade Candy
Buckeye Valley Fire Department	Computer Upgrades for New Software for Dispatch
Tonapah Valley Fire District	Contribution
COMMUNITY	
Arizona Order of Women's Legislators	Table Sponsorship
Avondale-Goodyear Hispanic Forum	Scholarship Sponsorship
Avondale-Goodyear Hispanic Forum	Contribution
Ayso Region 225 Far West Classic	Field Sponsorship
Buckeye Elks Lodge	Golf Tee Sponsorship
Buckeye Lions Club	Family Crisis Center
Buckeye Valley Public Library	Friends of the Library Sponsorship
The Nature Conservancy-Arizona Chapter	Corporate Council Membership Dues
Society of St. Vincent De Paul	School Clothes for Arlington School Children
St. Henry's Church	Needy Families
United We Win	United We Win Golf Tournament
Valley Citizens League	California Electrical Crisis
MAJOR GIFTS	
Buckeye Union High School	Construction of All Weather Track

Buckeye Union High School District No. 201

902 Eason Avenue
Buckeye, Arizona 85326
Phone 623-386-4423 Fax 623-386-9705

Mr. Marty Aramboel
Governing Board Member

Mr. Phillip R. Echeverria
Governing Board Member

Mrs. Jeanine Guy
Governing Board Member

Mr. Jerry Kerr
Governing Board Member

Mr. Gary Mayfield
Governing Board Member

July 2, 2001

Rufus D. Kellam, Director
Duke Energy
Arlington Valley Project
Duke Energy Maricopa, LLD
P.O. Box 26
Arlington, AZ 85322

Dear Mr. Kellam:

Your call to confirm Duke Energy's generous donation of $170,000.00 for the all-weather track at Buckeye Union High School represents a hallmark contribution in the storied history of the District. Indeed, Duke Energy is a gold metal Corporate Neighbor!

This bountiful contribution will make it possible for the District to immediately commence on the construction of the all-weather track. With the collection of $89,000.00 from various prior donors, the additional $170,000.00 will ensure a state-of-the-art track for our high school scholar/athletes coupled with use by our feeder schools, public agencies and our community. It is extremely timely as the District is rebuilding 75 percent of Buckeye Union High School with an anticipated completion date of June 2003.

Consistent with our earlier conversation, this letter will serve as an invoice for receipt of the $170,00.00 which will be made in two payments of $85,000.00. The first installment will be received by the District on July 15, 2001, and the second installment will be received by the District on December 15, 2001. Please issue the checks to: Buckeye Union High School District No. 201 with a memo (i.e., notation) for the BUHS All-Weather Track. Upon receipt of the first installment the District will commence immediately on the architectural, civil engineering and invitation to bid for the track. Our critical path way is to have the track completed for the 2001- 02 season. This is a very aggressive timeline.

Under your leadership Rufus, Duke Energy, has established a bonafide school/corporate partnership that will impact the Buckeye Valley for generations to come. You have been true to your word. You are the shining star!

Respectfully,

Dr. Henry E. Schmitt
Superintendent of Education

cc: Buckeye Union High School Governing Board

RECEIVED
JUL 0 2 2001
Duke Energy Maricopa, LLC

Dr. Henry Schmitt
Superintendent

Mr. Danny Hernandez
Principal

Ms Mary Ann Sphar
Assistant Principal

Mrs. Marquel L. Wheeler
Business Manager

EXHIBIT J-4

ECONOMIC AND FISCAL IMPACT STUDY AND UPDATE

Economic and Real Estate Consulting

JUL 5 2001

June 25, 2001

Mr. H. Max Shilstone
Duke Energy
5400 Westheimer
Houston, TX 77056

Re: Economic Impact of Arlington Valley Generating Facility Expansion

Dear Mr. Shilstone:

This firm prepared an economic and fiscal impact report for Duke Energy in December 1999 concerning the proposed construction of an electrical generating facility in the Arlington Valley area of Maricopa County. We understand Duke Energy intends to expand that generating facility by doubling its size, i.e. constructing a second plant that is similar to the first. The purpose of this letter is to outline the expected additional economic and fiscal impacts that may result due to the expansion. Our original report has been used as the basis for estimating the expected impact of a second generating facility.

If the assumptions of our original report still apply, the second generating facility would be expected to create approximately the same impact as the original generating plant. The economic impact of a particular facility or land use is typically proportional to the spending and employment associated with that facility or use. In other words, if Duke Energy's investment in a generating facility doubles, the economic impact would be expected to double as well.

In our December 1999 report, we assumed that the initial investment by Duke Energy would be $250 million, with local construction spending estimated at $67 million. The operation of the facility was expected to generate 25 full-time jobs.

We understand that the expansion of the site will require a similar investment by Duke Energy of $250 million and that the local construction cost occurring in Maricopa County will be similar to the original $67 million. The total investment in the generating plant is important since it establishes the market value for the site for property tax purposes. The plant is then depreciated over 30 years, straight-line. The only difference between the impact of the original plant and the second, additional facility is that number of full-time jobs required to operate second plant is 10, making a total of 35 jobs for the entire expanded generating site. The economic impact of the second facility's operations is, therefore, only 40% as large as the operation of the original generating plant.

Elliott D. Pollack & company

7505 East 6th Avenue, Suite 100 Scottsdale, Arizona 85251 * PH 480.423.9200 * FAX 480.423.5942 * Pollack@edpco.com *
www.arizonaeconomy.com

Given the above assumptions, the additional generating facility would yield approximately $62 million annually in economic activity in Maricopa County over its two-year construction schedule and an average of $2.1 million annually in economic activity over the first eight years of its operation. The following table summarizes those impacts.

Average Annual Economic Impact
Duke Energy Electric Generating Facility Addition
(in Inflated Dollars)

	Construction[1]	Operations[2]
Local Economic Output		
Direct output	$33,500,000	$1,551,000
Indirect output	$28,225,000	$598,000
Total output	$61,725,000	$2,149,000
Employment		
Direct jobs	298	10
Indirect jobs	345	17
Total jobs	643	27
Wages	$22,718,000	$739,800
Population		
Population supported by project	1,512	63
Households supported by project	577	24

[1]Annual total for each year of two year construction period.
[2]Average annual impact from 2003 - 2010.

Sources: IMPLAN; Duke Energy; Elliott D. Pollack & Co.

The impact of the combined operations of the original and second generating facility is shown on the following table. The site will create an average of $7.5 million in economic activity annually in Maricopa County over the first eight years of combined operations. A total of 94 jobs (35 direct and 59 indirect jobs) will be created by the generating site with wages of nearly $2.6 million. The construction of both generating facilities results in the injection of $134 million in direct spending in the Maricopa County economy over the four years required to construct the two plants, resulting in $247 million in total direct and indirect economic activity.

Average Annual Operations Economic Impact
Duke Energy Expanded Electric Generating Site
(in Inflated Dollars)

	Operations[1]
Local Economic Output	
Direct output	$5,428,000
Indirect output	$2,094,000
Total output	$7,522,000
Employment	
Direct jobs	35
Indirect jobs	59
Total jobs	94
Wages	$2,589,300
Population	
Population supported by project	222
Households supported by project	85

[1]Average annual impact over first eight years of operation.

Sources: IMPLAN; Duke Energy; Elliott D. Pollack & Co.

The fiscal impact of the second generating facility on city, county and state taxing authorities will only be slightly smaller than the original. Most of the fiscal impact of the generating facility is associated with property taxes levied on the capital investment in the facility and sales taxes levied on fuel consumption. The fiscal impact of the additional facility will be essentially the same as the original, if it has the same value and consumes similar amounts of natural gas. The annual operating impact of the second facility is projected to be about 2% lower than the original plant due to the lower employment level at the second facility.

As noted in the earlier impact report, Duke Energy's investment will have a significant impact on the assessed value and property tax rates of local school districts. The expanded site with the two generating facilities will have an assessed value greater than the current value of the entire Buckeye Union High School District. This should lead to significant reductions in property tax rates for local property owners once the facilities are added to the tax rolls.

If you should have any questions or comments about the information contained in the letter, please do not hesitate to contact us. We appreciate the opportunity to consult with you on your expansion plans.

Sincerely,

Richard C. Merritt

Richard C. Merritt, AICP
Senior Vice President

cc: Tom Campbell
Ed Bull

ECONOMIC AND FISCAL IMPACT OF DUKE ENERGY'S ELECTRIC GENERATING STATION ARLINGTON, ARIZONA

Prepared for:

Duke Energy

Prepared by:

Elliott D. Pollack and Company
7505 East Sixth Avenue, Suite 100
Scottsdale, AZ 85251

December 15, 1999

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Economic and Fiscal Impact
of
Duke Energy's Electric Generating Station
Arlington, Arizona

1.0 Executive Summary

Elliott D. Pollack and Company has been retained by Duke Energy to analyze the economic and fiscal impact of a proposed $250 million electric generating station to be located in a rural area southwest of the Town of Buckeye known as Arlington Valley. The plant will use natural gas as its primary fuel and will require a substantial quantity of water to generate steam. Approximately 2,800 acres of land will be purchased to provide a site for the plant and the water rights necessary to operate the facility. Construction is expected to start in February 2001, with completion slated for July 2002. The operation of the plant will generate 25 jobs.

While the investment by Duke Energy is estimated at $250 million, the local construction cost is estimated at about $67 million. Most of the cost of the generating station is associated with the purchase of gas and steam turbines that will be manufactured out of state.

The proposed Duke Energy electric generating station will be located in the Arlington Elementary and Buckeye Union High School Districts. Arlington Elementary (kindergarten through eighth grade) is a small district of approximately 155 students who are fed to the Buckeye Union District for secondary education. Buckeye Union has slightly over 1,000 students and serves a wide rural area of southwest Maricopa County.

This report will evaluate both the economic and fiscal effects of the proposed generating station. Economic impact analysis examines the regional implications of an activity in terms of three basic measures: sales or output, earnings and job creation. Fiscal impact analysis, on the other hand, evaluates the public revenues and costs created by a particular activity. In fiscal impact analysis, the primary revenue sources of a city, county or state are analyzed to determine how the activity may financially affect them. In addition, this report will evaluate the impact of the generating station on the Arlington Elementary and Buckeye Union High School Districts.

1.1 Economic Impact Summary

The economic impact of the Duke Energy generating station is substantial, resulting in the creation of nearly 643 total direct and indirect jobs annually during the two year construction period and 67 total direct and indirect jobs yearly during its operation. Local economic output during construction is $61.7 million annually and about $5

million per year thereafter. The project supports 577 households during construction and 60 households while in operation.

Table 1
Average Annual Economic Impact
Duke Energy Electric Generating Station
(in Inflated Dollars)

	Construction[1]	Operations[2]
Local Economic Output		
Direct output	$33,500,000	$3,877,000
Indirect output	$28,225,000	$1,496,000
Total output	$61,725,000	$5,373,000
Employment		
Direct jobs	298	25
Indirect jobs	345	42
Total jobs	643	67
Wages	$22,718,000	$1,849,500
Population		
Population supported by project	1,512	158
Households supported by project	577	60

[1]Annual total for each year of two year construction period.
[2]Average annual impact from 2003 - 2010.

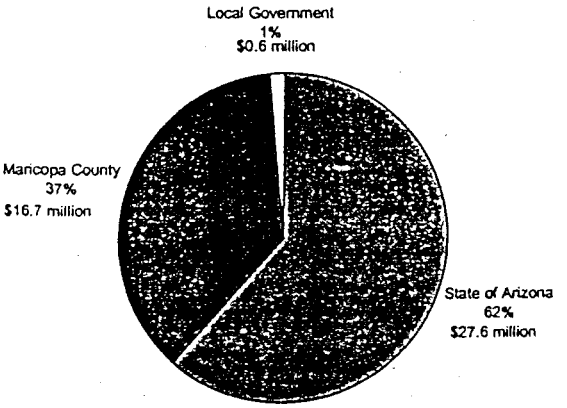
Sources: IMPLAN; Duke Energy; Elliott D. Pollack & Co.

1.2 Fiscal Impact Summary

One of the major benefits of the generating station is the increase in the assessed value of the County and other taxing districts within which the plant is located. The projected assessed value of the generating station and land, when first placed in operation and before deducting depreciation, is $62 million. This represents approximately 0.3% of the total $18 billion 1999 assessed value of the County, a fairly significant figure given the size of the metro area. A project of this magnitude is equivalent to a new regional shopping mall or large manufacturing plant from the standpoint of property tax revenue, even though the plant's value will slowly decline over the years as it is depreciated.

The electric generating station produces significant positive effects for the State of Arizona and Maricopa County totaling nearly $45 million dollars between 2001 and 2010. The majority of the revenue, 62%, accrues to the State, but Maricopa County and its taxing districts also receive $16.7 million. The taxation of real property, construction contracts and natural gas consumption accounts for about 90% of the revenue. Impacts resulting from the spending of workers supported by the plant contribute another $4.5 million over the 10 years. During construction of the plant, approximately $5.8 million accrues to governmental entities. After completion of the generating station, total revenues reach $5 million annually.

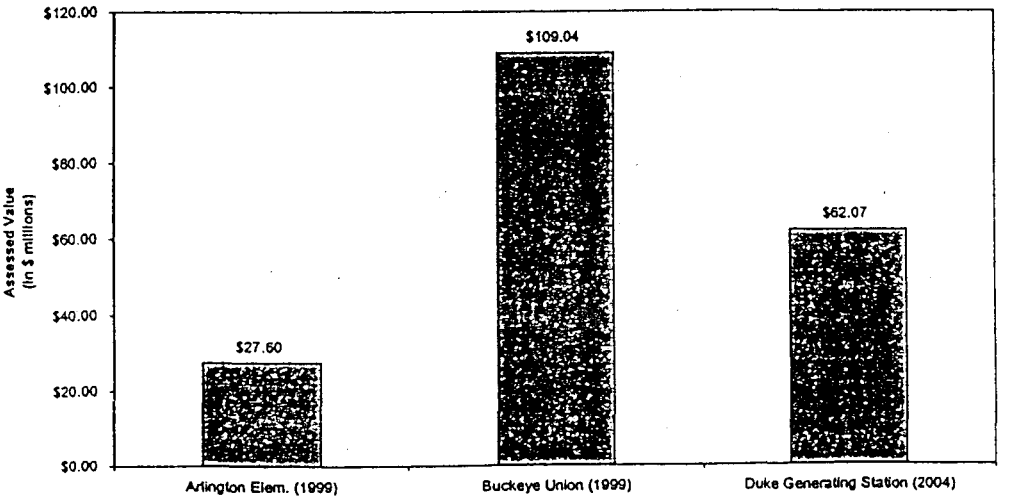
Chart 1
Distribution of Revenues
From Duke Energy Electric Generating Station
2001 - 2010
Sources: Duke Energy, IMPLAN, AZ Dept. of Revenue, Maricopa County Assessor, Elliott D. Pollack & Co.



1.3 Impact on School Districts

A large capital investment such as that proposed by Duke Energy will have a significant impact on the assessed value and tax rates of a school district. With the high assessment ratio of 25% for utility companies, the financing of schools is transferred in many respects from local residents to private business. When the plant is completed and added to the tax rolls in 2004, its estimated assessed value will be $62 million. Comparatively, this represents 125% of Arlington Elementary's 1999 primary assessed value and 57% of Buckeye Union's 1999 value.

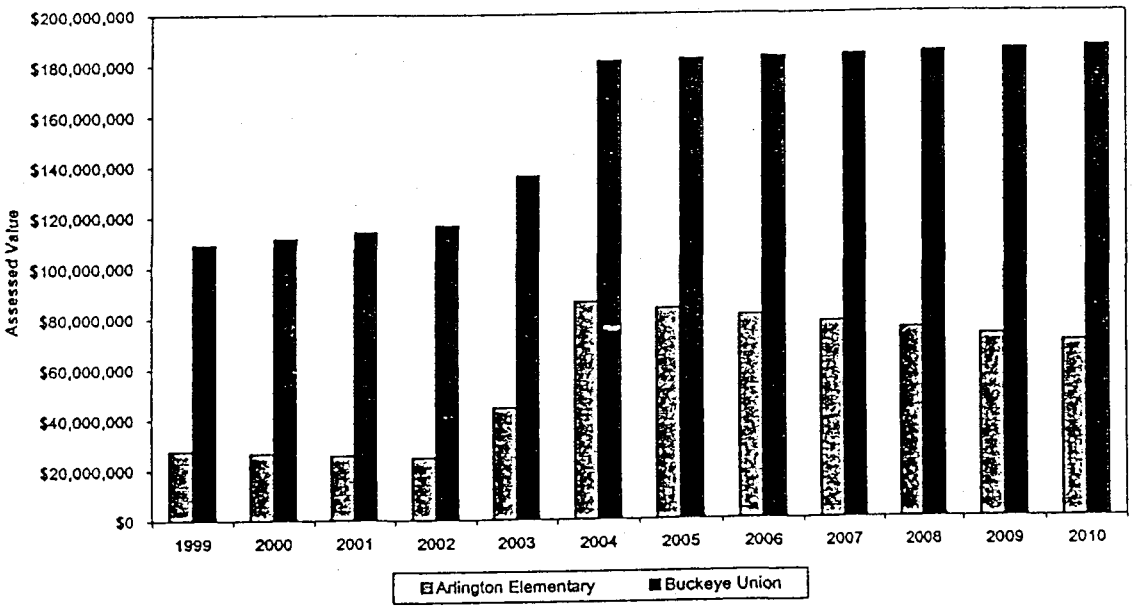
Chart 2
Comparison of Primary Assessed Values
Arlington Elementary District, Buckeye Union H. S. District, Duke Generating Station
Sources: AZ Dept. of Revenue, Maricopa County Assessor, Elliott D. Pollack & Co.



Duke Energy's investment in the generating station produces a large boost in the assessed valuation of both the Arlington Elementary and Buckeye Union Districts. The projected primary assessed value begins to climb in 2003 with the construction of the plant (there's a two year time lag between construction and the recording of the generating station on the tax rolls). By 2004, the full effect of the plant on assessed values is realized.

Chart 3

Projected Primary Assessed Values
Arlington Elementary and Buckeye Union School Districts
Sources: AZ Dept. of Revenue, Maricopa County Assessor, Elliott D. Pollack & Co.



As a result, the primary and secondary tax rate for both Arlington Elementary and Buckeye Union should experience significant decreases. For instance, Arlington Elementary's primary rate should drop by about 63% between 1999 and 2004 when the plant is completed. The rate is projected to decline from the current $2.2040 to $0.8187, assuming that the school district's revenues needs increase at 3% per year from their current level.

Likewise, Buckeye Union's primary rate is projected to decline by 30% between 1999 and 2004 if revenue needs grow by 3% per year. The primary tax rate falls from $2.1337 in 1999 to a projected $1.4880 in 2004. Similar decreases in the secondary tax rate will also occur.

Individual property owners should see a 46% decline in school district property taxes between 1999 and 2004 as a result of the construction of the electric generating station. The typical annual savings range from $95 for a 40 acre vacant parcel to $421 for a 160 acre agricultural parcel. While these savings seem small for each property owner, the effect across both the Arlington Elementary and Buckeye Union Districts is substantial. Based on the projected future assessed values for the plant and expected property tax

rates, Duke Energy will be absorbing over $1.8 million in school district property taxes each year, once the plant is in service. These are expenses that previously accrued to all other property owners located within the school districts.

Table 2

Estimated Annual School District Property Tax Savings Resulting From Duke Energy Electric Generating Station

Property type	Residence on 1 acre lot	40 acre vacant parcel	160 acre parcel in agriculture
Market value	$70,000	$23,280	$103,200
Assessed value	$7,000	$3,725	$16,512
1999 combined school property tax[1]	$282	$206	$914
Projected 2004 combined school property tax[2]	$153	$111	$493
Tax savings	**$129**	**$95**	**$421**
Percentage tax decrease	**45.7%**	**46.0%**	**46.0%**

[1]Combined Arlington Elementary and Buckeye Union tax rate of $5.5364; reduced homeowner rate of $4.0341.

[2]Projected combined rate of $2.9887; reduced homeowner rate of $2.1899.

Note: Tax calculations do not include County or special district property taxes.

Sources: AZ Dept. of Revenue; Maricopa County Assessor; Elliott D. Pollack & Co.

2.0 Methodology and Sources

This report will describe the projected economic and fiscal impact of the construction and operation of a privately-owned electric generating station on metro Phoenix. Economic impact analysis examines the regional implications of an activity in terms of three basic measures: sales or output, earnings and job creation. Fiscal impact analysis, on the other hand, evaluates the public revenues and costs created by a particular activity. In fiscal impact analysis, the primary revenue sources of a city, county or state are analyzed to determine how the activity may financially affect them.

This study will focus on the benefits that would accrue to the State of Arizona, Maricopa County, and the Arlington Elementary and Buckeye Union High School Districts from the construction of the Duke Energy electrical generating station. The site of the plant is not located within an incorporated area, so the effect on local municipalities will be negligible. The analysis assumes that the current tax structure of the State and County would continue at current rates into the future. The impact on the school districts will be evaluated from the standpoint of increased assessed valuation and potential effect on property tax rates.

The fiscal impact figures cited in this report have been generated from information provided by a variety of sources including:

- Arizona Department of Education;
- Arizona Department of Economic Security;
- Arizona Department of Revenue;
- Duke Energy;
- Maricopa County Assessor's office;
- U.S. Consumer Expenditure Survey.

On of the most important effects of the power plant is the impact on assessed values and property taxes. The Arizona Department of Revenue controls the valuation of electric utility company property for property tax purposes. Utility companies, mines, and railroads are known as "centrally assessed" property and are subject to different standards than other types of real property. The plant is placed on the tax rolls at the book cost of investment and then depreciated over the life of the investment. In this case, depreciation is calculated based on a 30 year straight-line plant life. Pollution control equipment receives a 50% market value exemption under state law. Electric utility company property is assessed at 25% of its full cash value.

During construction of the plant, property taxes are calculated based on 50% of the actual cost expended for the year ending December 31st. A two-year time lag occurs between actual construction of the plant and placing it on the tax rolls. For instance, if the plant were started in 2001 as anticipated, the value of the first year's construction activity would not reach the tax rolls until the 2003 tax year. The full value of the

plant will not be recorded for tax purposes until 2004, based on the projected completion in 2002.

Elliott D. Pollack and Company has relied upon Duke Energy for construction cost estimates, employment projections and operating expenditures. This firm has not provided any estimate of the projected governmental costs to provide services to the generating station. Such analysis is beyond the scope of this study. Unless otherwise stated, all dollar values are expressed in current, inflated dollars using a 3% annual inflation rate.

This report is organized to provide an overview of economic and fiscal impact analysis and the results attributed to this particular project. The following section describes the proposed generating station and the primary assumptions that will drive the impact analysis. Section 4.0 summarizes the economic impact of the generating station on the metro Phoenix area. The fiscal impact of the plant is outlined in Section 5.0. Lastly, the impact of the generating station on the local school districts is described in the final part of the study.

3.0 Description of Project

Duke Energy is proposing to construct a $250 million electric generating plant in a rural area southwest of the Town of Buckeye known as Arlington Valley. Approximately 2,800 acres valued at $5 million will be purchased to provide a site for the plant and the water rights necessary to operate the facility. The plant will use natural gas as its primary fuel, but will also require a substantial quantity of water to generate steam. Duke Energy expects to purchase approximately $50 million of natural gas per year to operate the plant. Construction is expected to start in February 2001, with completion slated for July 2002.

For property tax analysis, it is necessary to differentiate between various parts of the plant and the company's investment. Of the $250 million cost, approximately $10 million will be spent on pollution control equipment, which is the subject of a 50% property tax exemption.

The land parcels that are subject to purchase are all contiguous and located within the Arlington Elementary and Buckeye Union High School Districts. The property is located within Township Six West, Range 1 South, which will provide rail access to the site.

While the investment by Duke Energy is estimated at $250 million, the local construction cost is estimated at about $67 million. Most of the cost of the generating station is associated with the purchase of gas and steam turbines that will be manufactured out of state. The operation of the plant will generate 25 jobs.

4.0 Economic Impact of Generating Station

This portion of the report will outline the economic impacts of both the construction of the generating station as well as its operations. Analysis of the fiscal impacts of the project is provided in the Section 5.0. All dollar figures, unless otherwise stated, are expressed in current, inflated dollars.

An extensive spreadsheet model was developed to evaluate and calculate the fiscal and economic impacts of the Duke Energy generating station from 2001 to 2010. The first subsection describes the economic impact methodology while subsection 4.2 summarizes the total benefits.

4.1 Economic Impact Analysis Methodology

Economic impact analysis examines the economic implications of an activity in terms of sales or output, earnings, and employment. For this study, the following two economic activities associated with the generating station were evaluated:

- the construction of the plant and
- the operations of the plant once completed.

Construction phase economic impacts are generally short-term effects related to onsite and offsite construction employment and other industries that support the construction. The long-term consequences of a project are the operational phase impacts. These include employment, earnings and expenditures that recur over the long-term.

The different types of economic impacts are known as direct, indirect, and induced, according to the manner in which the impacts are generated. For instance, direct employment consists of permanent jobs held by the project employees. Indirect employment is those jobs created by businesses that provide goods and services essential to the operation or construction of the project. These businesses range from manufacturers (who make goods) to wholesalers (who deliver goods) to janitorial firms who clean the buildings. Finally, the spending of the wages and salaries of the direct and indirect employees on items such as food, housing, transportation and medical services creates induced employment in all sectors of the economy.

Economists have developed multipliers that are used to estimate the indirect and induced impacts of various economic activities. These indirect and induced ripple effects occur as the wages of direct employees are respent in local businesses on retail goods and services. In response to this spending, local businesses hire more staff and expand their operations, creating additional jobs in retailing, wholesaling, manufacturing, transportation and other service sectors. These secondary effects are captured in the analysis conducted in this study.

Multipliers have been developed by both public and private organizations for each state and county in the country. The Minnesota IMPLAN Group developed the multipliers

used in this study. The IMPLAN multipliers are used to estimate the impacts of project expenditures on a region (gross receipt or sales), earnings (the sum of wages and salaries, proprietors income, and other labor income), and employment (number of jobs).

4.2 Economic Impact of Duke Energy Electric Generating Station

As noted previously, the local economic impact of the construction of the generating station is significantly less than its full cost since most of the major components are manufactured out-of-state. The local construction contract is estimated at approximately $67 million, spent during 2001 and 2002. Duke Energy projects that 25 direct jobs will be permanently created for the operation of the plant. Plant operators are expected to earn the typical wage for public utility employees in Maricopa County of about $39,000 annually. From this data, the IMPLAN economic multipliers are used to calculate the total impact of the project.

The economic impact of the Duke Energy generating station is substantial, resulting in the creation of nearly 643 total direct and indirect jobs annually during the two year construction period and 67 total direct and indirect jobs yearly during its operation (see Table 3). Local economic output during construction is $61.7 million annually and about $5 million per year thereafter. The project supports 577 households during construction and 60 households while in operation.

The impacts described above are regional in nature and will affect cities throughout the metro Phoenix area. For instance, construction materials will be purchased from local vendors and construction employees might commute long distances to work on the plant. Most likely, these workers and their families will purchase their daily needs at stores close to their place of residence, helping to disperse the Duke Energy generating station's impact throughout many local cities. Full-time workers who operate the plant after construction will most likely live on the west side of Maricopa County, once again distributing the impact among a number of communities.

Table 3

Economic Impact on Maricopa County
Duke Energy Electrical Generating Station
(In Inflated Dollars)

Inflation rate: 3.0%

	Construction		Operations							
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Local Economic Output										
Direct output	$33,500,000	$33,500,000	$3,488,000	$3,592,000	$3,700,000	$3,811,000	$3,926,000	$4,043,000	$4,165,000	$4,290,000
Indirect output	$28,225,000	$28,225,000	$1,346,000	$1,386,000	$1,428,000	$1,471,000	$1,515,000	$1,560,000	$1,607,000	$1,655,000
Total output	$61,725,000	$61,725,000	$4,834,000	$4,979,000	$5,128,000	$5,282,000	$5,440,000	$5,604,000	$5,772,000	$5,945,000
Employment										
Direct jobs	298	298	25	25	25	25	25	25	25	25
Indirect jobs	345	345	42	42	42	42	42	42	42	42
Total jobs	643	643	67	67	67	67	67	67	67	67
Wages	$22,718,000	$22,718,000	$1,664,000	$1,714,000	$1,765,000	$1,818,000	$1,873,000	$1,929,000	$1,987,000	$2,046,000
Population										
Population supported by project	1,512	1,512	158	158	158	158	158	158	158	158
Households supported by project	577	577	60	60	60	60	60	60	60	60

Sources: IMPLAN; Duke Energy; Elliott D. Pollack & Co.

5.0 Fiscal Impact of Generating Station

5.1 Background

Fiscal impact analysis studies the public revenues associated with a particular economic activity. The primary revenue sources of local, county, and state governments (i.e. taxes) are analyzed to determine how an activity may affect the various jurisdictions. This section will only evaluate the impact on the governmental entities. The impact on local school districts will be analyzed in Section 6.0.

Fiscal impacts are categorized by type in this study, similar to economic impact analysis. Construction impacts relate to the revenues generated from construction of the power plant. The primary sources of revenue are the state, county, and local sales taxes levied on the value of construction activity. In this particular case, the project is not located in a municipality, so local sales taxes will not be applicable. Operation phase fiscal impacts result from payment of employee wages and expenditures related to operating the generating station. One of the most important on-going revenues are the property taxes that will be paid by Duke Energy.

In addition to the direct revenues described above, secondary fiscal effects also occur as a result of spending by construction and operations employees. For instance, employees of the plant will live in all parts of Maricopa County, benefiting those communities from their spending on housing, retail goods and services. Indirect and induced employment supported by the plant will also create fiscal impacts resulting from the spending of their wages. Examples of the types of secondary fiscal impacts that will be generated include State income taxes paid on wages and sales taxes paid on retail sales.

5.2 Revenue Sources

This section outlines the applicable tax rates of the various jurisdictions and the types of taxes that will be collected from construction and operation of the Duke Energy electric generating station.

- <u>Tax On Construction Materials</u>
  The State and County levies a sales tax on materials used in the construction of land or building improvements. That tax is calculated by State law under the assumption that 65% of the construction cost of the facility and its land improvements are related to construction materials with the remaining 35% devoted to labor. The sales tax rate is then applied to the 65% materials figure. The sales tax on construction materials is a one-time collection by the governmental entity.

  The State currently levies a 5.0% sales tax on construction activity. Maricopa County levies two sales taxes totaling 0.7%. The freeway tax, which is used to fund the County's freeway program, is levied at a 0.5% rate until 2006 when it

expires. In November 1998, the electorate approved a 0.2% levy for the construction of prison facilities that is schedule to expire at the end of 2007.

- Property Taxes

  Real estate taxes are typically based on the assessed value of real property as determined by County Assessor. In the case of an electrical generating station, however, the Arizona Department of Revenue conducts the valuation in accordance with State Statute. The market value of the power plant is established as the original cost less accumulated depreciation. For this report, the plant was depreciated over 30 years, straight-line. Pollution control equipment is provided a 50% exemption from taxation.

  The assessed value of the plant is calculated by multiplying the assessment ratio, determined by the property's use, by its full cash value. The assessment ratio for an electric utility plant is 25%; vacant land is assessed at 16%. Assessed value is expressed by the following equation:

  market value X assessment ratio = assessed value

  The property tax rate, expressed in dollars per $100 of assessed value, is then applied to the assessed value to determine the amount of property tax. There are two types of property taxes – primary taxes used to finance general government operations, and secondary taxes used to finance general obligation bonded debt, budget overrides and special districts. The primary tax is based on what is known as the limited property value, calculated under a formula spelled out in State law. Secondary taxes are based on full cash value of property. The limited value cannot exceed full cash value. For an electrical utility, the limited and full cash values are the same.

  The combined Maricopa County property tax rate (primary and secondary) for 1999 is $3.4250 per $100 of assessed value comprised of the following taxing entities or districts:

  - general County tax,
  - Community College tax,
  - Flood Control District tax,
  - Fire District Assistance tax,
  - County Free Library tax,
  - Central Arizona Water Conservation tax.

  In addition, direct and indirect employees supported by the construction and operation of the plant will also pay city property taxes on homes they occupy. The tax rate used for this analysis is the weighted average rate of the eight largest cities in the metro area or $1.4380 per $100 of assessed value. The value of a typical Maricopa County housing unit has been calculated at approximately $105,000. This value assumes that employees will occupy units in a pattern similar to the current inventory of housing in the Valley. Today,

single family homes account for 66.1% of the housing stock, townhouses 8.1%, and apartments 25.8%. The current average sale price of these units is $131,000, $85,000, and $43,800 respectively, with the weighted average of all units at $104,776.

- Sales/Use Tax.
  The electric generating station will consume a large quantity of natural gas, estimated at $50 million per year. The State and County will charge a use or sales tax on this consumption at the 5.0% rate for the State and 0.7% rate for the County.

  Fiscal impacts also result from the spending by direct and indirect employees supported by the construction and operation of generating station. Most of the employees supported by the project will reside within one of Maricopa County's cities or, at the very least, purchase goods from retailers located within a local municipality. Based on data from the U. S. Consumer Expenditure Survey, the projected extent of retail spending and resulting sales tax receipts was calculated.

  State and County sales tax rates for employee spending are the same as cited previously (5.0% for State and 0.7% for County). The retail sales tax receipts for local cities are based on the weighted average tax rate for all cities in Maricopa County or 1.38%.

- State Income Tax
  The State of Arizona collects taxes on personal income. The tax rate used in the analysis averages about 1.7% of gross income for construction-related wages and 1.3% for operations-related earnings. These percentages are based on the most recently available income tax data from the State and the projected wage levels of jobs created by the project. This tax will apply to the wages and earnings of direct and indirect employment resulting from construction and operation of the generating station. Portions of this tax are redistributed through revenue sharing to cities throughout Arizona based on population.

- State Unemployment Tax
  Unemployment insurance tax for employees is 2.7% on the first $7,000 of earned income. This factor is applied to the projected wages and earnings of direct and indirect employees involved in construction and operation of the project.

- Gas Tax
  The State of Arizona collects a motor vehicle fuel tax of $0.18 per gallon. The tax revenue is calculated based on a vehicle traveling 12,000 miles per year at 20 miles per gallon. Portions of this tax are distributed to cities and counties throughout Arizona based on a formula that includes population and the origin of gasoline sales.

- Vehicle License Tax
  The vehicle license tax is a personal property tax placed on vehicles at the time of annual registration. The average tax in Maricopa County is $148 and funds are shared between the cities, county and state in accordance with population based formulas.

The above tax categories represent the largest sources of revenues that will be generated to city, county and state governments.

5.3 Fiscal Impact of Duke Energy Electric Generating Station

One of the major benefits of the generating station is the increase in the assessed value of the County and other taxing districts within which the plant is located. The projected assessed value of the generating station and land, when first placed in operation and before deducting depreciation, is $62 million (see Table 4). This represents approximately 0.3% of the total $18 billion 1999 assessed value of the County, a fairly significant figure given the size of the metro area. A project of this magnitude is equivalent to a new regional shopping mall or manufacturing plant from the standpoint of property tax revenue, even though the generating station's value will slowly decline over the years as it is depreciated.

Table 4
Projected Market and Assessed Values
Duke Energy Electric Generating Station
(in Inflated Dollars)

	Projected Market Value				
	Plant Value	P.C.E.*	Land	Total Value	Assessed Value
2001	$0	$0	$1,680,000	$1,680,000	$268,800
2002	$0	$0	$1,680,000	$1,680,000	$268,800
2003	$73,333,333	$1,527,778	$5,000,000	$79,861,111	$19,515,278
2004	$240,000,000	$5,000,000	$5,150,000	$250,150,000	$62,074,000
2005	$232,000,000	$4,833,333	$5,304,500	$242,137,833	$60,057,053
2006	$224,000,000	$4,666,667	$5,463,635	$234,130,302	$58,040,848
2007	$216,000,000	$4,500,000	$5,627,544	$226,127,544	$56,025,407
2008	$208,000,000	$4,333,333	$5,796,370	$218,129,704	$54,010,753
2009	$200,000,000	$4,166,667	$5,970,261	$210,136,928	$51,996,909
2010	$192,000,000	$4,000,000	$6,149,369	$202,149,369	$49,983,899

*Pollution Control Equipment

Sources: AZ Dept. of Revenue; Maricopa County Assessor; Elliott D. Pollack & Co.

Table 4 shows the projected depreciated value of the plant over time. The analysis assumes there will be no additional capital improvements to the site in the future. The value of the land to be acquired by Duke Energy has been inflated at a 3.0% rate given historical land appreciation trends in the area.

As shown on Table 5 on page 17, the electric generating station will produce significant positive effects for the State of Arizona and Maricopa County totaling nearly $45 million

dollars between 2001 and 2010. About 90% of the revenue is derived from taxation of real property, construction contracts and natural gas consumption. Impacts resulting from employment spending and wages contribute another $4.5 million over the 10 years. During construction of the plant, approximately $5.8 million per year accrues to governmental entities. After completion of the generating station, total revenues reach $5 million annually.

The State of Arizona reaps most of the rewards of the plant, accounting for $27.4 million in revenue or 62% of the total. Maricopa County also gains about $16.7 million in tax revenue, primarily from property taxes. It should be noted that most of these revenues do not flow directly to the County's general fund, but rather to county-wide taxing jurisdictions such as the Community College District and Flood Control District. Cities in the county gain the least because the plant is located in a rural area. Any impact on local cities is the result of spending of wages by persons supported by the generating station.

It needs to be emphasized that the above revenue figures are based on the current tax structure of the State and County. Any increase in sales or income tax rates would produce even greater benefits. The high tax valuation of the plant also provides a significant boost to the assessed valuation of the County, helping to stabilize or even reduce County property tax rates. In addition, the figures do not include corporate income taxes that may be paid to the State by Duke Energy.

Table 5

Fiscal Impact on Arizona and Maricopa County
Duke Energy Electrical Generating Station
(In Inflated Dollars)

Inflation rate: 3.0%

Fiscal Impact of Project	Construction 2001	Construction 2002	Operations 2003	2004	2005	2006	2007	2008	2009	2010	Total
State of Arizona											
Construction sales tax	$1,089,000	$1,089,000									$2,178,000
Sales tax on fuel consumption			$2,500,000	$2,575,000	$2,652,000	$2,732,000	$2,814,000	$2,898,000	$2,985,000	$3,075,000	$22,231,000
Maricopa County											
Construction sales tax	$152,000	$152,000									$304,000
Sales tax on fuel consumption			$350,000	$361,000	$371,000	$382,000	$113,000	$0	$0	$0	$1,577,000
Property tax	$9,000	$9,000	$668,000	$2,126,000	$2,057,000	$1,988,000	$1,919,000	$1,850,000	$1,781,000	$1,712,000	$14,119,000
Fiscal Impacts of Employees											
State of Arizona											
Retail sales tax[1]	$483,000	$483,000	$44,000	$45,000	$47,000	$48,000	$49,000	$51,000	$52,000	$54,000	$1,356,000
Income tax[1]	$393,000	$393,000	$22,000	$23,000	$23,000	$24,000	$25,000	$26,000	$26,000	$27,000	$982,000
Unemployment tax	$122,000	$122,000	$13,000	$13,000	$14,000	$14,000	$14,000	$15,000	$15,000	$16,000	$358,000
Gas tax[1]	$69,000	$69,000	$7,000	$7,000	$8,000	$8,000	$8,000	$8,000	$9,000	$9,000	$202,000
Vehicle license tax[1]	$95,000	$95,000	$10,000	$10,000	$11,000	$11,000	$11,000	$12,000	$12,000	$12,000	$279,000
Maricopa County											
Retail sales tax	$80,000	$80,000	$7,000	$8,000	$8,000	$8,000	$2,000	$0	$0	$0	$193,000
Property tax	$166,000	$166,000	$17,000	$18,000	$18,000	$19,000	$20,000	$20,000	$21,000	$21,000	$486,000
Local Government											
Retail sales tax	$158,000	$158,000	$14,000	$15,000	$15,000	$16,000	$16,000	$17,000	$17,000	$18,000	$444,000
Property tax	$70,000	$70,000	$7,000	$8,000	$8,000	$8,000	$8,000	$8,000	$9,000	$9,000	$205,000
Total Impact											
State of Arizona	$2,251,000	$2,251,000	$2,596,000	$2,673,000	$2,755,000	$2,837,000	$2,921,000	$3,010,000	$3,099,000	$3,193,000	$27,586,000
Maricopa County	$407,000	$407,000	$1,042,000	$2,513,000	$2,454,000	$2,397,000	$2,054,000	$1,870,000	$1,802,000	$1,733,000	$16,679,000
Local Government	$228,000	$228,000	$21,000	$23,000	$23,000	$24,000	$24,000	$25,000	$26,000	$27,000	$649,000
Total All Impacts	$2,886,000	$2,886,000	$3,659,000	$5,209,000	$5,232,000	$5,258,000	$4,999,000	$4,905,000	$4,927,000	$4,953,000	$44,914,000

[1] A portion of these taxes are shared with cities, towns and counties under revenue sharing.

Sources: IMPLAN; Duke Energy; Arizona Department of Revenue; Maricopa County Assessor's Office; Elliott D. Pollack & Co.

6.0 Impact of Generating Station on School Districts

6.1 Background

The Duke Energy electric generating station is located in the Arlington Elementary and Buckeye Union High School Districts. Arlington Elementary (kindergarten through eighth grade) is a small district of approximately 155 students who are fed to the Buckeye Union District for secondary eduation. Buckeye Union has slightly over 1,000 students and serves a wide rural area of southwest Maricopa County.

The history of assessed values of the two districts is shown on Table 6. Arlington's assessed value has been declining since 1991 as a result of the large percentage of utility company investments within the District. For 1999, over 50% of the District's assessed value is attributable to utility and pipeline company improvements. Since these properties depreciate over time, the assessed value declines as well. Buckeye Union's assessed value has been growing since the end of the local real estate depression in 1995. Utilities account for about 31% of Buckeye Union's assessed value.

Table 6
Assessed Valuation History
Arlington Elementary and Buckeye Union High School Districts

Arlington Elementary #47

	Primary Property Tax		Secondary Property Tax		Property Tax Revenue	
	Valuation	Tax rate	Valuation	Tax rate	Primary	Secondary
1991	$34,673,905	$2.2854	$37,110,165	$0.0000	$792,437	$0
1992	$33,854,336	$2.4430	$35,455,605	$0.0000	$827,061	$0
1993	$32,074,642	$2.3907	$32,670,713	$0.0000	$766,808	$0
1994	$31,496,043	$2.2549	$32,099,408	$0.1973	$710,204	$63,332
1995	$32,562,122	$1.9804	$33,388,798	$0.3933	$644,860	$131,318
1996	$30,589,918	$2.3780	$31,139,091	$0.2090	$727,428	$65,081
1997	$30,271,539	$2.2309	$31,006,780	$0.4229	$675,328	$131,128
1998	$29,622,791	$2.3097	$30,632,190	$0.4192	$684,198	$128,410
1999	$27,601,070	$2.2040	$28,536,546	$0.4816	$608,328	$137,432
Compound annual change 1996-99	-3.37%		-2.87%			

Buckeye Union High School #201

	Primary Property Tax		Secondary Property Tax		Property Tax Revenue	
	Valuation	Tax rate	Valuation	Tax rate	Primary	Secondary
1991	$115,410,114	$2.5579	$129,471,406	$0.7654	$2,952,075	$990,974
1992	$119,897,053	$2.1808	$127,640,825	$0.5166	$2,614,715	$659,393
1993	$109,944,995	$2.5032	$113,431,370	$0.5817	$2,752,143	$659,830
1994	$107,249,347	$2.6897	$109,847,874	$0.6343	$2,884,686	$696,765
1995	$105,322,499	$2.0479	$109,517,107	$0.5521	$2,156,899	$604,644
1996	$101,996,864	$2.3267	$104,597,699	$0.7058	$2,373,161	$738,251
1997	$102,860,395	$2.5973	$106,842,353	$0.6617	$2,671,593	$706,976
1998	$104,992,419	$2.5043	$109,689,634	$0.7414	$2,629,325	$813,239
1999	$109,037,307	$2.1337	$114,684,129	$0.7171	$2,326,529	$822,400
Compound annual change 1996-99	2.25%		3.12%			

Sources: Maricopa County Assessor; Elliott D. Pollack & Co.

The financing of public education in Arizona is a complex matter. Funding comes from a variety of local, state, and federal sources based on complicated formulas. For fiscal year

1997-98, local property taxes provided 47% of total public school funding within Maricopa County while the State contributed 45%. Federal and County sources contributed the remaining revenue. Two types of property taxes accomplish funding at the local level:

- Primary taxes used to finance school operations; and
- Secondary taxes used to finance general obligation bonded debt and budget overrides.

According to the Arizona Department of Education, local property taxes provided about 86% and 62%, respectively, of the Arlington and Buckeye Union Districts' total budgets during fiscal year 1997-98. The proposed Duke Energy electric generating station will increase the assessed value of the school districts and provide two primary benefits:

- Funding for schools can be increased without raising tax rates or, alternatively, current funding levels can be maintained while reducing the tax rate; and
- The districts' bonding capacities will be increased to support new capital improvements.

Both of the above benefits are subject to spending and debt limitations provided in State law. In addition, the financing of public school capital facilities and the future of the secondary property tax is currently in a state of flux due to the passing of the Students FIRST bill by the State Legislature in July 1998. A discussion of the implications of Students FIRST is included in the last part of this section.

6.2 Impact of Duke Energy Generating Station on School Districts

A large capital investment such as that proposed by Duke Energy will have a significant impact on the assessed value and tax rates of a school district. With the high assessment ratio of 25% for utility companies, the financing of schools is transferred in many respects from local residents to private business. The analysis contain in this section will illustrate the potential impact of the power plant on local school property taxes.

When the plant is completed and added to the tax rolls in 2004, its estimated assessed value will be $62 million. Comparatively, this represents 125% of Arlington Elementary's 1999 primary assessed value and 57% of Buckeye Union's 1999 value. Clearly, the generating station should have an immediate positive effect, resulting in lower school tax rates.

Chart 4

Comparison of Assessed Values
Arlington Elementary District, Buckeye Union H. S. District, Duke Generating Station

Sources: AZ Dept. of Revenue, Maricopa County Assessor, Elliott D. Pollack & Co.

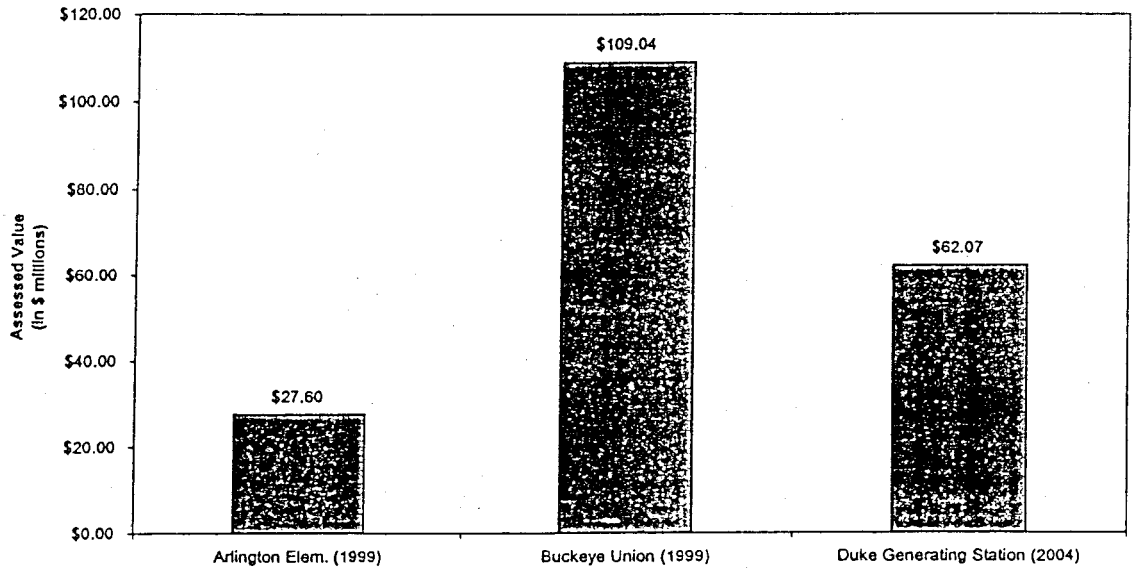


Table 7 has been developed as an example of the effect of the plant on primary tax rates. The primary rate has been used because of the uncertainty on the future of the secondary rate due to Students FIRST. The assumptions are the following:

- The existing primary property tax base for Arlington Elementary continues to decline in the future at the rate of 3.37% per year, similar to the rate experienced between 1996 and 1999. Buckeye Union's primary tax base is assumed to grow at a 2.25% annual rate.

- The Duke Energy generating station is added to the tax rolls in 2003 as partially completed. In 2004, the full value of the completed plant takes effect.

- The "desired revenue" column represents the 1999 primary tax revenue generated to each school district, increased by 3% per year thereafter.

- The "projected tax rate" column is the primary rate that would need to be levied to achieve the desired revenue.

As noted on Table 7, the projected tax rate for both Arlington Elementary and Buckeye Union should experience significant decreases. For instance, Arlington Elementary's rate should drop by about 63% between 1999 and 2004 when the plant is completed. The rate declines from the current $2.2040 to $0.8187. However, if the need for revenues increases at 3% per year, the tax rate would rise to $2.6692 by 2002 before the effects of

the generating station are noticed, then drop to $0.8187 by 2004. This represents a decline of about 69%.

Table 7

Impact of Duke Energy Electric Generating Station On Local School Districts' Primary Tax Rate

(In Inflated Dollars)

Arlington Elementary District

	Projected Assessed Value	Desired Revenue	Projected Tax Rate*
1999	$27,601,070	$608,328	$2.2040
2000	$26,671,153	$626,577	$2.3493
2001	$25,772,566	$645,375	$2.5041
2002	$24,904,253	$664,736	$2.6692
2003	$44,419,531	$684,678	$1.5414
2004	$86,139,195	$705,218	$0.8187
2005	$83,311,460	$726,375	$0.8719
2006	$80,511,783	$748,166	$0.9293
2007	$77,739,265	$770,611	$0.9913
2008	$74,993,042	$793,730	$1.0584
2009	$72,272,276	$817,541	$1.1312
2010	$69,576,162	$842,068	$1.2103

Buckeye Union High School District

	Projected Assessed Value	Desired Revenue	Projected Tax Rate*
1999	$109,037,307	$2,326,529	$2.1337
2000	$111,490,505	$2,396,325	$2.1494
2001	$113,998,897	$2,468,215	$2.1651
2002	$116,563,724	$2,542,261	$2.1810
2003	$136,079,002	$2,618,529	$1.9243
2004	$181,260,257	$2,697,085	$1.4880
2005	$181,924,846	$2,777,997	$1.5270
2006	$182,650,509	$2,861,337	$1.5666
2007	$183,438,623	$2,947,177	$1.6066
2008	$184,290,601	$3,035,593	$1.6472
2009	$185,207,884	$3,126,660	$1.6882
2010	$186,191,949	$3,220,460	$1.7296

*Expressed in dollars per $100 or assessed value.

Sources: AZ Dept. of Revenue; Maricopa County Assessor; Elliott D. Pollack & Co.

Likewise, Buckeye Union's rate declines by 30% between 1999 and 2004 and then continues to grow slowly as the desired revenue figure grows by 3% per year. The tax rate falls from $2.1337 in 1999 to a projected $1.4880 in 2004.

Residents of the area will, therefore, see a large decline in their property tax bills for the school districts over the next five years as the burden shifts to the power plant. The impact on County property taxes will not be noticeable because of the large size of the County's tax base. However, as noted previously, the power plant will help to stabilize County tax rates and relieve some of the burden on local residents.

To illustrate the fiscal impact of the power plant on individual property owners, Table 8 outlines the projected school district tax savings for three property types in the Arlington Valley area. The properties include a residence on a one acre lot, a 40 acre vacant, desert parcel and a 160 acre site currently in cultivation. The residence is assessed at a 10% assessment ratio while the larger, unimproved properties have a 16% ratio. Homeowners also receive a 35% discount on the primary school tax under current State law. The projected market values of the properties have been confirmed with the County Assessor's office and through sampling of property tax records. The calculations do not include County property taxes or any special district taxes that may apply to certain parcels.

Table 8

Estimated Annual School District Property Tax Savings Resulting From Duke Energy Electric Generating Station

Property type	Residence on 1 acre lot	40 acre vacant parcel	160 acre parcel in agriculture
Market value	$70,000	$23,280	$103,200
Assessed value	$7,000	$3,725	$16,512
1999 combined school property tax[1]	$282	$206	$914
Projected 2004 combined school property tax[2]	$153	$111	$493
Tax savings	**$129**	**$95**	**$421**
Percentage tax decrease	**45.7%**	**46.0%**	**46.0%**

[1]Combined Arlington Elementary and Buckeye Union tax rate of $5.5364; reduced homeowner rate of $4.0341.

[2]Projected combined rate of $2.9887; reduced homeowner rate of $2.1899.

Note: Tax calculations do not include County or special district property taxes.

Sources: AZ Dept. of Revenue; Maricopa County Assessor; Elliott D. Pollack & Co.

The table shows that property owners should see a 46% decline in school district property taxes between 1999 and 2004 as a result of the construction of the electric generating station. The annual savings range from $95 for the 40 acre vacant parcel to $421 for the agricultural parcel. While these savings seem small for each property owner, the effect across both the Arlington Elementary and Buckeye Union Districts is substantial. Based on the projected future assessed values for the plant and expected property tax rates, Duke Energy will be absorbing over $1.8 million in school district property taxes each year, once the plant is in service. These are expenses that previously accrued to all other property owners located within the school districts.

6.3 Students FIRST Legislation

In July 1998, the State Legislature passed the Students FIRST bill that dramatically reformed the way public schools are constructed. Passage of the bill was in response to the State Supreme Court's finding that Arizona's capital school finance system was unconstitutional. The basis for school construction financing until 1998 had been bonded indebtedness, i.e. the local secondary property tax. The system was found by the courts, however, to be unconstitutional since it failed to treat all school children equally.

Students FIRST establishes that the State must provide the funding for building adequate schools. The use of bonding is still permitted, but only to go above and beyond the minimum standards provided by the State. Capital overrides must be approved in an election.

Students FIRST will eventually have an impact on the revenues that are generated locally for school construction. Previously approved capital improvement bonds will continue to be paid by school districts, but will be phased out as bonds are retired. The extent of override bonds that will be issued in the future to augment the State capital funding is, obviously, unknown.

There are misconceptions by the public that Students FIRST will eventually do away with school property taxes. Nothing could be further from the truth. Students FIRST only affects the secondary school property tax that is used to construct capital facilities. The primary tax levy, representing the majority of the property tax, will continue to provide support for school operations as in the past.

In addition, existing outstanding debt carried by a school district will continue to be paid by the secondary levy in the future. According to the 1997-1998 Annual Report of the Arizona Superintendent of Public Instruction, Arlington Elementary has no outstanding debt while Buckeye Union has $3.25 million. Therefore, even with Students FIRST, Buckeye Union will need to levy a secondary property tax in the future. Students FIRST also permits the issuance of local school district debt to enhance the State's capital improvement funding. Bonding is limited to a maximum of 10% of the district's assessed value compared to a 30% limit prior to Students FIRST.

The financing of public education is an extremely complex and emotional issue. It is too early to tell whether Students FIRST will be able to address all the needs of districts throughout the State. Changes in the system will undoubtedly occur in the future as experience is gained. In the meantime, the local school district property tax will continue to be a primary source of funding.

EXHIBIT
A-5
admitted

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DUANE L. SHROUFE
DEPUTY DIRECTOR
STEVE K. FERRELL

September 17, 2001

Mr. Robert Kuhfuss
Planner
Department of Planning and Development
Maricopa County
411 North Central Avenue, 3rd Floor
Phoenix, Arizona 85004-2191

Re: Comprehensive Plan Amendment No. CPA2001001 and Major Amendment to Special Use Permit Case No. Z2001117 for Arlington Valley Generating Facility, Maricopa County

Dear Mr. Kuhfuss:

The Arizona Game and Fish Department (Department) has reviewed the above-referenced Comprehensive Plan Amendment and Major Amendment to Special Use Permit for the Arlington Generating Facility. The following comments are provided for your consideration.

The Department provided special status species records from the Heritage Database Management System for the Comprehensive Plan Amendment and Special Use Permit for the first generating facility. We note that this information is presented in Section 16 of the Addendum to Application for Special Use Permit.

The Department understands that this second generating facility will be adjacent to the first facility and will be sited on retired agricultural land. For these reasons, the Department does not anticipate any significant adverse impacts to special status species, or other wildlife species, resulting from the approval of these amendments.

The Department notes that Special Condition 13 of the Certificate of Environmental Compatibility to Duke Energy Maricopa, L.L.C. (Duke Energy) required Duke Energy to form a partnership with the Department to provide enhanced wildlife habitat on lands that border Centennial Wash. Over the past year, the Department has been working with Duke Energy and Ducks Unlimited on a plan to enhance wildlife habitat on these lands. We look forward to continuing this partnership to develop a meaningful wildlife habitat enhancement project in the Buckeye area.

Thank you for the opportunity to review and comment on these amendments. If you have any questions, please contact me at 520-342-0091.

Sincerely,

William C. Knowles
Habitat Specialist
Region IV, Yuma

cc: Russell Engel, Habitat Program Manager, Region IV
Larry Voyles, Regional Supervisor, Region IV
Bob Broscheid, Proj. Eval. Prog. Supervisor, Habitat Branch

AGFD # 09-14-01 (A)

EXHIBIT
A-6
admitted

STATE HISTORIC PRESERVATION OFFICE LETTER

Arizona ®
State Parks

Jane Dee Hull
Governor

State Parks
Board Members

Chair
Walter D. Armer, Jr.
Benson

Vice-Chair
Suzanne Pfister
Phoenix

Joseph H. Holmwood
Mesa

John U. Hays
Yarnell

Elizabeth J. Stewart
Tempe

Vernon Roudebush
Safford

Michael E. Anable
State Land
Commissioner

Kenneth E. Travous
Executive Director

Arizona State Parks
1300 W. Washington
Phoenix, AZ 85007

Tel & TTY: 602.542.4174
www.pr.state.az.us

800.285.3703
from (520) area code

General Fax:
602.542.4180

Director's Office Fax:
602.542.4188

"Managing and conserving natural, cultural, and recreational resources"

In reply refer to **SHPO-2000-404**
No historic properties affected

September 10, 2001

Thomas H. Campbell
Lewis and Roca
40 North Central Avenue
Phoenix, AZ 85004-4429

RE: Duke Energy Maricopa Application for Certificate of Environmental Compatibility; Arlington Valley Energy Facility II; Docket No. L 00000-01-0117; AZ Corp. Comm. SHPO-2000-404 (7592)

Dear Mr. Campbell:

Thank you for consulting with our office about the above referenced application. The supporting cultural resources survey was previously reviewed. No historic properties are present in the Arlington Valley Energy Facility II project area.

If you have any questions or concerns, please contact me at (602) 542-7142 or by e-mail at jmiller@pr.state.az.us.

Sincerely,

Jo Anne Miller
Compliance Specialist/Archaeologist
State Historic Preservation Office

4

EXHIBIT
A-7
admitted

PETER MOCK GROUNDWATER REPORTS

1203348.1

A

2001

Peter Mock Groundwater Consulting, Inc.

◆ Studies ◆ Simulations ◆ Reviews ◆ Communications ◆
◆ Strategic Advances ◆ Advanced Technical Tool Development ◆

August 13, 2001

REGULAR MAIL

Mr. H. Max Shilstone
Duke Energy North America
5400 Westheimer Court
Houston, Texas 77056

REGISTERED GEOLOGIST
CERTIFICATE NO. 21614
PETER A. MOCK
Date Signed 8/13/01
ARIZONA, U.S.A.

Subject: Results of Simulations of Potential Groundwater Responses to Proposed Additional Pumping for the Arlington Valley Energy Facility

Dear Mr. Shilstone:

Peter Mock Groundwater Consulting, Inc. (PMGC) has completed simulations of potential groundwater responses resulting from additional pumping recently proposed for the Arlington Valley Energy Facility (AVEF). The AVEF discussed in this letter report is located in the Centennial Wash Area of the Hassayampa Sub-Basin of the Phoenix Active Management Area. Because the groundwater flow model of the Centennial Wash Area used to conduct these simulations has been extensively reviewed and documented in previous permit application proceedings, and because the methodology and results of the present simulations are relatively simple to explain, the report on the simulations is summarized in the body of this letter.

PMGC used the existing groundwater flow model, called the Centennial Wash Area model (CWA model), developed in 2000 for three energy companies (Duke Energy North America [Duke], Pinnacle West Energy, and Sempra Energy Resources) proposing power plants in the vicinity of the Palo Verde Nuclear Generating Station west of Phoenix, Arizona. Development of the CWA model and the results of subsequent simulations for permit applications during 2000 are documented in two primary reports[1,2]. These two reports were submitted as supporting documentation for Maricopa County and State of Arizona permit

[1] Peter Mock Groundwater Consulting, Inc., 2000a. Evaluation of Groundwater Responses to Pumping for Proposed Power Plants in the Centennial Wash Area, Maricopa County, Arizona Interim Report, Prepared for Sempra Energy Resources, dated April 4, 2000, 64 pages plus 24 figures.

[2] Peter Mock Groundwater Consulting, Inc., 2000b. Evaluation of Groundwater Responses to Pumping for Proposed Power Plants in the Centennial Wash Area, Maricopa County, Arizona Model Simulation Report, Prepared for Duke Energy North America, Pinnacle West Energy and Sempra Energy Resources, dated July 7, 2000, 22 pages plus 13 figures.

5337 E. CAMELBACK MANOR DR • PARADISE VALLEY, AZ 85020 • PHONE (602) 522-0884

applications by each of the three energy companies. Figure 1 (attached) shows the CWA groundwater flow model grid along with selected local geographic features.

A technical group including participants from the Arizona Department of Water Resources (ADWR), Maricopa County, community members, and representatives of the energy companies provided input and comment on interpretation of local groundwater flow conditions and development of the model. ADWR received a copy of the model input files, reviewed them in detail, and filed a formal review of the model[1] with the Power Plant and Transmission Line Siting Committee of the Arizona Corporation Commission in August 2000 accepting the model for use in projecting groundwater responses to pumping in the Centennial Wash Area.

The simulations described here consider an increase in pumping from 6,817 acre-feet per year (ac.-ft./yr.) to 7,816 ac.-ft./yr of groundwater pumping to supply water for the AVEF. This proposed increase of approximately 1,000 ac.-ft./yr. is the subject of permit applications to be submitted by Duke to Maricopa County and the State of Arizona. As with the simulations run in 2000, the cumulative impacts of the power plants pumping over a 30-year planning horizon were evaluated by subtracting simulated water-level elevations for the end of 2030 from the simulated water-level elevations as of the end of 2000. The water-level elevations being compared (subtracted one from the other) are from CWA Model Layer 4, which represents the Lower Alluvial Unit beneath most of the groundwater basin in the CWA.

The additional pumping of approximately 1,000 ac.-ft./yr. considered here is assumed to be allocated equally to five well locations recently proposed by Duke for the north end of the AVEF property. Inspection of the available historical well capacity and pumping volume data indicate the pumping rates proposed by Duke have been achieved in this area in the past for irrigation water supply with acceptable drawdowns.

No modifications to the CWA model were necessary to run theses projections other than to move future AVEF pumping to the five updated locations and to add the additional groundwater pumping to the previous CWA Model Scenario 1 simulation. CWA Model Scenario 1 comprised 18,200 ac.-ft./yr. of groundwater pumping for the three power plants and 4,400 ac.-ft./yr. of pumping from groundwater users surrounding the proposed power plant properties (PMGC, 2000b). The outputs of the model for each simulation were monitored in terms of solution convergence as well as local and global mass balances.

The attached Figures 2 through 5 present the results of the CWA model simulation from a number of perspectives. Figure 2 shows the results of Scenario 1 corresponding to Figure 8 of PMGC (2000b). Estimated thirty-year drawdowns range from approximately five feet at the CWA basin margins to more than 75 feet at well locations west of the AVEF. Figure 3 shows

[1] Hydrologic Review of Sempra Energy Resources Power Plant Application, Docket Number L-00000S-00-0101, Memorandum from Dale Mason, Supervisor, Groundwater Modeling Section Hydrology Division, Arizona Department of Water Resources, To Dennis Sundie, Power Plant and Transmission Line Siting Committee, dated August 31, 2000.

results of Scenario 1 pumping, but with the future pumping for the AVEF moved to the five updated locations at the north end of the AVEF property. Estimated thirty-year drawdowns range from approximately five feet at the CWA basin margins to more than 95 feet at well locations on the north end of the AVEF. More drawdown is simulated in the vicinity of the updated well locations because of their closer spacing than was assumed in 2000 (PMGC, 2000b). Figure 4 shows the results of a simulation of Scenario 1 combined with an additional 1,000 ac.-ft./yr. allocated evenly to the five updated AVEF well locations. Estimated thirty-year drawdowns range from approximately five feet at the CWA basin margins to more than 110 feet at well locations on the north end of the AVEF. The maximum drawdowns estimated with the CWA Model are averages for the 1,000 by 1,000 foot square model cells containing pumping wells. Drawdowns experienced in the actual pumping wells will likely be greater due to well inefficiency and the exponential shape of drawdown cones as they approach a pumping well.

Figure 5 shows the differences between the simulation results shown in Figures 3 and 4. These differences are the additional drawdown due to the proposed increase of 1,000 ac.-ft./yr. pumping at the AVEF and they are estimated to range from less than 5 feet at distances of one to four miles from the AVEF well locations to more than 20 feet at the AVEF well locations.

Figure 6 is a time series of simulated water level elevations at a location in Layer 4 between the five proposed AVEF well locations. Simulated water-level elevations at this location are indicative of some of the largest potential impacts from proposed pumping at the AVEF. At this location on the AVEF after 30 years of operations, no change from current conditions is estimated to result in a rise of 20 feet; Scenario 1 pumping from locations assumed in 2000 is estimated to result in drawdowns of 65 feet; Scenario 1 pumping with AVEF pumping from the five updated locations is estimated to result in drawdowns of 95 feet; and Scenario 1 pumping with AVEF pumping from the five updated locations plus an additional 1,000 ac.-ft./yr. is estimated to result in drawdowns of 110 feet.

The resulting estimates of drawdowns appear physically reasonable given my understanding of the groundwater flow system and the quantities of pumping assumed for the AVEF and surrounding areas.

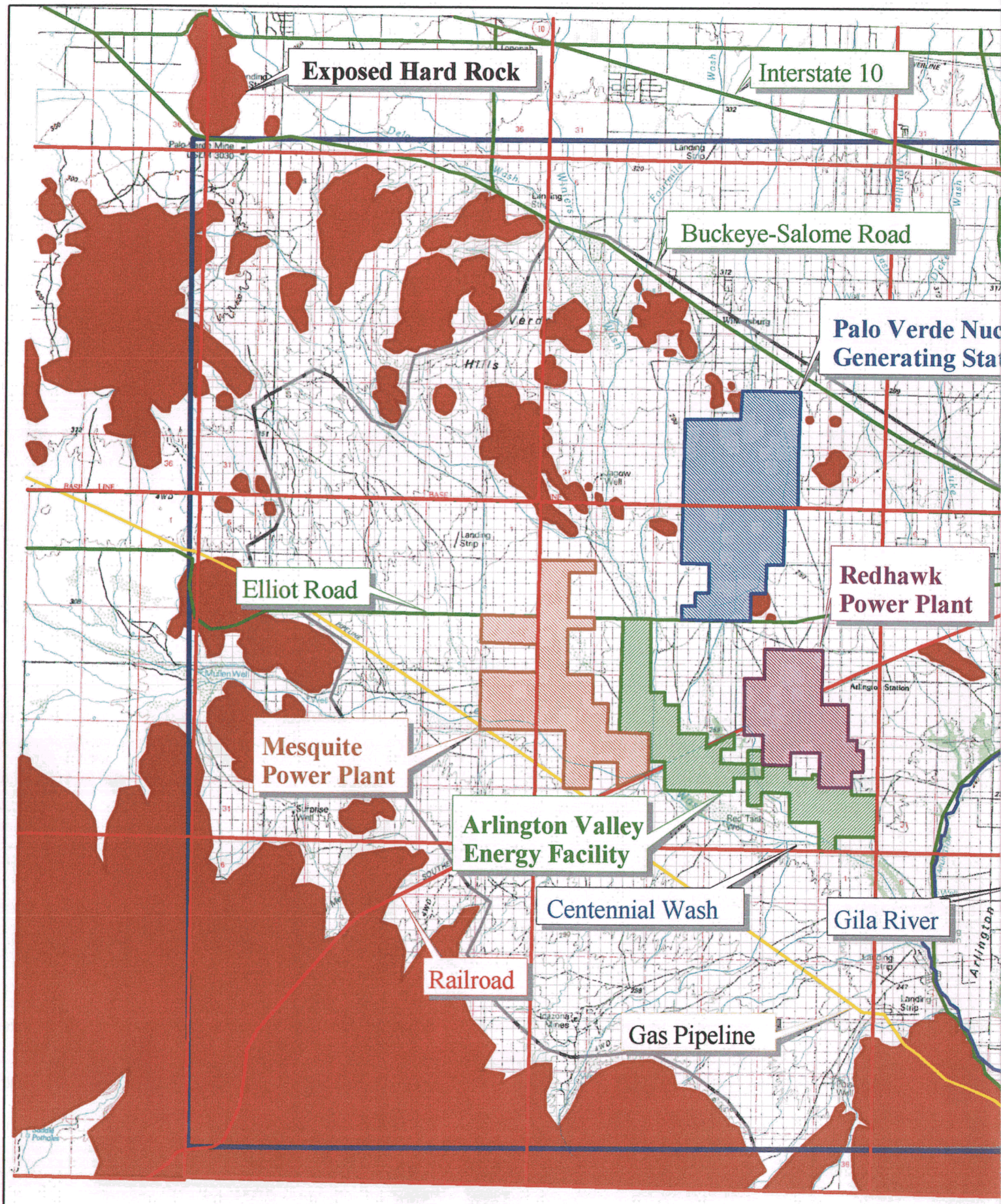
Sincerely,

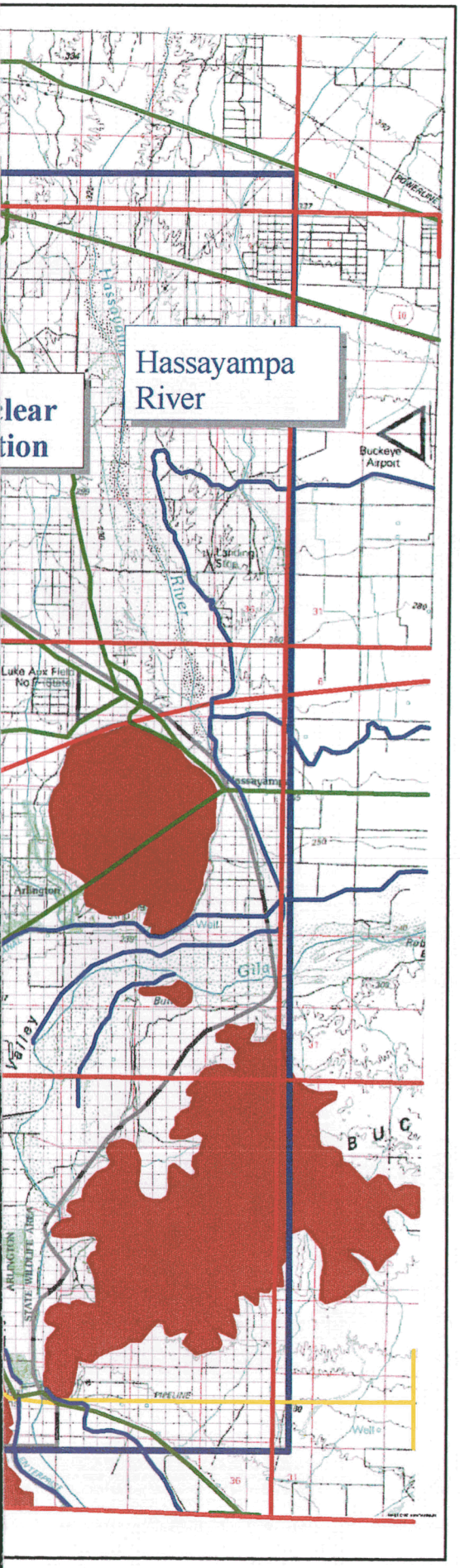
Peter A. Mock

Peter A. Mock, Ph.D., R.G.
President and Principal Hydrologist/Geologist
Peter Mock Groundwater Consulting, Inc.

Attachments: Figures 1 through 6

Copies: Daryl Manhart/Burch & Cracchiolo (six copies – hand delivered)


Exposed Hard Rock
Interstate 10
Buckeye-Salome Road
Palo Verde Nuc
Generating Stat
Elliot Road
Redhawk
Power Plant
Mesquite
Power Plant
Arlington Valley
Energy Facility
Centennial Wash
Gila River
Railroad
Gas Pipeline



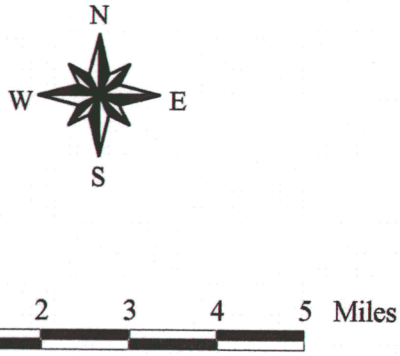
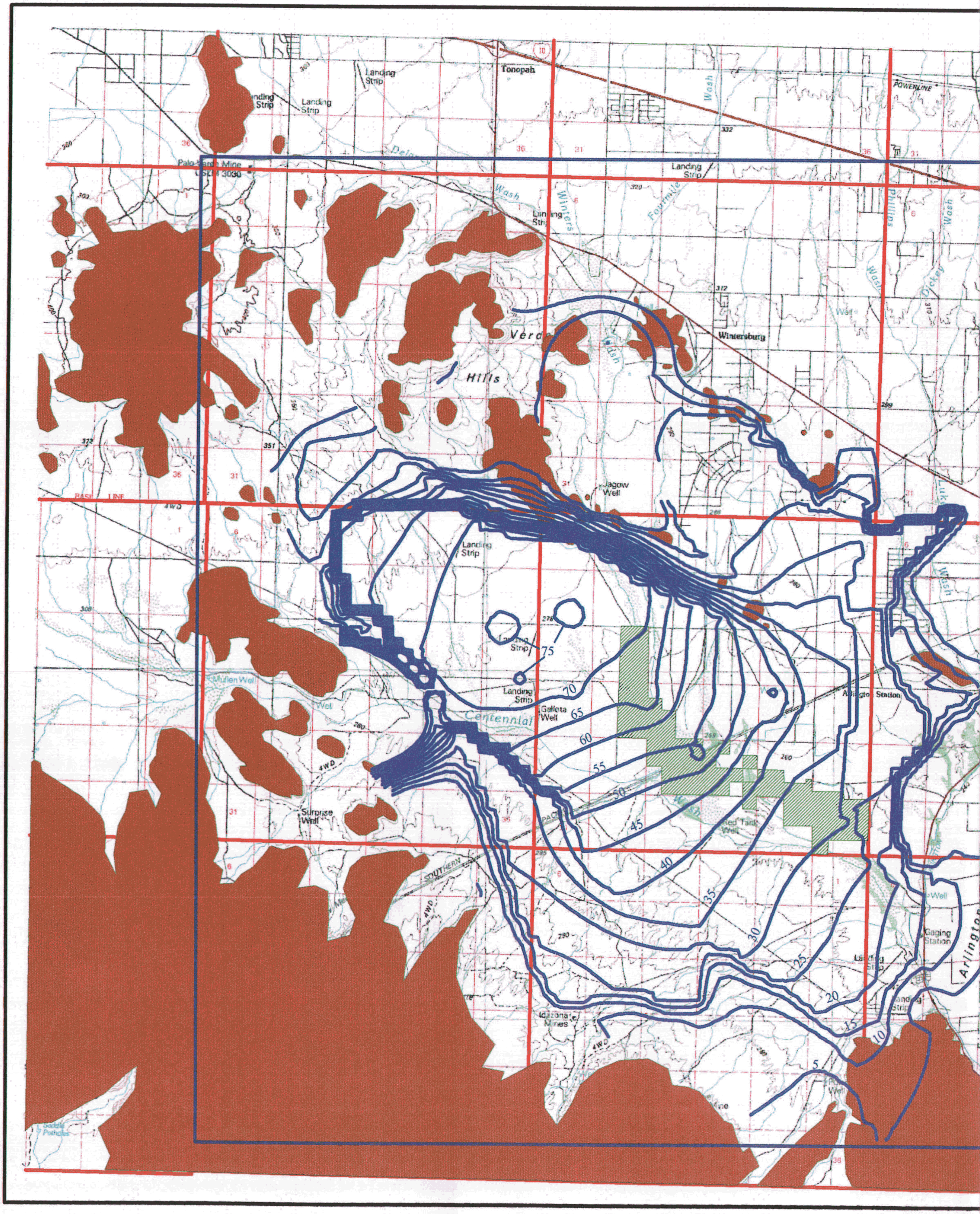


Figure 1 CWA Model Grid (PMGC, 2000b) and Selected Local Features



Tonopah
Landing Strip
Palo Verde Mine
POWERLINE
Winters
Fourmile
Wash
Phillips
Dickey
Wintersburg
Verde
Hills
Jagow Well
BASE LINE
4WD
Landing Strip
Galleta Well
Centennial
Arlington Station
Mullen Well
Surprise Well
Red Tank Well
SOUTHERN
PACIFIC
Gaging Station
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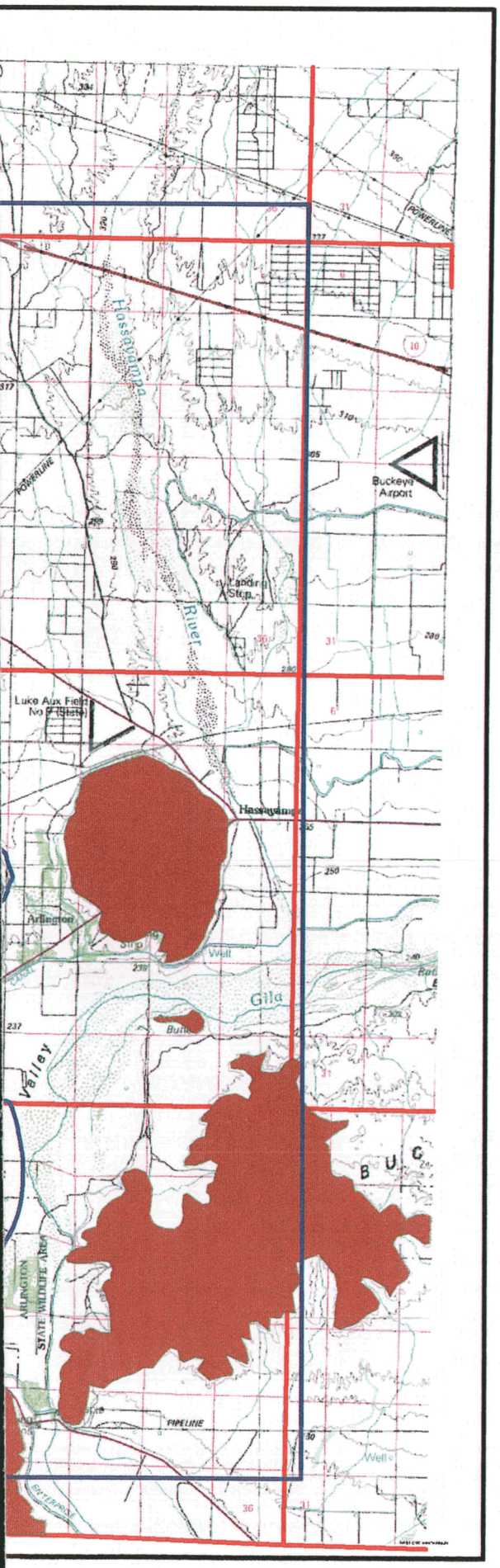
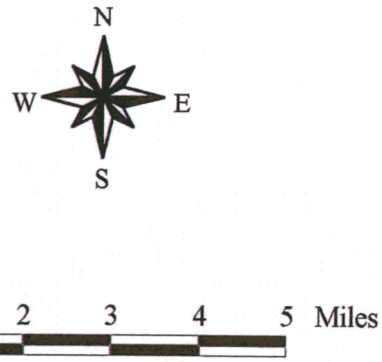
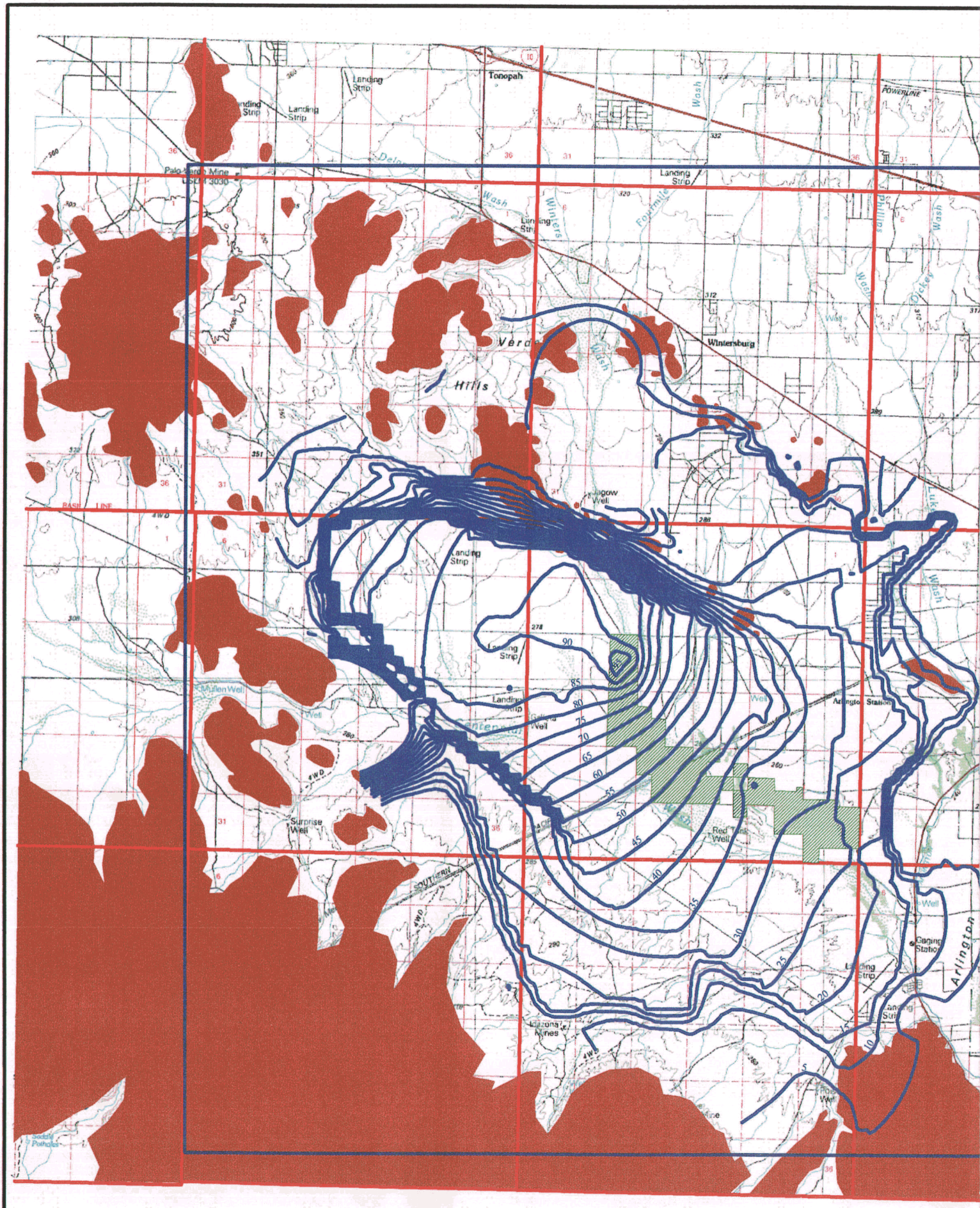




Contours are of Equal Change in Water Level from 5 to 75 feet

(AVEF Property shown in green)

Figure 2 Estimated Drawdown in Feet from Year 2000 Conditions in Layer 4 for 12/31/2030 (Scenario 1 of PMGC 2000b)


Tonopah
Landing Strip
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Jagow Well
Mullen Well
Surprise Well
Red Tank Well
Arlington Station
Arlington
Lazona Mines
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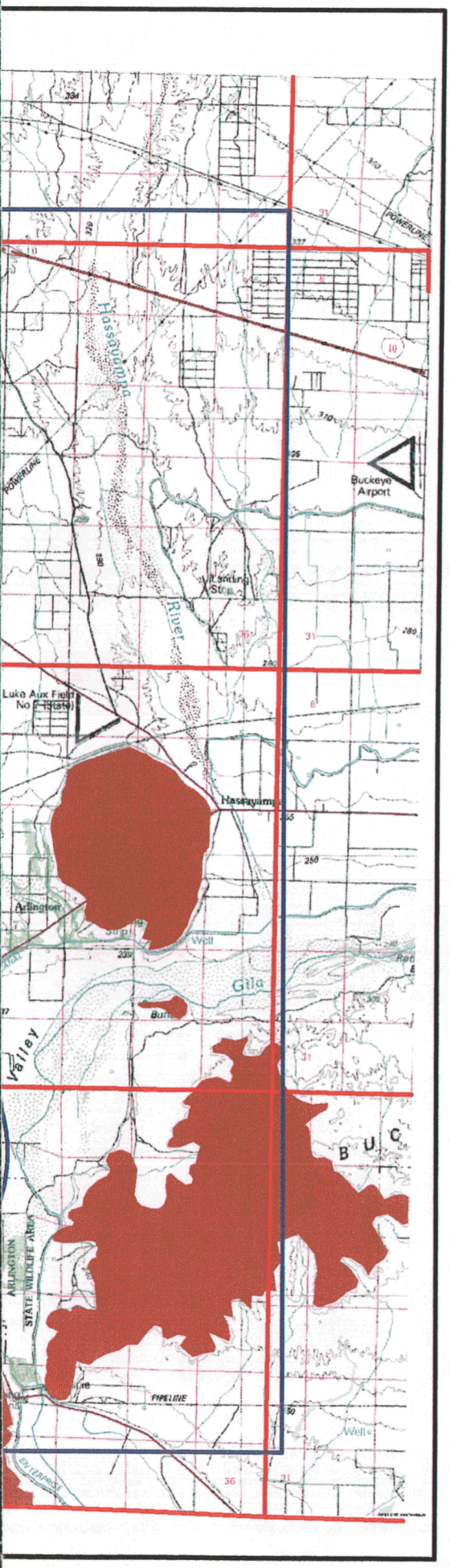
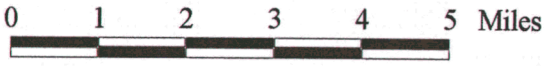
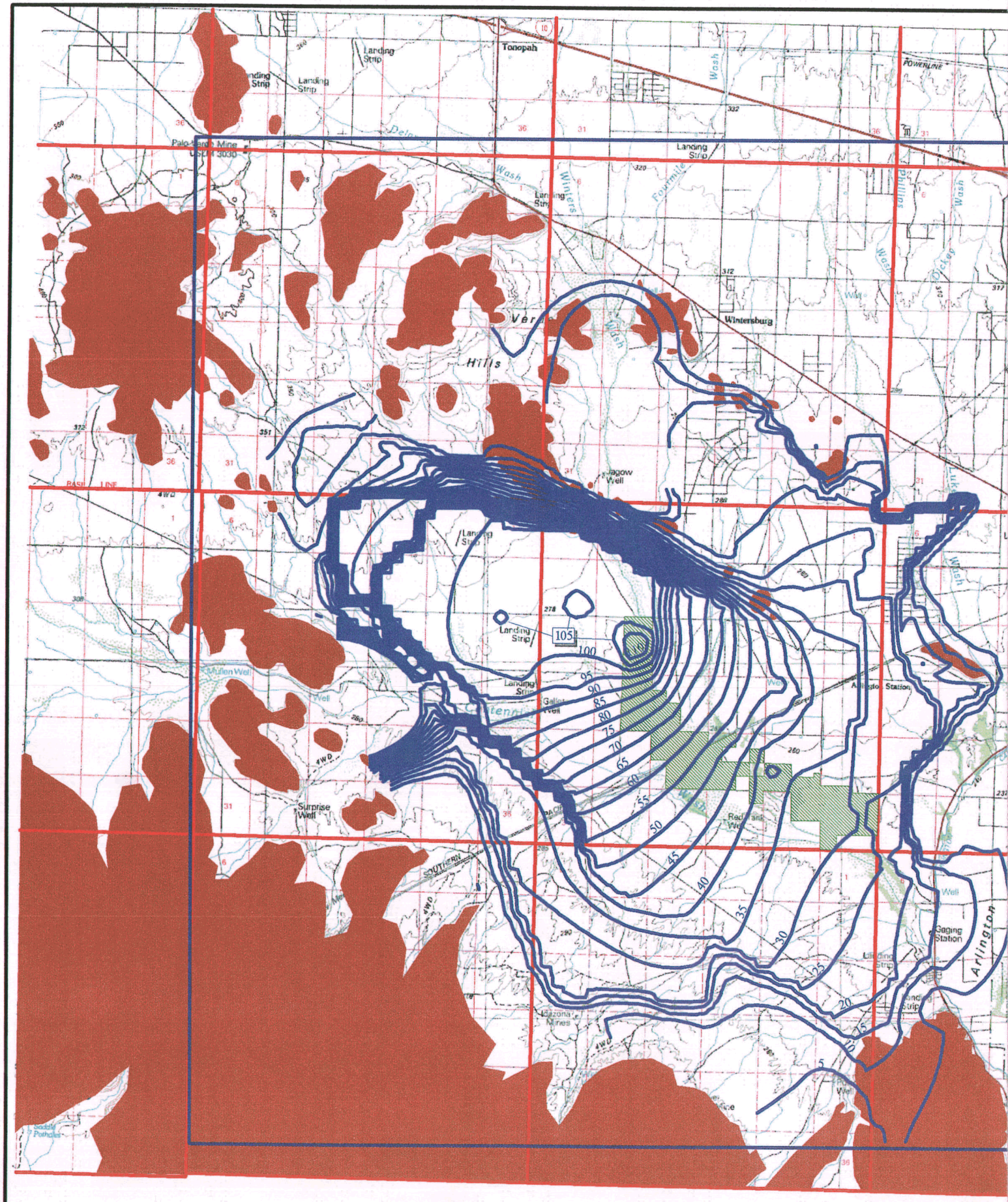




Contours are of Equal Change in Water Level from 5 to 95 feet

(AVEF Property shown in green)

Figure 3 Estimated Drawdown in Feet from Year 2000 Conditions in Layer 4 for 12/31/2030 (AVEF Well Locations Updated for Scenario 1 of PMGC 2000b)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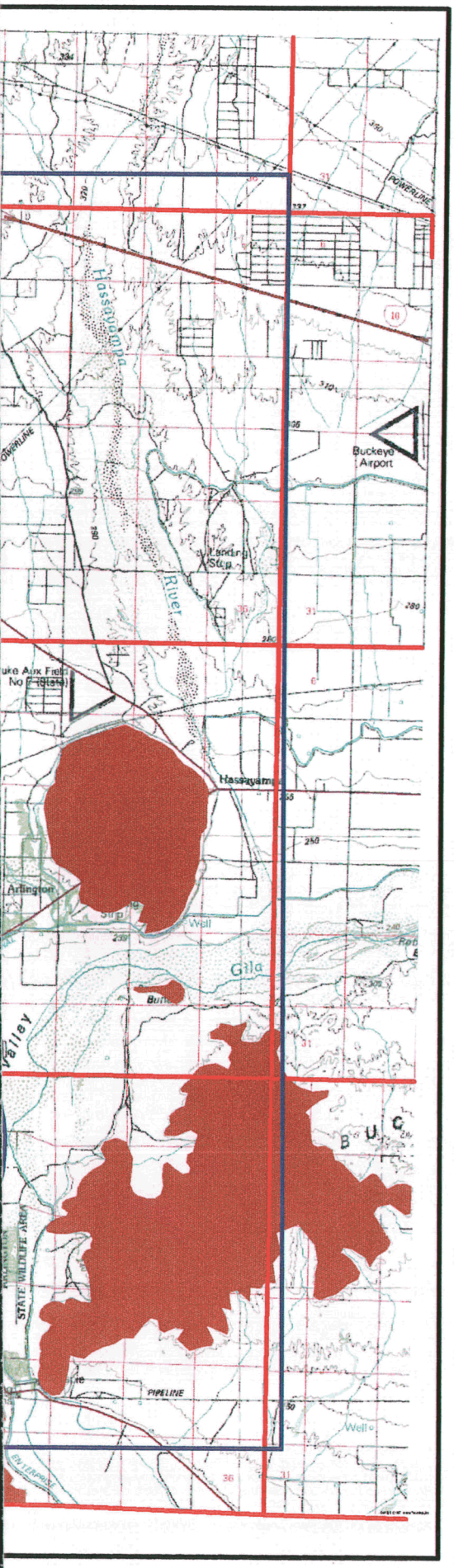
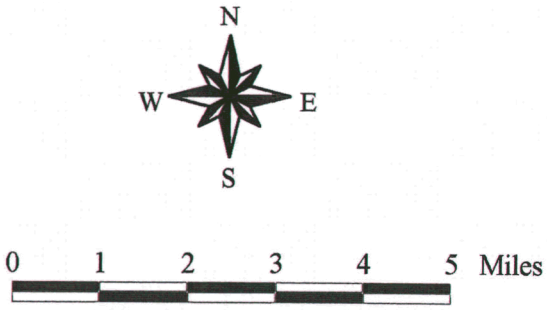
Mullen Well
Gallen Well
Surprise Well
Red Tank Well
Arlington Station
Gaging Station
Arlington
Lazona Mines
Saddle Potholes
POWERLINE
SOUTHERN

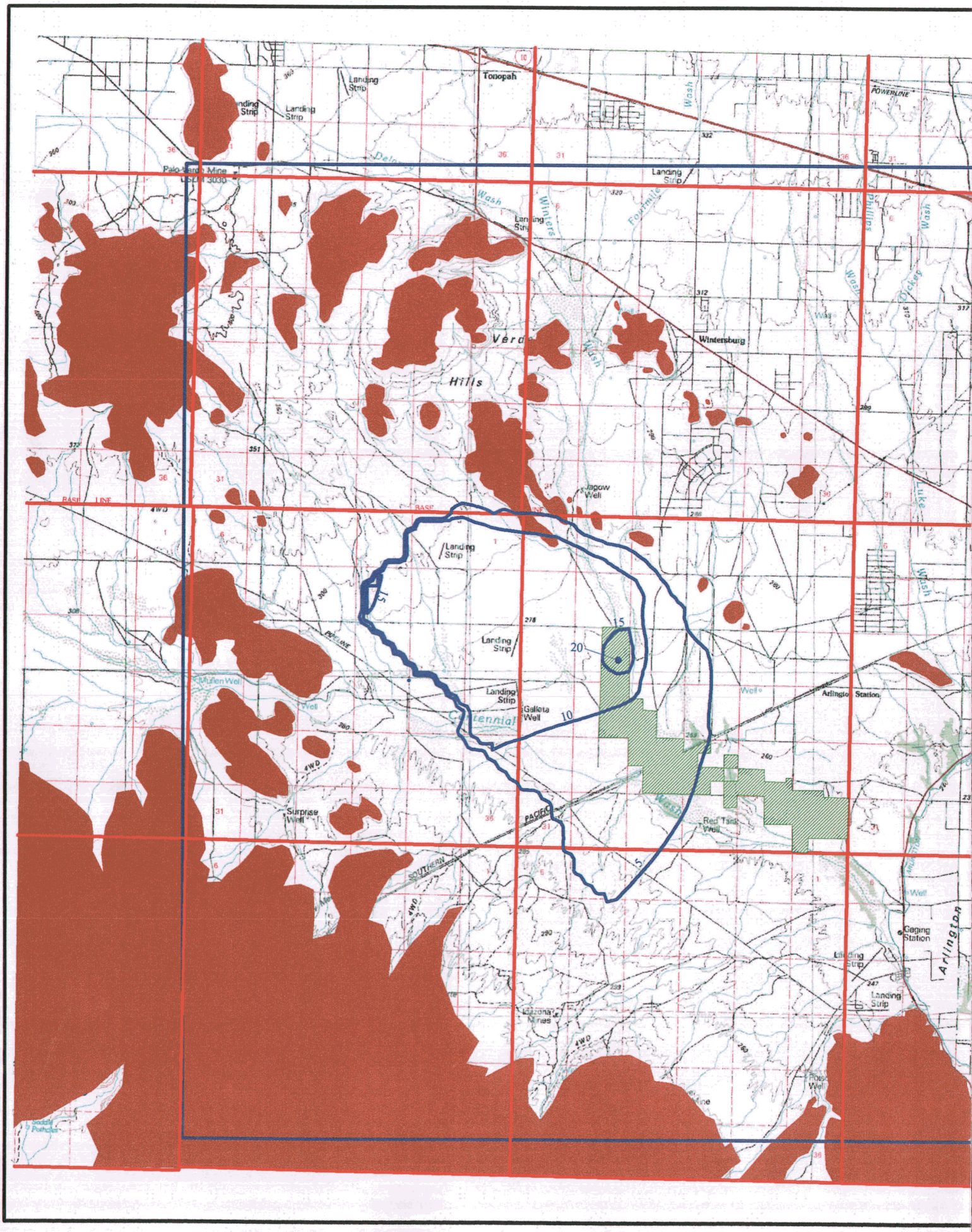




Contours are of Equal Change in Water Level from 5 to 110 feet

(AVEF Property shown in green)

Figure 4 Estimated Drawdown in Feet from Year 2000 Conditions in Layer 4 for 12/31/2030 (AVEF Well Locations Updated for Scenario 1 of PMGC 2000b and Total AVEF Pumping Increased by 1,000 ac.-ft./yr.)


Tonopah
Landing Strip
Palo Verde Mine
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Galleta Well
Centennial
Arlington Station
Red Tank Well
Surprise Well
Mulen Well
Gaging Station
Arlington
Arizona Mines
Poison Well
POWERLINE
BASE LINE
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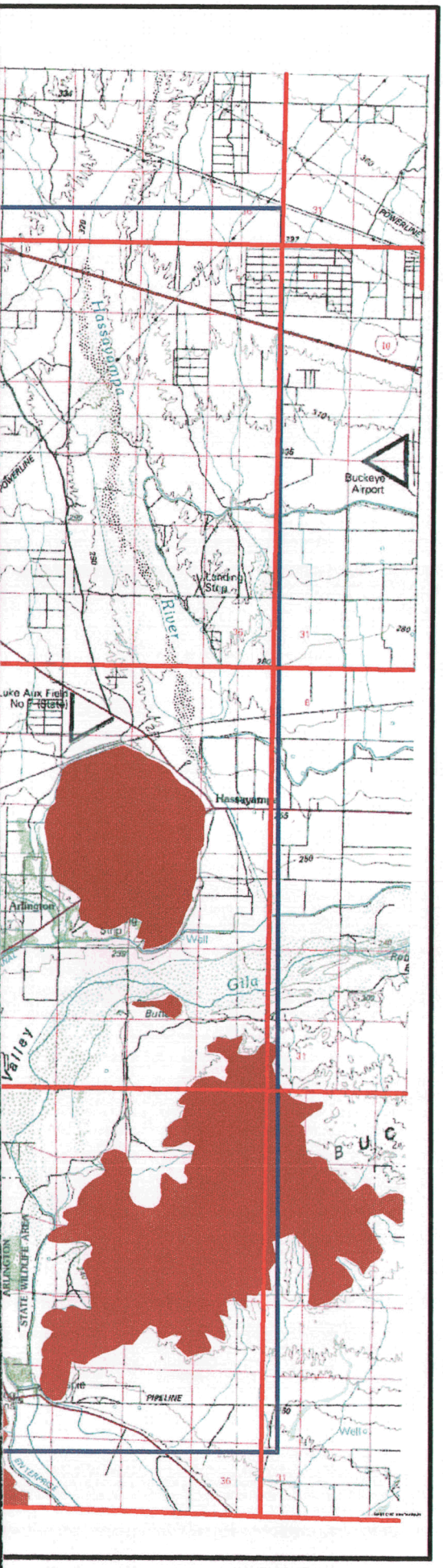

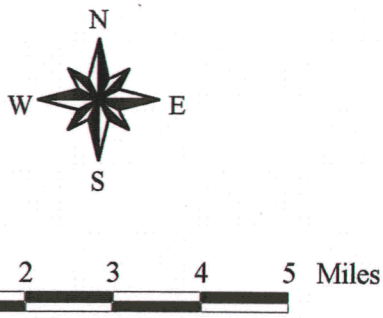

Contours are of Equal Change in Water Level from 5 to 20 feet

(AVEF Property shown in green)

Figure 5 Additional Drawdown in Feet Between 2000 and 2030 Due to Increase in Total AVEF Pumping of 1,000 ac.-ft./yr. (Difference between Drawdowns Shown in Figures 3 and 4)

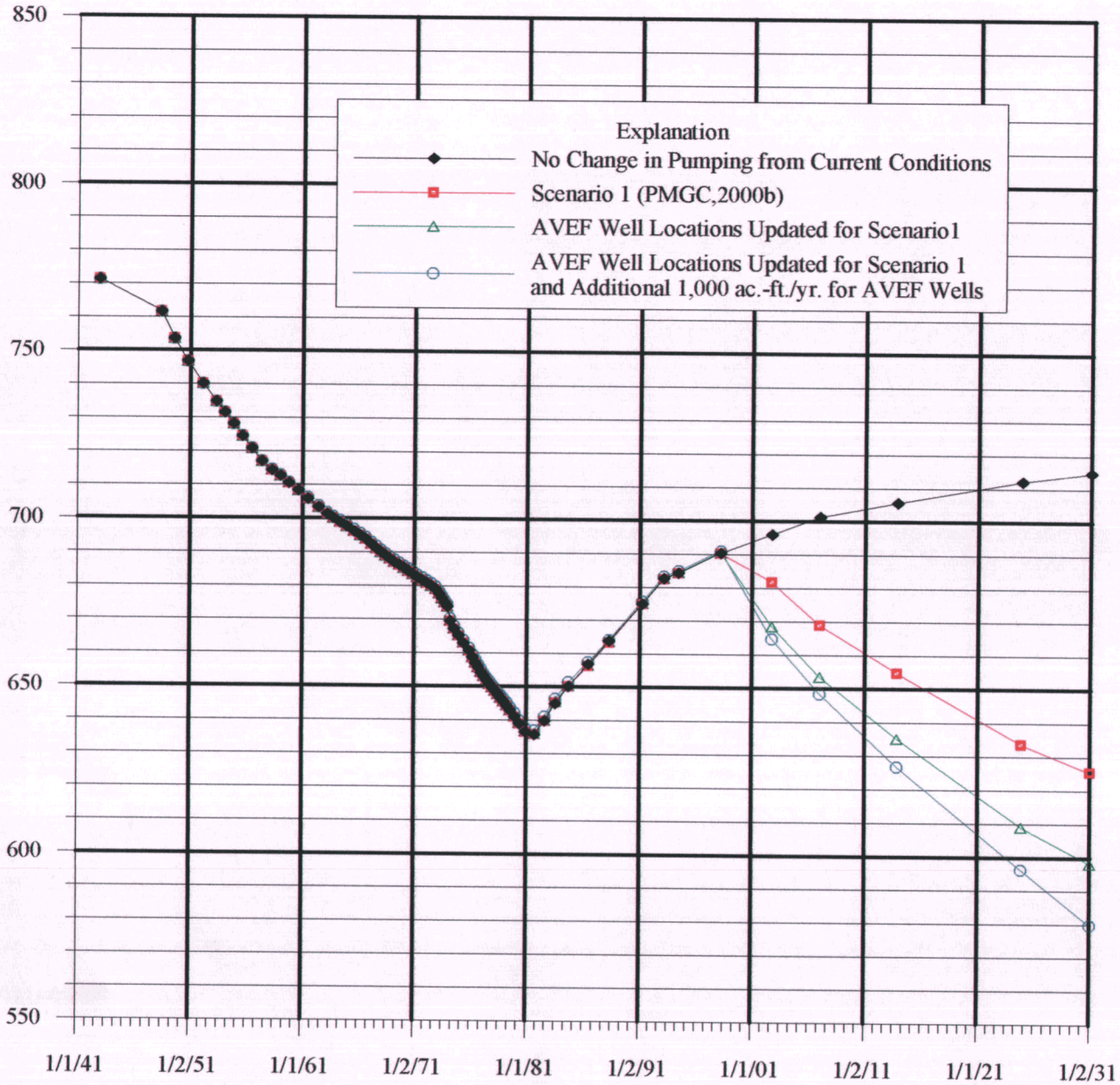

Figure 6 Simulated Water-Level Elevations in the Center of the Updated AVEF Well Locations (Layer 4 of the CWA Model)

B

2000

Evaluation of Groundwater Responses to Pumping for Proposed Power Plants in the Centennial Wash Area, Maricopa County, Arizona

Model Simulation Report

Prepared for:
Duke Energy North America
Pinnacle West Energy
Sempra Energy Resources

Prepared by
Peter Mock Groundwater Consulting, Inc.
Phoenix, Arizona

July 7, 2000

REGISTERED GEOLOGIST
CERTIFICATE NO.
21614
PETER A.
MOCK
Date Signed 7/7/2000
ARIZONA, U.S.A.

1.0 INTRODUCTION

1.1 Purpose

The purpose of this report is to describe a computer model developed to simulate the flow of groundwater in the Centennial Wash Area and the results of using that model to project groundwater flow 30 years into the future. The proposed pumping will occur within the Phoenix Active Management Area (PAMA) under the Groundwater Management Act of 1980. The Arizona Department of Water Resources (ADWR) oversees the conversion of grandfathered rights from irrigation use to electrical power generation use, and implements a reduction in the amount of those water rights in the conversion. Maricopa County and the community of residents in the vicinity of the proposed power plants have asked that the proposed power plants estimate the response of groundwater in the area to the proposed pumping.

1.2 Scope

As requested by Maricopa County and the community, the groundwater pumping and resulting groundwater response for all three proposed power plants were evaluated together. Therefore, the projections developed here represent cumulative responses. The future projections were made under five different conditions or scenarios of groundwater pumping. The primary scenario is pumping for the three proposed power plants at their full statutory rights (18,200 acre-feet per year [ac.-ft./yr.]).

To provide for comparison with other conditions, four additional scenarios were also simulated for the future. In the agricultural use scenario, a return to full use of the agricultural pumping rights associated with the land acquired for the proposed power plants (31,200 ac.-ft./yr.) was simulated. Two urban growth scenarios were simulated. In the first urban growth scenario, water use for the proposed power plant properties was estimated at common densities and ADWR's per capita goal (150 gallons per capita per day [gpcd]) lead to an estimate of 9,600 ac.-ft./yr. In the second urban growth scenario, water use for a hypothetical urban development of 100,000 people at ADWR's per capita goal and no common landscaping, lakes or golf courses lead to an estimate of 16,800 ac.-ft./yr. Finally, a scenario of no change from recent conditions on the proposed power plant properties lead to a water use estimate of 3,100 ac.-ft./yr.

1.3 Previous Relevant Studies

The only nearby current groundwater flow model is for the East and West Salt River Valley Sub-basins of the PAMA (Corell and Corkhill, 1994). The western extent of this model, called the ADWR SRV model, is approximately at Hassayampa and therefore does not provide coverage in the Centennial Wash Area.

The "Evaluation of Groundwater Responses to Pumping for Proposed Power Plants in the Centennial Wash Area, Maricopa County, Arizona Interim Report" (the "Interim Report" (PMGC, 2000) compiled geologic and hydrologic information for the Centennial Wash Area. Based on the simplistic comparison of historic pumping and water-level change data, the impacts of the proposed power plant pumping at their statutory limits were projected in the Interim Report to be less than half of 120 feet drawdown (60 feet) in 30 years.

1.4 Role of Model Simulation

A computer simulation of the Centennial Wash Area was developed in order to test the conclusions developed in the Interim Report against the results of aquifer tests recently conducted in the area and against selected water-level data collected over the last 60 years by the U.S. Geological Survey (USGS) and ADWR. The Centennial Wash Area groundwater flow model also allows comparison of several scenarios of future water use conditions. Comparison of scenarios indicates the different potential outcomes of different land uses in terms of water use. Water use is only one consideration to be weighed by Maricopa County in evaluating alternative land uses. Other considerations include air quality and transportation.

1.5 Plan of Development

This report is divided into sections as follow: project background, hydrogeology, computer code selection, model construction, model calibration, predictive simulations, and summary/conclusions.

2.0 PROJECT BACKGROUND

2.1 Project Elements

The Centennial Wash Area comprises the valley floor and floodplain of Centennial Wash south of the northern Palo Verde Hills. The selection of the Centennial Wash Area for focused analysis of groundwater flow conditions was documented in the Interim Report (PMGC, 2000). The Palo Verde Nuclear Generating Station (PVNGS) is located between the Palo Verde Hills and is included in the Centennial Wash Area.

Three new power plants are proposed for the Centennial Wash Area. The plants will be built and operated by: Duke Energy of North America, Pinnacle West Energy Corporation, and Sempra Energy Resources. The design and water use of the plants are described in the Interim Report (PMGC, 2000). The Duke and Sempra plants will use groundwater acquired as grandfathered irrigation water rights conveyed under Arizona State law to Type I non-irrigation rights. The Pinnacle West plant will primarily use treated municipal wastewater effluent purchased from PVNGS, but has also obtained Type I non-irrigation rights to groundwater.

2.2 Project Setting

The geography, topography, climate, land use and surface hydrology of the Centennial Wash are discussed in the Interim Report (PMGC, 2000). The Centennial Wash Area can be characterized as being relatively flat and having an arid climate. Land use is agricultural or open desert. Water flows throughout the year in the Gila River, but only rarely. Water in the tributaries of the Gila River, such as Centennial Wash, flows only in direct response to large storm events.

2.3 Project Objectives

One objective of this model study was to prepare a groundwater flow model that matched historic measured changes in groundwater levels while incorporating the work of hydrologists and geologists up to the time of this writing. The second objective was to identify and run simulations of future groundwater levels under five scenarios of water use representative of varying land uses. The development of five scenarios allows Maricopa County and community members to compare the groundwater responses to alternative land uses.

3.0 HYDROGEOLOGY

The hydrogeology of the Centennial Wash Area was assembled from geologic and hydrologic studies of adjacent and overlapping areas conducted over the past 60 years. A summary of the previous studies, data, and current integrated interpretation can be found in the Interim Report (PMGC, 2000). A brief summary of key findings of the Interim Report relevant to construction of the model is presented in this section.

3.1 Geologic Conceptual Model

The geologic materials underlying the Centennial Wash Area control the flow of groundwater in the area. Based on review of previous works by ADWR, USGS, and the consultant for siting of PVNGS (Fugro), a simplified conceptual model of the local geology was assembled from consideration of all of these works.

The oldest rocks in the Centennial Wash Area comprise the granitic Basement Complex (BC). Volcanic eruptions during Tertiary time spread the Volcanic-Sedimentary Sequence (VSS) on the BC. Erosion and local deposition created the Red Unit (RU) and Lower Alluvial Unit (LAU), which covered the slopes of granitic and volcanic peaks. Normal faulting during the Basin and Range Disturbance offset blocks of the BC, VSS, RU and LAU and created basins that eventually filled with the Middle Alluvial Unit (MAU) and Upper Alluvial Unit (UAU). A particularly uniform silt-clay interval of the MAU, called the Palo Verde Clay, was deposited under lacustrine (lake) conditions. The Upper Silt Deposits of the MAU and the Upper Sand and Gravel Deposits of the UAU dominate the current land surface, although the LAU is present at land surface in the western end of the Centennial Wash Area.

3.2 Hydrostratigraphic Units

From the lithostratigraphic units of the conceptual geologic model described above, and consideration of water levels and saturation on a regional basis, hydrostratigraphic units were selected for hydraulic analysis. The VSS, the RU, and the LAU are together considered here as the principal regional aquifer system. The Palo Verde Clay of the MAU is considered here to be a regional aquitard. Limited perched aquifers are also considered here which develop in the Upper Silt Deposits of the MAU or the Upper Sand and Gravel Deposits of the UAU.

3.3 Hydrologic Boundaries

Boundaries interpreted to allow negligible flow of groundwater ("no-flow boundaries") are those contacts of the hydrostratigraphic units with the BC. Such contacts occur beneath the hydrostratigraphic units or along the southern and western

mountain fronts. A ridge of unusually shallow BC underlies both lines of surface exposures of VSS comprising the Palo Verde Hills.

Boundaries that strongly influence groundwater flow, but can allow significant flow are those contacts between the Palo Verde Clay of the MAU and the other hydrostratigraphic units, and between the Upper Silt Deposits of the MAU and the Upper Sand and Gravel Deposits of the UAU associated with the Gila River in the Arlington Valley. Of particular importance to this project is the discontinuous lateral extent of the Palo Verde Clay. The Palo Verde Clay does not appear to be present west of Winters Wash, an area where the LAU rises to land surface.

3.4 Hydraulic Properties

The transmissivity of the principal regional aquifer was estimated from aquifer tests conducted for siting of the PVNGS and for the proposed power plants. The first RedHawk test, the two Duke tests, and the PVNGS test are documented in ARCADIS-Geraghty&Miller (1999), Hargis+Associates (2000), and Fugro (1978). The Sempra test data and the most recent Redhawk test data are being prepared for publication at this writing (July 2000). The currently available transmissivity estimates are summarized in Table 1.

Table 1 Transmissivity and Hydraulic Conductivity Estimates

Well	Transmissivity (ft^2/d)	Open interval (feet)	Hydraulic Conductivity (ft/d)	Comments
(B-01-06)34abb	13,000	800	16	PVNGS Well - 1973
(C-01-06)14dbb	16,000	900	18	Redhawk Well - 2000
(C-01-06)23cdb	7,000	660	11	Redhawk Well - 2000
(C-01-06)21bcb	11,000	700	16	Duke Well – 1999
(C-01-06)21cbb2	11,000	700	16	Duke Well - 1999
(C-01-06)18bbb	32,000	1000	32	Sempra Well - 2000
(C-01-06)07bbb2	19,000	700	27	Sempra Well - 2000
(C-01-07)24dbb	8,000	600	13	Sempra Well - 2000

The estimated transmissivity typically ranges from 10,000 to 20,000 feet squared per day (ft^2/day) at most of the locations where the tests were conducted. The exceptions are 7,000 and 8,000 ft^2/day at the more southerly locations and 32,000 ft^2/day in the north-central part of the Sempra property. The transmissivity estimates are assumed to apply primarily to the LAU, although spinner flow meter data are not available to confirm the percentage of flows originating in the individual lithostratigraphic units.

Because little information is available on the producing intervals of the wells, their open intervals at the time of construction were used to estimate saturated thickness and calculate average horizontal hydraulic conductivity values from the transmissivity estimates. Intervals of these older wells may be blocked by fill. Therefore, the saturated thickness estimates may be larger than correct.

The average horizontal hydraulic conductivity estimates (see Table 1) typically range from 11 to 18 feet per day (ft/day). Exceptions are two larger values (27 and 32 ft/day) near the northern end of the Sempra Property. Significant intervals of VSS and RU were encountered in many of the tested wells, and these units would be expected to have relatively low hydraulic conductivity. The horizontal hydraulic conductivity of the LAU is expected to be much larger than the averages calculated here.

Because the individual lithologic materials comprising the principal aquifer system were expected to have distinctly different hydraulic conductivity values, the estimation of a simple average value for the principal aquifer system was considered problematic. Using the distribution of the lithostratigraphic units available from extension of the Fugro (1978) work (PMGC, 2000), hydraulic conductivity values of the various lithostratigraphic units making up the hydrostratigraphic units were estimated separately from comparison of the lithostratigraphic materials with published sources (Freeze and Cherry, 1979). The estimated distribution of hydraulic conductivity in the Centennial Wash Area model is summarized in Section 6.0.

Storage properties were estimated from comparison for the materials with published sources (Lohman, 1979). The specific storage of all units was estimated to be 1×10^{-6} ft^{-1}. The specific yield of the LAU was estimated to be 0.15, the specific yield of the Upper Sand and Gravel Deposits of the UAU was estimated to be 0.25, and the specific yield of the Upper Silt Deposits of the MAU was estimated to be 0.07.

3.5 Sources and Sinks

The detailed distribution of sources and sinks on the Centennial Wash Area is given in the Interim Report (PMGC, 2000). Some of the estimates were refined after the completion of the Interim Report. The pumping distribution over time was primarily refined based on analysis of cropped area plots obtained from the files of Gookin Engineers, Ltd.

Pumping rates were estimated separately for the individual power plant properties, PVNGS, the Wintersburg area, the Arlington Valley area, and other properties in the Centennial Wash Area. The cropped acreage in each property was multiplied by 3.4 feet per year (ft./yr.). The result was estimated to represent total water pumped and total water applied to crops on the cropped acreages.

Recharge was originally simulated for all cropped acreages at 80% efficiency up to 1981 and 90% efficiency after 1981. During calibration (discussed in Section 6.0), analysis of potential travel times to groundwater based on ideas presented in ADWR's SRV model report (Corell and Corkhill, 1994) indicated approximately 10 years would be required for agricultural recharge on acreages west of Winters Wash where the LAU is exposed at land surface and near Wintersburg. Therefore, recharge was lagged forward in time 10 years from the time periods analyzed for cropped acreage in these areas.

Analysis of travel times of recharge indicated approximately 100 years are required for agricultural recharge to reach the water table in areas where the Upper Silt Deposits of the MAU are exposed at land surface. Therefore, recharge was not simulated for irrigated acreages in these areas. It is assumed that the vadose zone is still absorbing the excess agricultural recharge in these areas.

Analysis of travel times of recharge in the Arlington Valley (shallow water table and exposed Upper Sands and Gravels of the UAU) indicated approximately one year is required for agricultural recharge. No lagging of recharge was applied to the Arlington Valley area cropped acreages.

4.0 COMPUTER CODE DESCRIPTION

4.1 Selection

The three-dimensional finite-difference modular groundwater flow model (MODFLOW) of the USGS (McDonald and Harbaugh, 1988) was selected for the Centennial Wash Area model. This code was selected because it is extensively tested, widely used and accepted by regulatory agencies for similar purposes. MODFLOW allows the representation of the complex distribution of the geologic materials and sources and sinks in the Centennial Wash Area. MODFLOW. Also, graphical use interfaces are available that allow efficient construction, inspection and operation of a MODFLOW model for a specific site, such as the Centennial Wash Area. Finally, MODFLOW is widely available. This feature allows efficient transfer of the completed model to others to review or to refine and use for future analyses.

A version of MODFLOW, modified to run and be easily inspected during operations under the Windows operating system, was used. MODFLOW^{Win32} (Environmental Simulations, Inc., 1998) was used and is a modified version of MODFLOW88 (McDonald and Harbaugh, 1988). The input files generated by Groundwater Vistas (Environmental Simulations, Inc., 1998) typically run without modification with the USGS versions MODFLOW88 or MODFLOW96 obtained from the Internet (see USGS, 2000).

4.2 Solution Techniques

The Pre-Conditioned Conjugate Gradient (PCG2) matrix solution technique (Hill, 1990) was selected for the simulations conducted here. This method is the current method of choice for both finite difference (e.g., MODFLOW) and finite element simulations.

4.3 Assumptions

MODFLOW assumes that single-phase (only fully saturated) groundwater flow can be represented by Darcy's Law and that the flow of saturated groundwater is at constant temperature and dissolved substance concentration. Flow in fractured rocks is assumed to be as an equivalent porous medium. The flow may be transient (vary in time) and aquifer properties and system inflows and outflows may vary in both time and space.

4.4 Limitations

MODFLOW cannot simulate variably saturated, density-dependent or high-velocity flow. The distributions of hydraulic parameters for the Centennial Wash groundwater system are not perfectly known and introduce uncertainty into the model results.

Likewise, the future conditions of land use, water use, and the hydrologic cycle are not perfectly known at this time.

4.5 Effects on Model

Based on review of the available data, the characteristics of groundwater in the Centennial Wash Area appear to be consistent with the assumptions made in MODFLOW. Therefore, MODFLOW's assumptions are not expected to have a significant effect on simulations of groundwater flow for the Centennial Wash Area.

The effects of the limitations described above on model construction and results are considered acceptably small for the projections presented here. Considering only saturated groundwater flow is considered acceptable for the purpose of projecting drawdowns in the Centennial Wash Area. Uncertainties in future conditions surrounding the proposed power plants are likely not large enough to seriously affect saturated thicknesses during the simulation. The calibration of the Centennial Wash Area model and the availability of pumping test-based estimates of transmissivity for the vicinity of the proposed power plants indicate that the model is acceptable for making the drawdown estimates presented here.

4.6 Pre- and Post-processing Software

Data entry and pre- and post-processing of the Centennial Wash Area model were accomplished with Groundwater Vistas (Environmental Simulations, Inc., 1998). This software provides a graphical user interface that represents the input data and output results with colors and shapes that allow rapid inspection of key variable distributions.

5.0 MODEL CONSTRUCTION

5.1 Model Domain

Figure 1 shows the model grid overlain on selected base maps (roads, railroads, rock outcrops, and surface water features). Inactive cells in Layer 1 are filled black on Figure 1. The model grid for the Centennial Wash Area model consists of 93 rows and 96 columns and forms a uniform mesh of square grid cells each 1000 feet on each side.

The layers in the Centennial Wash Area model are uniform in thickness and individual elevations with a few exceptions. Table 2 summarizes the layer extents and the hydrostratigraphic units they represent.

Table 2 Model Layers

Layer Number	Top Elevation (Feet amsl)	Bottom Elevation (Feet amsl)	Thickness (Feet)
1	850 or water table (770 or water table in Arlington Valley)	700 (680 in Arlington Valley)	Varies with water table
2	700 (680 in Arlington Valley)	650	30 – 50
3	650	600	50
4	600	500	100
5	500	350	150
6	350	100	250
7	100	-500	600

In general, the layers were selected to allow separate, accurate representation of the Palo Verde Clay and to concentrate more layers in the shallowest part of the groundwater system where vertical gradients were largest.

5.2 Representation of Hydraulic Properties

Within the elevations represented by each relatively flat model layer, several lithostratigraphic units occur in the Centennial Wash Area. Each lithostratigraphic unit was given a unique zone number that relates to uniform hydraulic properties. For example, the Palo Verde Clay occurs in portions of Layer 2 and has one set of hydraulic properties: horizontal hydraulic conductivity, vertical hydraulic conductivity, specific storage and specific yield.

The structural contour maps of each lithostratigraphic unit presented in the Interim Report (PMGC, 2000) were compared to the top and bottom elevations of each layer to assign zones in each layer to represent the lithostratigraphic units in each layer. For example, in Layer 3, the LAU zone was assigned wherever the top and bottom elevations of the LAU crossed the top or bottom elevations of the model layer.

5.3 Representation of Sources and Sinks

Recharge from washes was found to be important to maintain simulated steady-state water levels in the area between the Palo Verde Hills, but resulted in excessive build up of water elsewhere. The washes were identified from topographic maps and various recharge rates were tried in 28 cells during calibration to match measured water level elevations. A total of approximately 1,800 ac.-ft./yr. was applied at an instantaneous rate of 8×10^{-3} ft./day for these small washes.

Recharge from the Arlington Canal Company Canal was simulated at a rate of approximately 10,000 ac.-ft./yr. throughout the simulations described here.

Recharge from excess agricultural irrigation was simulated for areas indicated as cropped on plots obtained from Gookin Engineers, Ltd., USGS and ADWR. No differentiation based on crop types was attempted because the crop type data were not available. A constant value of 2×10^{-3} ft/day (0.72 ft/yr) or approximately 20% of applied water was initially assigned for earlier periods (1941 to 1981). A constant value of 1×10^{-3} ft/day (0.36 ft/yr) or approximately 10% of applied water was initially assigned for later periods (1982 to 2000), except in Arlington Valley where abundant surface water supplies did not lead to the need to increase efficiency with time. As described earlier, later calibration work lead to elimination of recharge in areas where the Upper Silt Deposits of the MAU are present at land surface, and an increase to 3×10^{-3} ft/day (1.09 ft/yr) or approximately 30% of applied water.

Pumping wells were each represented as individual well cells in the model. Pumping for agricultural irrigation was estimated by multiplying the cropped area times 3.4 ft/yr for all areas indicated as cropped in records described in the previous paragraph. Pumping for domestic uses and stock watering was considered negligible (less than 500 ac.-ft./yr.). The pumping for wells was typically distributed across the individual model layers based on their open intervals and relative individual transmissivity values. Most of the pumping was attributed to the LAU and Red Unit below the Palo Verde Clay (Layers 4 through 7) east of Winters Wash. The pumping was primarily distributed to the LAU (Layers 2 through 7) west of Winters Wash where the Palo Verde Clay is interpreted to be absent. Pumping from wells in the Arlington Valley was attributed to the Upper Sands and Gravels of the UAU (Layer 1).

Table 3 and Figure 2 present the estimated historical pumping rates developed for this model. Pumping was larger than 60,000 ac.-ft./yr. during the period 1948 to 1962, when the Gila River was relatively dry and the Arlington Valley farmers relied primarily on groundwater (estimated pumping in Arlington Valley was assumed to increase to 24,000 ac.-ft./yr.). Pumping along Centennial Wash was typically 35,000 to 40,000 ac.-ft./yr. until 1981 when pumping started to decline with shrinking cropped acreages. Pumping in the area in the 1990s ranged from 6,300 to 7,500 ac.-ft./yr.

Table 3 Estimated Historical Pumping Rates (ac.-ft./yr.)

Stress Period Start	Stress Period End	Stress Period Duration	Sempra Property	Duke Property	Pinnacle West Property	Other Centennial Wash	PVNGS	Wintersburg Area Property	Arlington Valley	Total
1941	1947	7	0	0	0	0	0	0	0	0
1948	1952	5	2,700	7,900	5,500	9,000	7,800	2,000	24,500	59,400
1953	1957	5	1,900	7,550	5,800	10,350	7,300	2,350	24,500	59,750
1958	1962	5	1,100	7,200	6,100	11,700	6,800	2,700	24,500	60,100
1963	1965	3	2,250	7,500	6,100	9,450	7,150	2,700	2,400	37,550
1966	1966	1	2,250	7,500	6,100	9,450	7,150	2,700	2,400	37,550
1967	1972	6	3,400	7,800	6,100	7,200	7,500	2,700	2,400	37,100
1973	1973	1	6,550	8,000	6,050	8,600	6,000	2,550	2,400	40,150
1974	1975	2	6,550	8,000	6,050	8,600	6,000	2,550	2,400	40,150
1976	1978	3	9,700	8,200	6,000	10,000	0	2,400	2,400	38,700
1979	1980	2	9,700	8,200	6,000	10,000	0	2,400	2,400	38,700
1981	1981	1	6,550	6,400	4,200	6,050	0	1,500	3,800	28,500
1982	1984	3	3,400	4,600	2,400	2,100	1,300	600	5,200	19,600
1985	1986	2	1,300	6,600	2,000	1,900	2,300	600	3,000	17,700
1987	1990	4	1,100	5,000	600	1,900	1,600	400	1,700	12,300
1991	1992	2	100	2,500	0	500	1,900	0	1,800	6,800
1993	1993	1	0	2,200	0	600	1,700	0	1,800	6,300
1994	2000	7	0	3,100	0	400	1,900	0	2,100	7,500

The MODFLOW stream package was used to simulate the Gila River. Conductance and stages were varied during the steady state simulation to develop gaining conditions in most of the Arlington Valley (17,000 ac.-ft./yr.) and losing conditions in the far southern Arlington Valley (3,000 ac.-ft./yr.). For the transient period, no changes were made to the stream package inputs except to remove it entirely from 1948 to 1962 when river flows were relatively negligible and large drawdowns were noted in wells in the Arlington Valley.

Evapotranspiration was simulated for the area along the Gila River in the Arlington Valley. The acreages of phreatophytes given in the Interim Report (PMGC, 2000) were entered and rates and extinction depths were varied during calibration to achieve the approximate total evapotranspiration rate of 8,000 ac.-ft./yr.

5.4 Representation of Boundary Conditions

Boundaries of no-flow surround the model and are the primary boundary condition along the south and western edges of the model area (see Figure1). The distribution of no-flow cells varies with layer. The area of active cells generally decreases with depth. The ridge of BC beneath the Palo Verde Hills is represented as inactive cells in Layers 5, 6, and 7.

Approximately 15,000 ac.-ft./yr. of inflow to the model area was provided by a specified head boundary aligned with the Buckeye-Salome Road set at elevations derived from water level maps presented in the Interim Report. The model then calculates inflow necessary to maintain those prescribed heads as water levels change within the model. Additional inflow to the model of approximately 4,000 ac.-ft./yr. was provided by a prescribed flux (flow rate) boundary aligned across the Gila River Channel near Hassayampa.

A minor amount (100 ac.-ft./yr.) of mountain front recharge was added to the model uniformly along all mountains fronts in the Centennial Wash Area. Approximately 7,000 ac.-ft./yr. of outflow from the model area into the Gila Bend Basin was provided by a prescribed flux boundary aligned with the Gila River channel south from Gillespie Dam.

5.5 Representation of Initial Conditions

Based on inspection of hydrographs presented in the Interim Report (PMGC, 2000), development of the groundwater system by human activities and changes from natural conditions began shortly after 1940. Therefore, water-level elevation information up to 1940 was used to assemble a pre-development (~1940) water level map for the Centennial Wash Area. Initial conditions for the model were developed from a steady-state simulation, which represents the pre-development conditions.

5.6 Representation of Time

The steady state model represents groundwater flow before development of the groundwater reservoir began in approximately 1940. Time in the transient model represents a calibration period (1/1/1941 to 12/31/2000) followed by a prediction or projection period (1/1/2001 to 12/31/2030). In order to allow the model to represent the numerous significant changes in sources and sinks, time was divided into 19 stress periods. All stresses (sinks or sources) are constant within a stress period. Each stress period was divided into time steps that allowed the model to calculate the changes in water-level elevation resulting from changes in stresses. Table 4 presents the stress periods and time steps used in the Centennial Wash Area transient model.

Table 4 Model Time Representation				
Time Period	Stress Period	Number Time Steps	Incremental Multiplier	Time (years) (Cumulative)
1/1/41 – 12/31/47	1	3	1.20	7 (7)
1/1/48 – 12/31/52	2	20	1.02	5 (12)
1/1/53 – 12/31/57	3	30	1.01	5 (17)
1/1/58 – 12/31/62	4	30	1.01	5 (22)
1/1/63 – 12/31/65	5	20	1.02	3 (25)
1/1/66 – 12/31/66	6	10	1.03	1 (26)
1/1/67 – 12/31/72	7	73	1.00	6 (32)
1/1/73 - 12/31/73	8	20	1.00	1 (33)
1/1/74 – 12/31/75	9	25	1.03	2 (35)
1/1/76 – 12/31/78	10	60	1.00	3 (38)
1/1/79 – 12/31/80	11	25	1.03	2 (40)
1/1/81 – 12/31/81	12	5	1.20	1 (41)
1/1/82 – 12/31/84	13	15	1.05	3 (44)
1/1/85 – 12/31/86	14	5	1.20	2 (46)
1/1/87 – 12/31/90	15	8	1.20	4 (50)
1/1/91 – 12/31/92	16	5	1.20	2 (52)
1/1/93 – 12/31/93	17	5	1.20	1 (53)
1/1/94 – 12/31/00	18	8	1.20	7 (60)
1/1/01 – 12/31/31	19	20	1.10	30 (90)

5.7 Selection of Calibration Targets and Goals

For the steady state model, 46 pre-development water-level measurements were selected as targets and assigned for comparison to simulated water level elevations in Layer 1. The goal for steady state calibration was to remove obvious bias from the calibration cross-plot (equal spread above and below the 1:1 correlation line) and to match simulated water level elevations to measured water-level elevations to within 20 feet on average. The 20-foot criterion is based on the idea that the total water level drop through this modeled system is approximately 200 feet and the simulation accuracy should be within 10% of the total water level drop.

For the transient model, 305 water-level measurements at 10 wells were selected as targets to address the 60-year calibration period. The goal for transient calibration was to remove obvious bias from the calibration cross-plot, match the general shape and level of the selected hydrographs in the vicinity of the Power Plants, and to match simulated water level elevations to measured water-level elevations to within 20 feet on average (as in the steady state model).

5.8 Numerical Parameters

For the steady state simulation, the PCG2 solver was set to allow 500 outer iterations and 80 inner iterations while achieving a head change residual of 1×10^{-7} feet and a mass flow residual of 1 cubic foot per day. For the transient simulation, the PCG2 solver was set to allow 200 outer iterations and 50 inner iterations while achieving a head change residual of 0.01 feet and a mass flow residual of 10 cubic feet per day. The differences between the criteria for the steady state and transient models were required to achieve overall mass balance errors of less than 1 percent in the simulations.

6.0 MODEL CALIBRATION

6.1 Comparing Simulated Values to Measurements

For the steady state simulation, the distribution of differences between measured and simulated water-level elevations (residuals) was plotted and inspected for trends in the spatial distribution of the residuals. The individual measured and simulated water-level elevations were also compared on a cross-plot with identical axes and Groundwater Vistas calculated calibration statistics.

For the transient simulation, the measured and simulated water-level elevations were compared for selected individual hydrograph locations. The measured and simulated water-level elevations were also compared on a cross-plot with identical axes and Groundwater Vistas calculated calibration statistics.

6.2 Parameter Estimation

Table 5 lists the hydraulic property estimates developed for the Centennial Wash Area model. In general, published sources were used to estimate hydraulic conductivity and storage properties (Freeze and Cherry, 1979; Lohman, 1979). Where estimates of transmissivity were available, the total transmissivity of the interval open to the tested well was set equal to the aquifer test result. Minor adjustments were attempted during a few calibration runs of the steady state model, but the original estimates based on published values provided reasonable results as discussed in the next subsection.

Table 5 Hydraulic Properties

Zone Number/Lithology	K_H (ft/d)	K_V (ft/d)	S_s (ft^{-1})	S_y (dim)
10/Volcanic Sedimentary Sequence	0.005	0.005	1×10^{-6}	0.02
15/Red Unit	7	0.7	1×10^{-6}	0.07
20/Lower Alluvial Unit	100	10	1×10^{-6}	0.15
25/Palo Verde Clay of MAU	0.002	0.001	1×10^{-6}	0.02
30/Upper Silt Deposits of MAU	0.5	0.05	1×10^{-6}	0.07
35/Upper Sands and Gravels of UAU	300	30	1×10^{-6}	0.25

6.3 Calibration Results

Figure 3 presents the simulated steady state water-level elevations and computed residuals (measured minus simulated) for Layer 1 of the steady state model. The residuals are relatively evenly distributed in the model. Figure 4 presents the cross plot of simulated and measured water level elevations for the steady state model. The residuals are relatively evenly distributed about the 1:1 line. Table 6 summarizes the calibration statistics calculated by Groundwater Vistas. The standard deviation and root mean squared residual indicate the steady state model is, on average, within the 20 foot criterion selected for this model.

Table 6 Calibration Statistics		
Statistic	**Steady State**	**Transient**
Number of Targets	46	305
Minimum Residual	-16.8	-65.87
Maximum Residual	48.76	59.68
Mean Residual (feet)	6.6	1.3
Standard Deviation of Residuals (feet)	13.0	19.3
Sum of Squared Residuals (feet squared)	9,770	114,000
Mean of Residual Absolute Values (feet)	10.7	15.3
Root Mean Squared Residual	14.6	19.3

Figure 5 presents the simulated water-level elevations and interpreted flow directions in Layer 3 for 12/31/2000. Calibration targets are not available for this time period, but the general direction and spacing of contours is similar to recent water level maps prepared by ADWR (PMGC, 2000).

Figure 6 shows simulated and measured hydrographs at four selected locations in the transient model. The general shape and values of the hydrographs match to an acceptable degree. Simulated drawdowns and rises beneath the Redhawk property ([C-01-06]14dbb) are larger than measured, but much of the simulation is within 20 feet of measured values at this point. Figure 7 presents the cross plot of simulated and measured water level elevations for the transient model. The residuals are relatively evenly distributed about the 1:1 line, with the exception of targets in Layer 3 in the area north of PVNGS where simulated water levels are alternately too low or too high. The distance of this area from the area of the power plants makes this area of lesser concern for model calibration and operation.

Table 6 summarizes the calibration statistics calculated by Groundwater Vistas. The standard deviation and root mean squared residual indicate the transient state model is, on average, within the 20 foot criterion selected for this model.

7.0 PREDICTIVE MODEL SIMULATIONS

7.1 Definition

Five scenarios were defined for future simulations with the calibrated Centennial Wash Area groundwater flow model. The five scenarios address five possible land uses for the Centennial Wash Area:

1. Three Proposed Power Plants

2. Return to Full Agricultural Production

3. Urban Development
   a. Level I – 57,000 residents
   b. Level II – 100,000 residents

4. No change

The three proposed power plants have purchased the land or options to buy the land with irrigation grandfathered water rights. The return to full agricultural production indicates the maximum groundwater pumping allowed for irrigation by state law on the lands acquired by the proposed power plants. The proposed power plants will be forced to use much less than the irrigation grandfathered right for electrical power generation. Urban development has been moving towards this area at an increasing pace in recent years. The water use associated with urban development is yet another option that could have been realized for the land if the proposed power plants had not purchased the land or options to purchase the land. Two views of urban development were developed. In the first urban scenario, the value of 6,500 acres of power plant property is multiplied by 3.5 housing units per acre, 2.5 residents per housing unit, and 150 gpcd. For the second urban scenario, the value of 100,000 residents is multiplied by 150 gpcd. Finally, much of the land is currently sitting idle and groundwater continues to recover (rise) from its low point in the early 1980s. The results of simulating the five scenarios for 30 years are subtracted from the simulation for 12/31/2000. The resulting changes (drawdowns or rises) can be compared to evaluate the outcomes of various land uses for the Centennial Wash Area.

7.2 Representation of Future Conditions

Table 7 summarizes the pumping rates selected to simulate the five scenarios of possible land use for the Centennial Wash Area. For each scenario, all pumping outside of the land for the proposed power plants was maintained at values reported to ADWR for the later 1990s (4,400 ac.-ft./yr.). For Scenario 1, wells were simulated on the power plant properties totaling their Type I rights - 18,200 ac.-ft./yr. For Scenario 2, wells were simulated on the power plant properties totaling their irrigation grandfathered rights -

31,200 ac.-ft./yr. For Scenario 3a, wells were simulated on the power plant properties totaling the amount derived from assuming densities and water use described before, which is comparable to a population of 57,000 residents using a total of 9,600 ac.-ft./yr. For Scenario 3b, wells were simulated on the power plant properties totaling the amount derived from assuming a population of 100,000 people and 150 gpcd - 16,800 ac.-ft./yr. Scenario 4 includes wells pumping on the power plant properties at 3,100 ac.-ft./yr.

Table 7 Pumping Rates Used for Future Scenarios (ac.-ft./yr.)

Scenario	Duke Property	Pinnacle West Property	Sempra Property	Power Plant Properties Total	Other Pumping	Total Pumping
1	6,800	3,400	8,000	18,200	4,400	22,600
2	11,200	5,000	15,000	31,200	4,400	35,600
3a	3,400	1,600	4,600	9,600	4,400	14,000
3b	6,000	2,700	8,100	16,800	4,400	21,200
4	3,100	0	0	3,100	4,400	7,500

7.3 Results

The results for each scenario are presented in Figures 8 to 12. They are the differences between the simulation at the end of the transient calibration period (12/31/00) and the simulation at the end of the prediction period (12/31/2030). The simulation results are shown for Layer 3, except for Scenario 2, which is presented for Layer 4 because Layer 3 was locally dewatered. The simulated water-level elevations were noted to be similar in Layers 3 through 7, so using Layer 4 for presenting the results of Scenario 2 does not present any barriers to comparing the scenario results.

The contours of equal change in the water-level elevation of Layer 3 over 30 years for Scenario 1 (Type I rights) (Figure 8) indicate the maximum responses in Layer 3 are slightly over 75 feet beneath the western Centennial Wash Area. Twenty feet of drawdown extends to the limits of the Centennial Wash basin (the area south of the Palo Verde Hills). The Arlington Canal appears to present a barrier to drawdown. The extension of drawdowns to the Gila River in the southern Arlington Valley coincides with the area where the Palo Verde Clay is not present in deeper intervals such as Layer 3.

The contours of equal change in the water-level elevation of Layer 4 over 30 years for Scenario 2 (return to full agricultural use) (Figure 9) indicate the maximum responses in Layer 4 are slightly over 180 feet beneath the western Centennial Wash Area. Twenty feet of drawdown extends to the limits of the Centennial Wash basin (the area south of the Palo Verde Hills). Layer 3 was dewatered in the center of the western area. The Arlington Canal appears to present a barrier to drawdown. The extension of drawdowns to the Gila River in the southern Arlington Valley coincides with the area where the Palo Verde Clay is not present in deeper intervals such as Layer 3.

The contours of equal change in the water-level elevation of Layer 3 over 30 years for Scenario 3a (urban expansion to 57,000 residents) (Figure 10) indicate the maximum responses in Layer 3 are slightly over 15 feet beneath the western Centennial Wash Area. Drawdown greater than 5 feet is limited to the Centennial Wash Area and does not reach to the Arlington Canal in Scenario 3a.

The contours of equal change in the water-level elevation of Layer 3 over 30 years for Scenario 3b (urban expansion to 100,000 residents) (Figure 11) indicate the maximum responses in Layer 3 are slightly over 65 feet beneath the western Centennial Wash Area. Twenty feet of drawdown extends to the limits of the Centennial Wash basin (the area south of the Palo Verde Hills), but not to the Arlington Canal.

The contours of equal change in the water-level elevation of Layer 3 over 30 years for Scenario 4 (no change from current conditions) (Figure 12) indicate the maximum responses in Layer 3 are rises of slightly over 25 feet beneath the western Centennial Wash Area. Ten feet of rise extends to the limits of the Centennial Wash basin (the area south of the Palo Verde Hills). The Arlington Canal appears to present a barrier to rises. The extension of rises to the Gila River in the southern Arlington Valley coincides with the area where the Palo Verde Clay is not present in deeper intervals such as Layer 3.

7.4 Discussion

Figure 13 is a comparison of the five scenarios for a point in Layer 4 where predicted drawdowns are largest. The predicted responses of the groundwater system in the Centennial Wash Area to the pumping for the three power plants at their Type I rights (Scenario 1) are similar to the predicted responses for urban expansion to a resident population with 100,000 people using groundwater as their source of water supply (Scenario 3b). The predicted responses for Scenarios 1 and 3b are less than occurred during historical periods of heavy agricultural use (1950 to 1980).

The predicted responses to no change in recent pumping levels are diminishing rises in water levels of more than 25 feet. The predicted responses for urban expansion to a resident population with 57,000 people using groundwater as their source of water supply (Scenario 3a) are intermediate between the no change simulations and the simulations for the power plants or for urban supply to 100,000 people. The predicted changes to a return to full agricultural use of the power plant properties are much larger than in the other scenarios (more than 180 feet of drawdown).

The predicted responses shown are for Layer 3 where most of the drawdown occurs. Responses above the Palo Verde Clay, in intervals tapped by many domestic wells, will be significantly less than in Layer 3, as observed in the historical hydrographs (PMGC, 2000)

7.5 Limitations and Effects on Model Results

The available information has been extensively used in the analysis of the hydrogeology of the Centennial Wash Area (PMGC, 2000). As with most groundwater investigations, the subsurface of the Centennial Wash Area is not completely known. However, the available data for lithology and hydraulic properties collected from hundreds of wells were used in the construction of the model, and calibration indicates the model represents the groundwater system to an acceptable degree.

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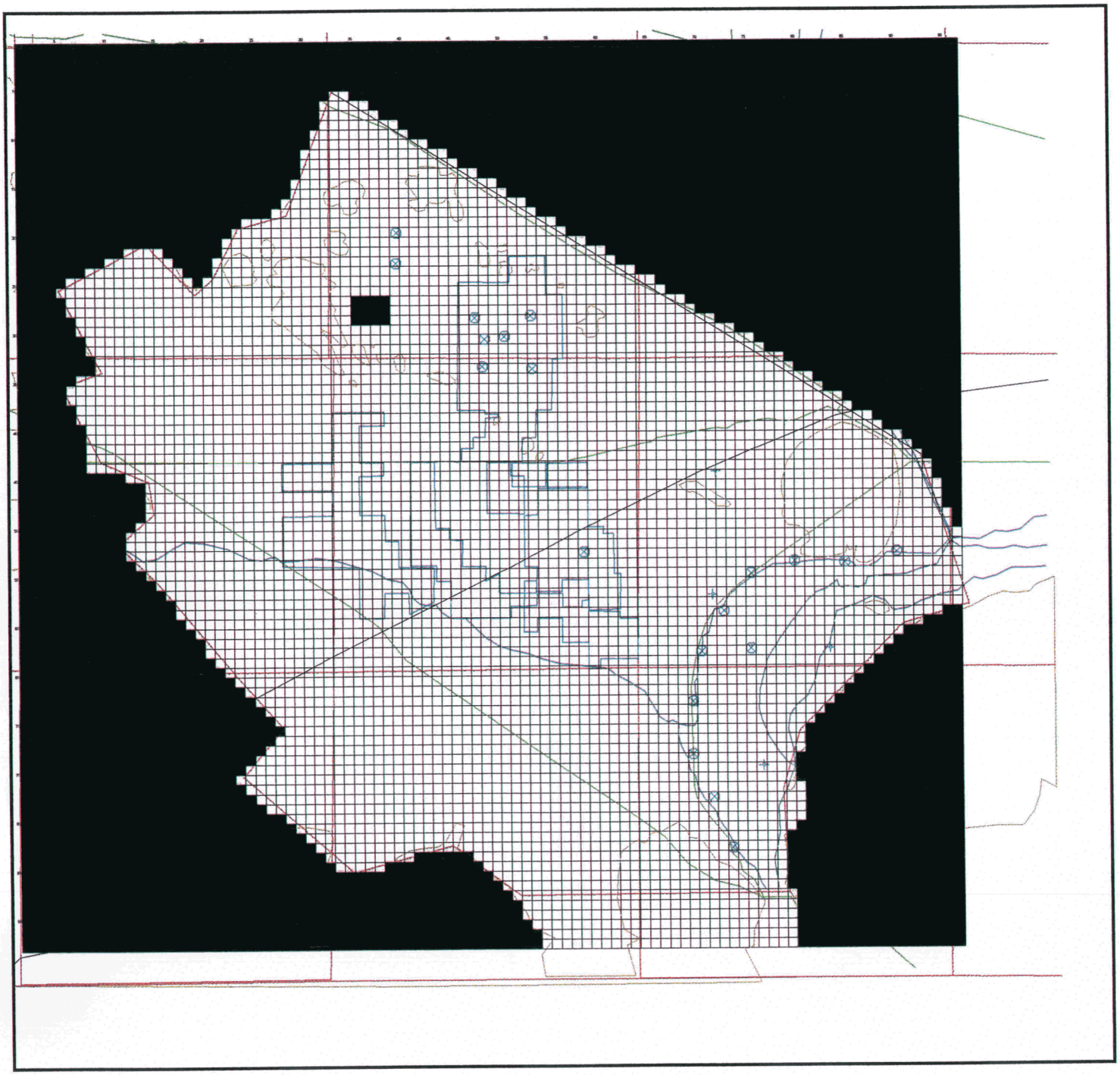


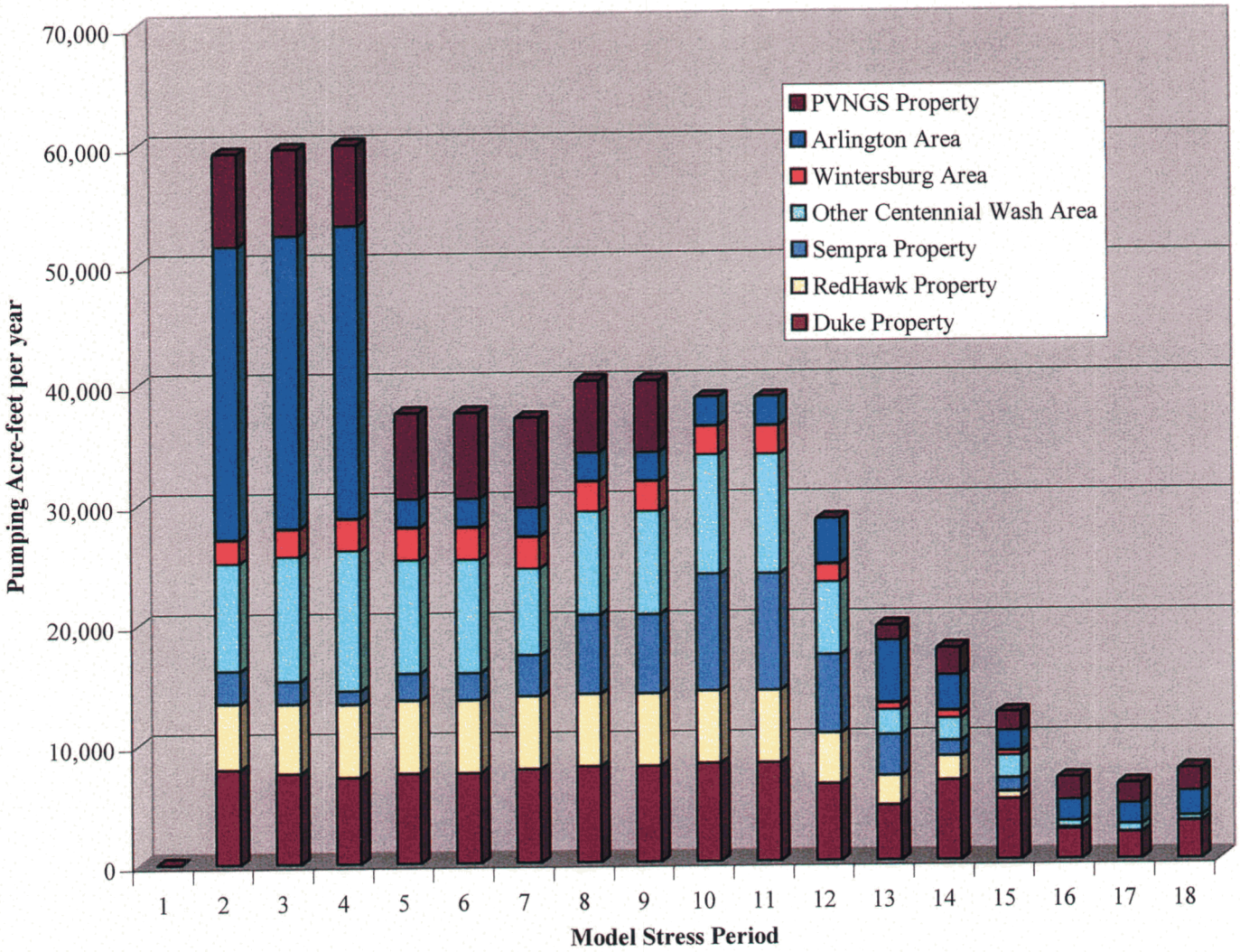
Explanation

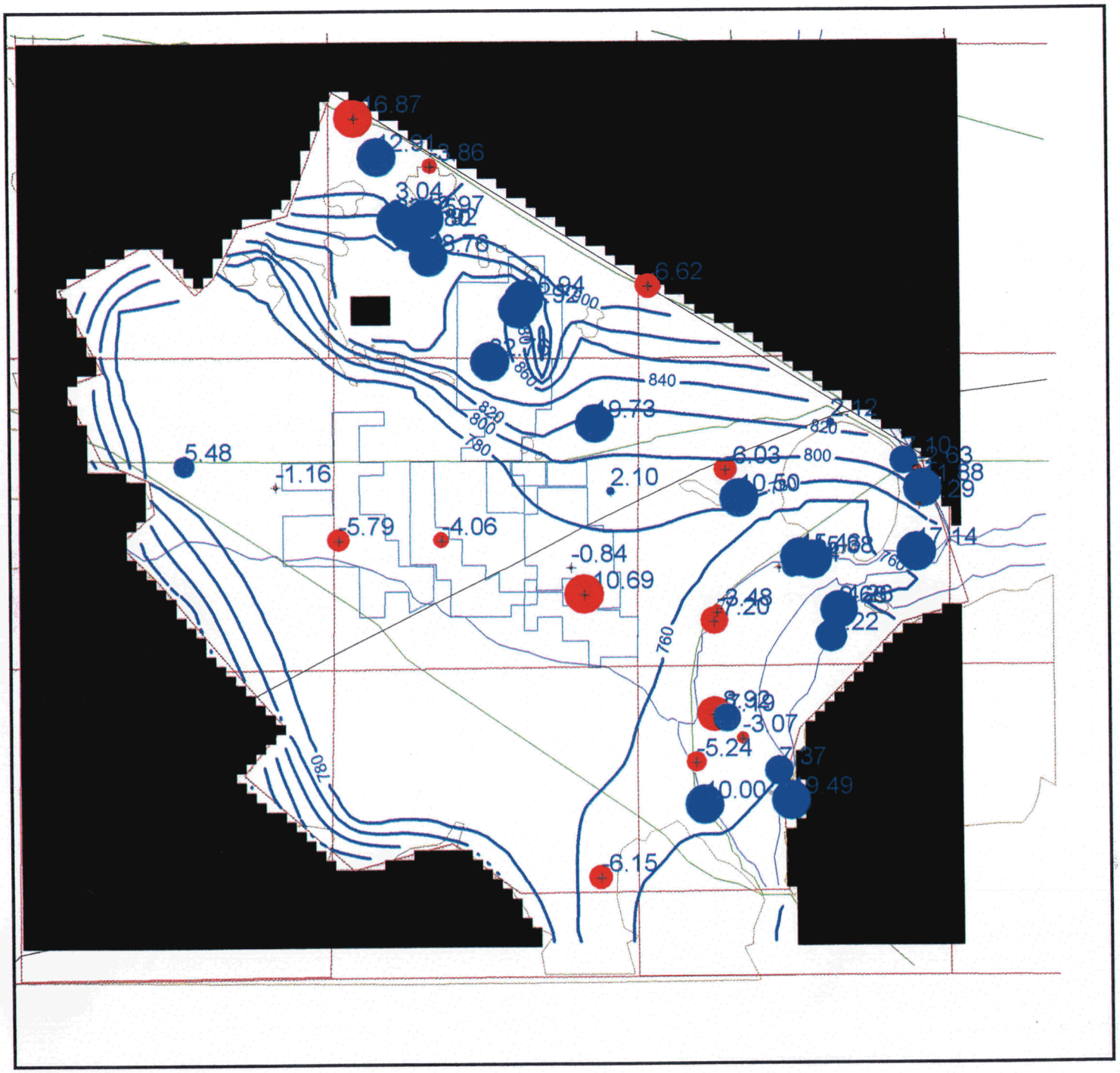
Squares are Uniformly 1000' x 1000'
Filled Squares are Inactive in Layer 1

Scale is 1" = 15,000'
North is up

Figure 1 Model Grid

Figure 2 Reconstructed Historical Pumping for Centennial Wash Area





Explanation

Water-Level Elevation Contours (20-foot Intervals)
Points are Target Locations and Values are
Residuals (Measured minus Simulated)

Scale is 1" = 15,000'
North is up

Figure 3 Steady State (~1940) Simulation Results

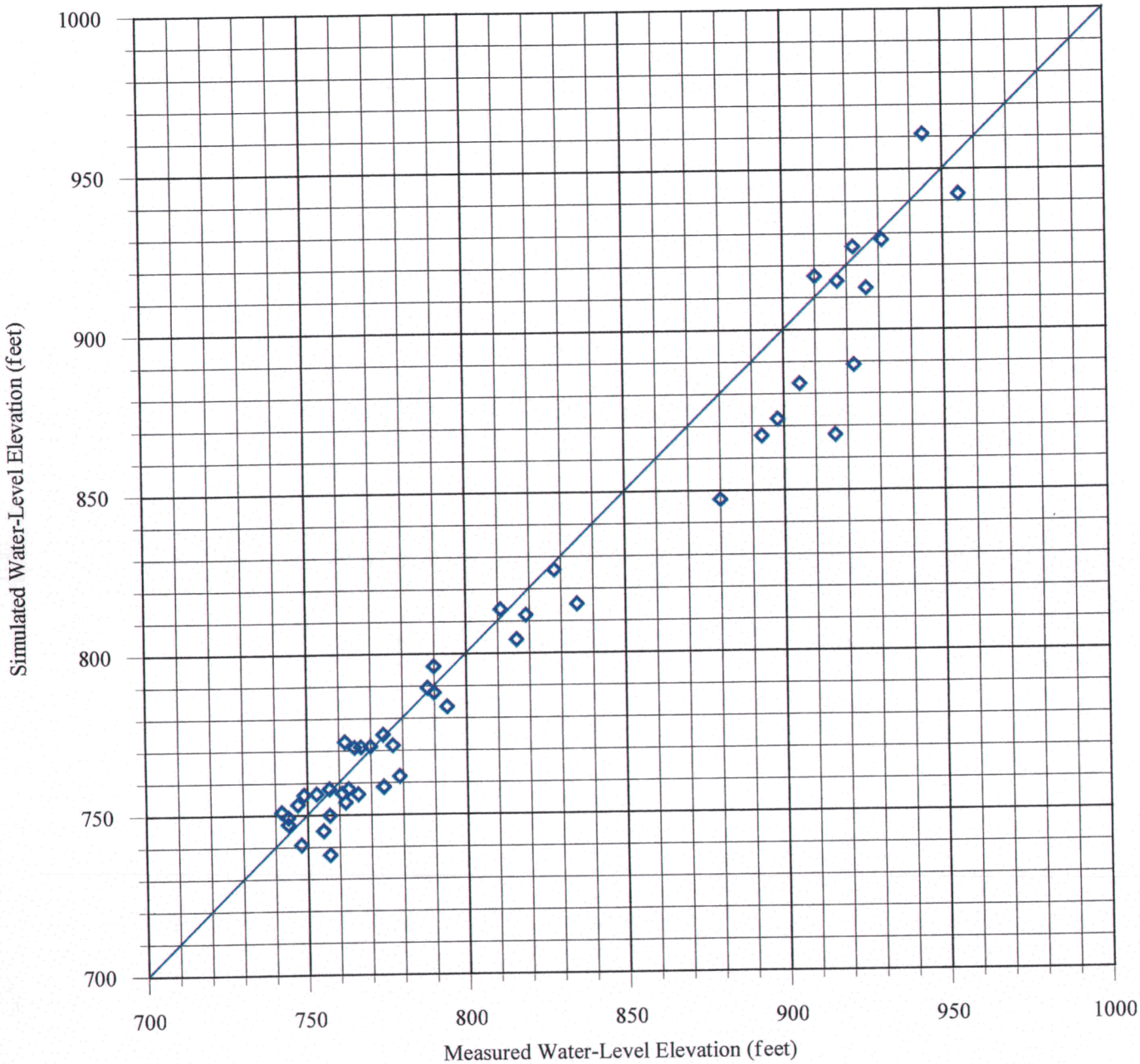


Figure 4 Cross Plot for Steady State (~1940) Model

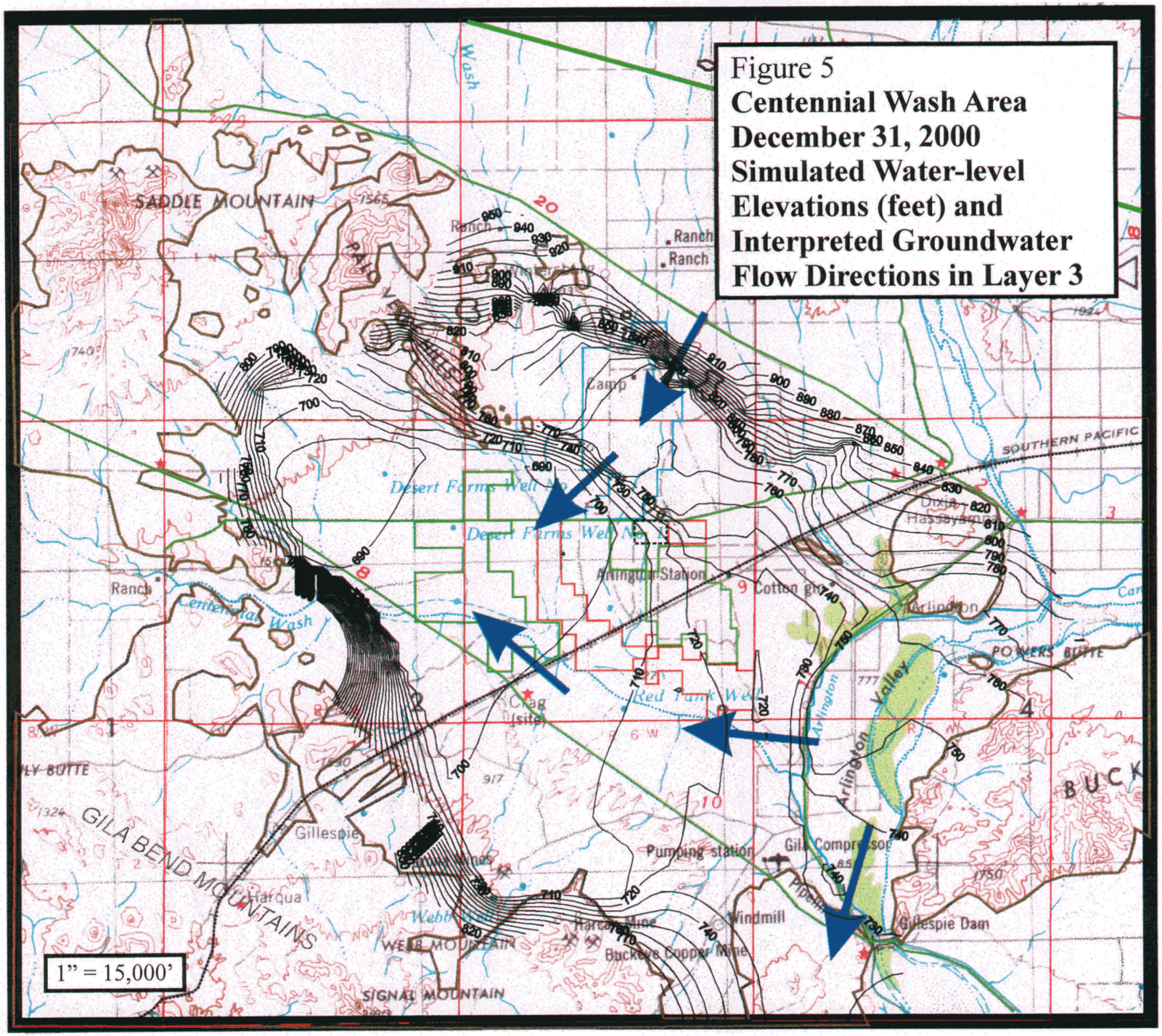


Figure 5
Centennial Wash Area December 31, 2000 Simulated Water-level Elevations (feet) and Interpreted Groundwater Flow Directions in Layer 3

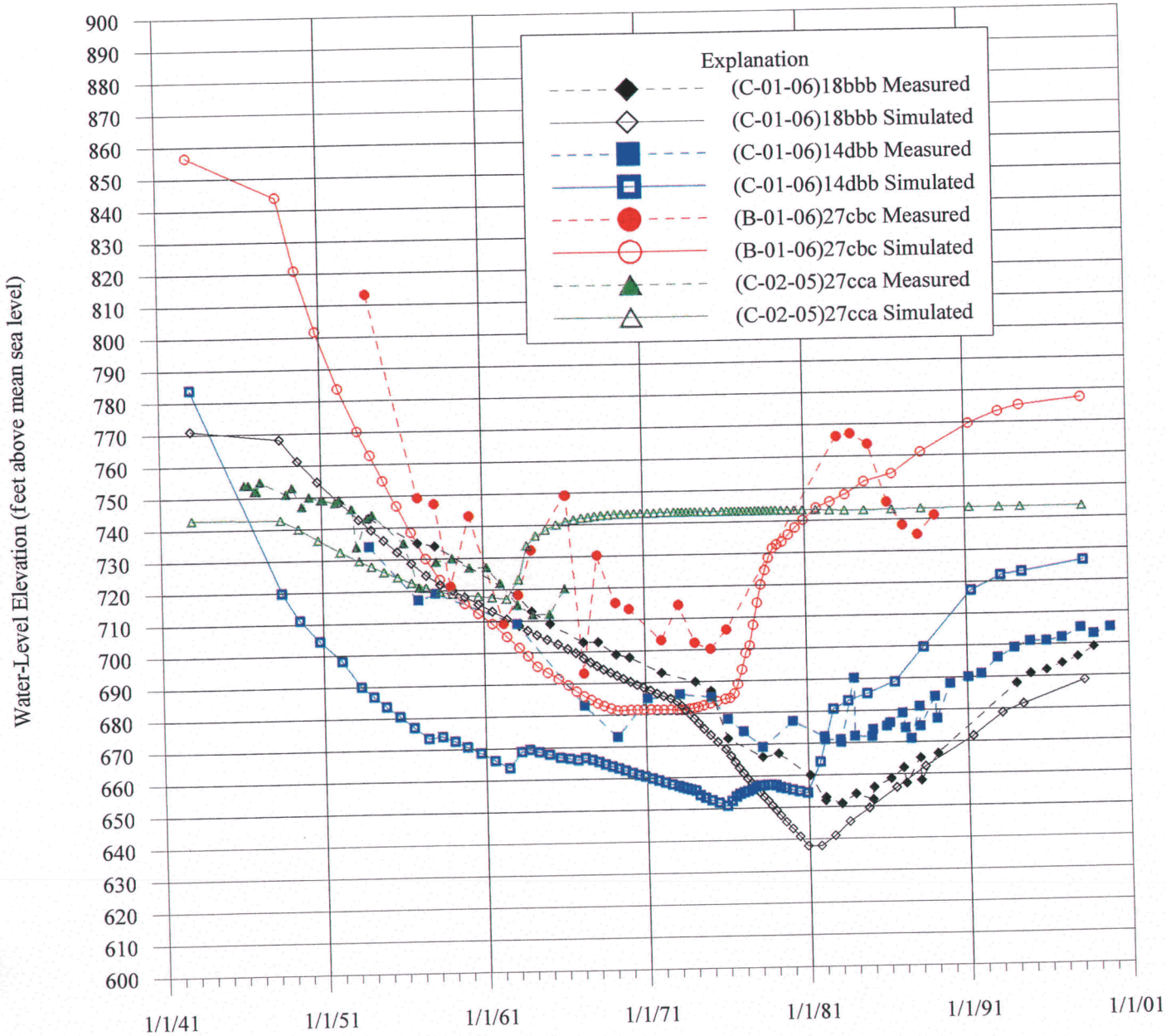


Figure 6 Comparison of Selected Measured and Simulated Hydrographs

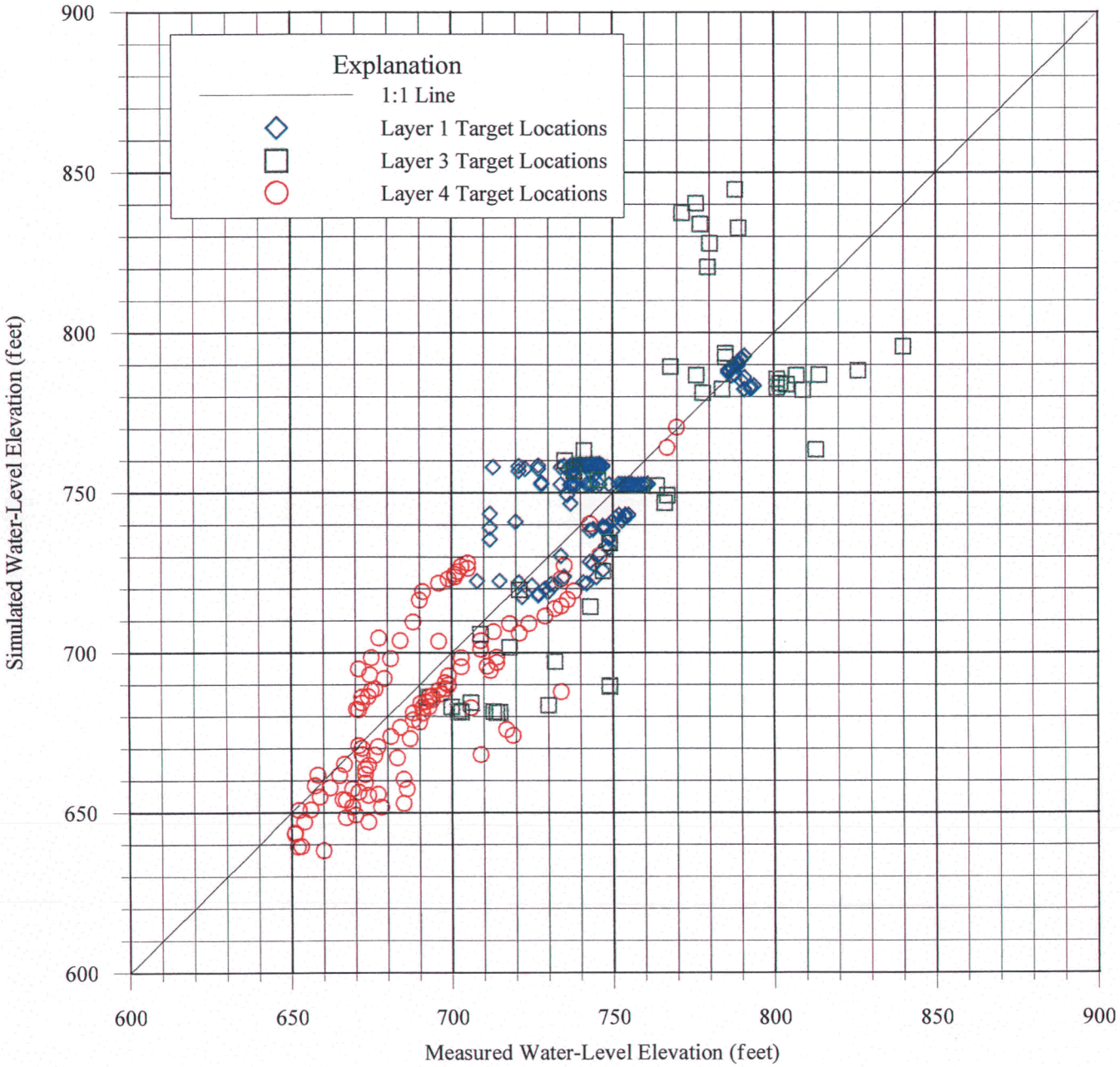


Figure 7 Cross Plot for Transient (1941-2000) Model

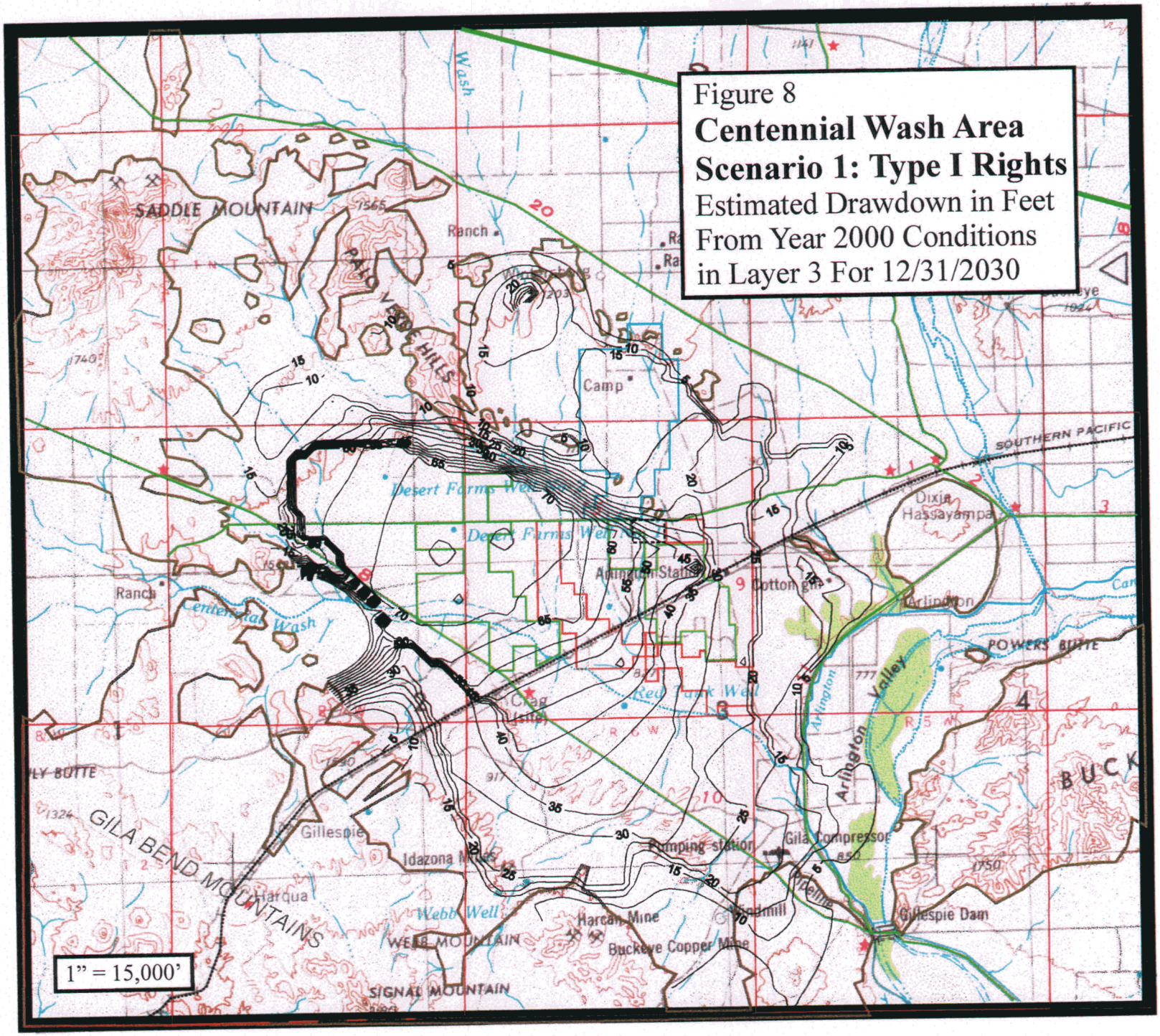


Figure 8
Centennial Wash Area
Scenario 1: Type I Rights
Estimated Drawdown in Feet
From Year 2000 Conditions
in Layer 3 For 12/31/2030
1" = 15,000'
SADDLE MOUNTAIN
GILA BEND MOUNTAINS
SIGNAL MOUNTAIN
WEBB MOUNTAIN
SOUTHERN PACIFIC
POWERS BUTTE
Arlington Valley
Gillespie Dam
Gillespie
Harqua
Idazona
Ranch
Camp
Dixie
Hassayampa
Arlington
Cotton gin
Arlington Station
Desert Farms Well
Centennial Wash
Red Tank Well
Webb Well
Harcan Mine
Buckeye Copper Mine
Windmill
Pumping station
Gila Compressor
Clag
BUCK

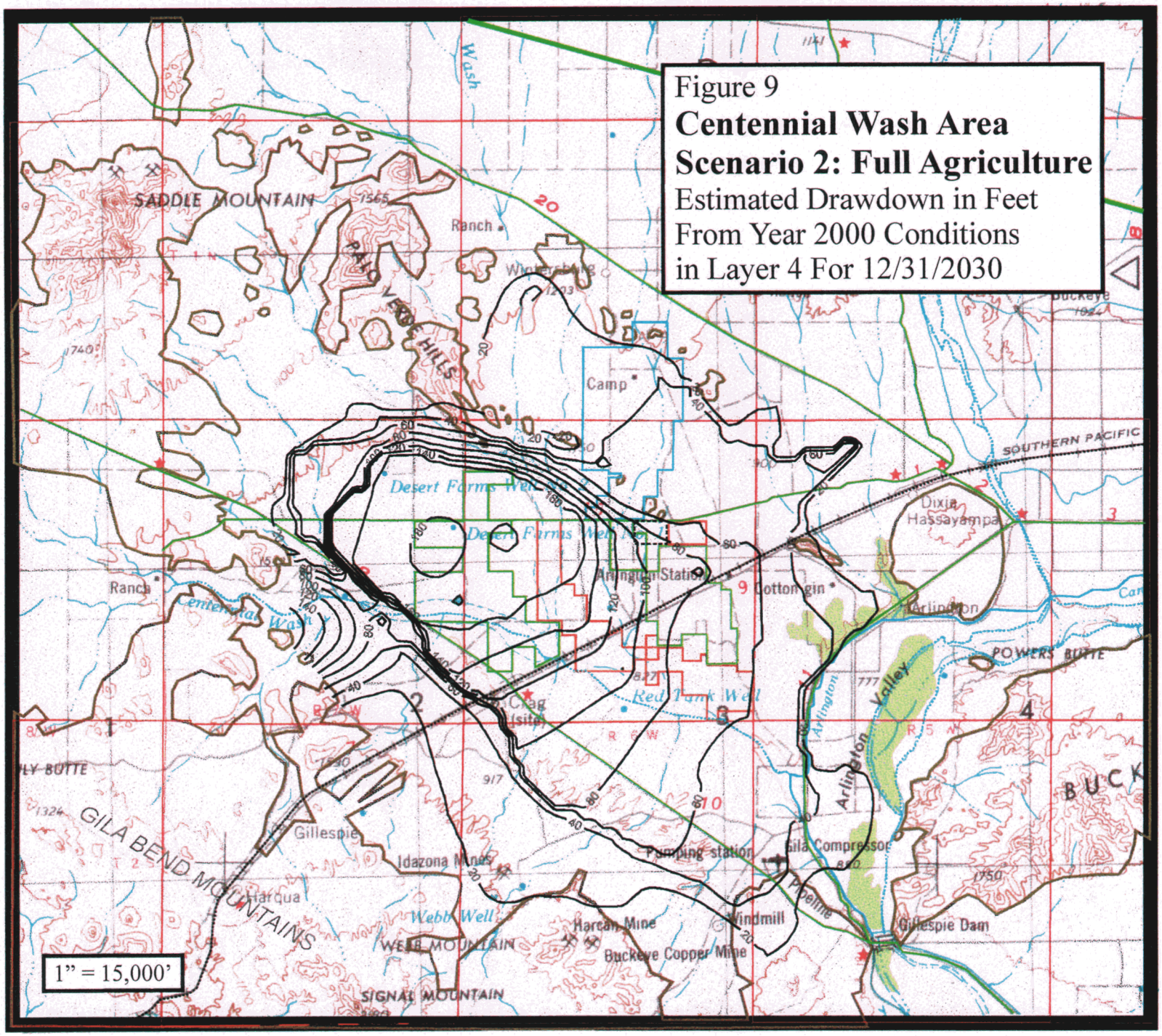


Figure 9
Centennial Wash Area
Scenario 2: Full Agriculture
Estimated Drawdown in Feet
From Year 2000 Conditions
in Layer 4 For 12/31/2030
SADDLE MOUNTAIN
Ranch
Camp
Desert Farms Well
Arlington Station
Cotton gin
Dixie
Hassayampa
SOUTHERN PACIFIC
Arlington
POWERS BUTTE
Red Tank Well
Arlington Valley
Gillespie
Idazona Mines
Harqua
Webb Well
WEBB MOUNTAIN
Harcan Mine
Buckeye Copper Mine
Pumping station
Gila Compressor
Windmill
Pipeline
Gillespie Dam
GILA BEND MOUNTAINS
SIGNAL MOUNTAIN
1" = 15,000'

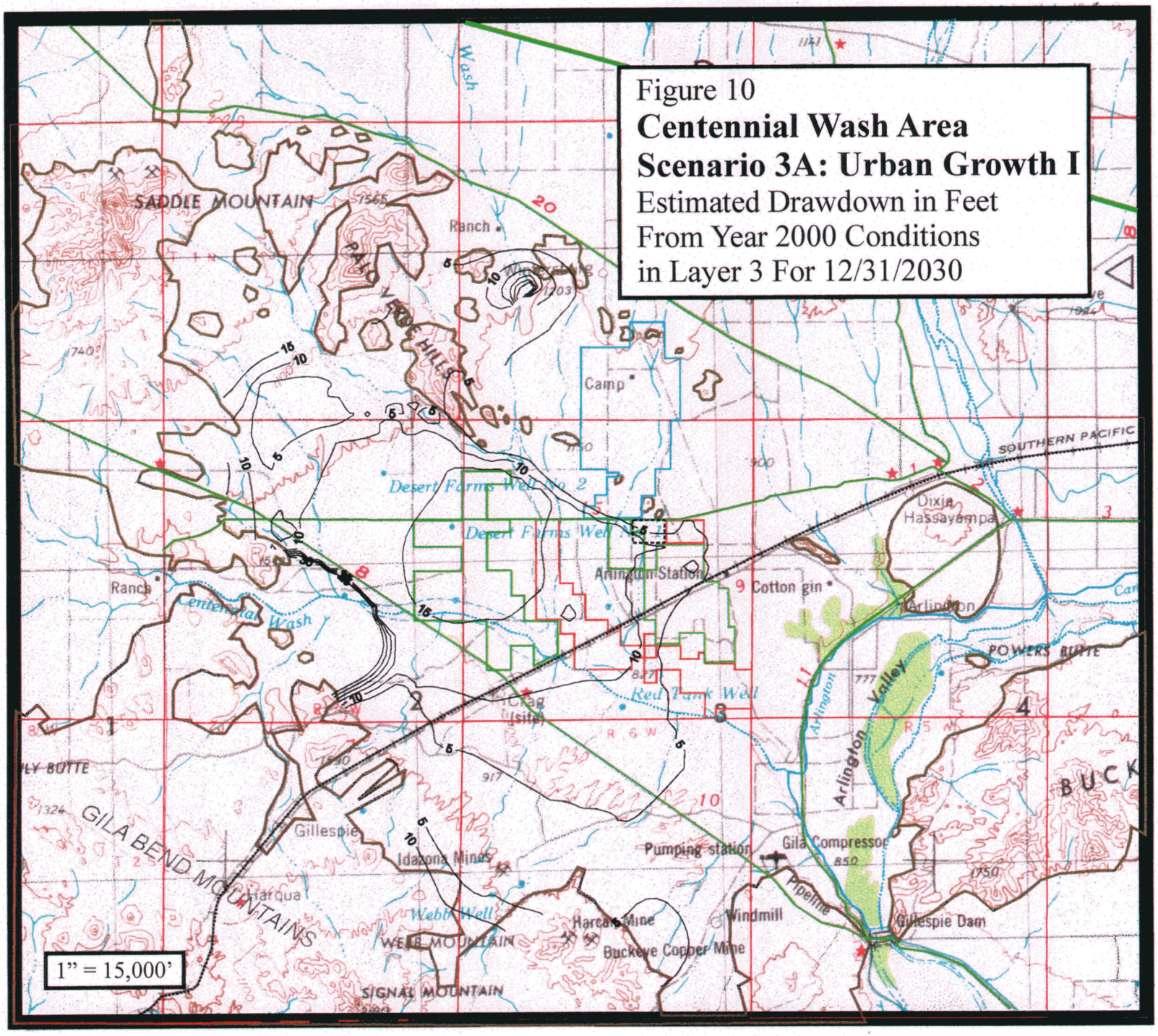


Figure 10
Centennial Wash Area
Scenario 3A: Urban Growth I
Estimated Drawdown in Feet
From Year 2000 Conditions
in Layer 3 For 12/31/2030
SADDLE MOUNTAIN
Ranch
Camp
Desert Farms Well No. 2
Desert Farms Well No. 1
Arlington Station
Cotton gin
Dixie
Hassayampa
SOUTHERN PACIFIC
Centennial Wash
Red Tank Well
Crag (site)
POWERS BUTTE
Arlington Valley
GILA BEND MOUNTAINS
Gillespie
Idazona Mines
Harqua
Webb Well
WEIR MOUNTAIN
Harcase Mine
Buckeye Copper Mine
Pumping station
Gila Compressor
Pipeline
Windmill
Gillespie Dam
SIGNAL MOUNTAIN
BUCK
1" = 15,000'

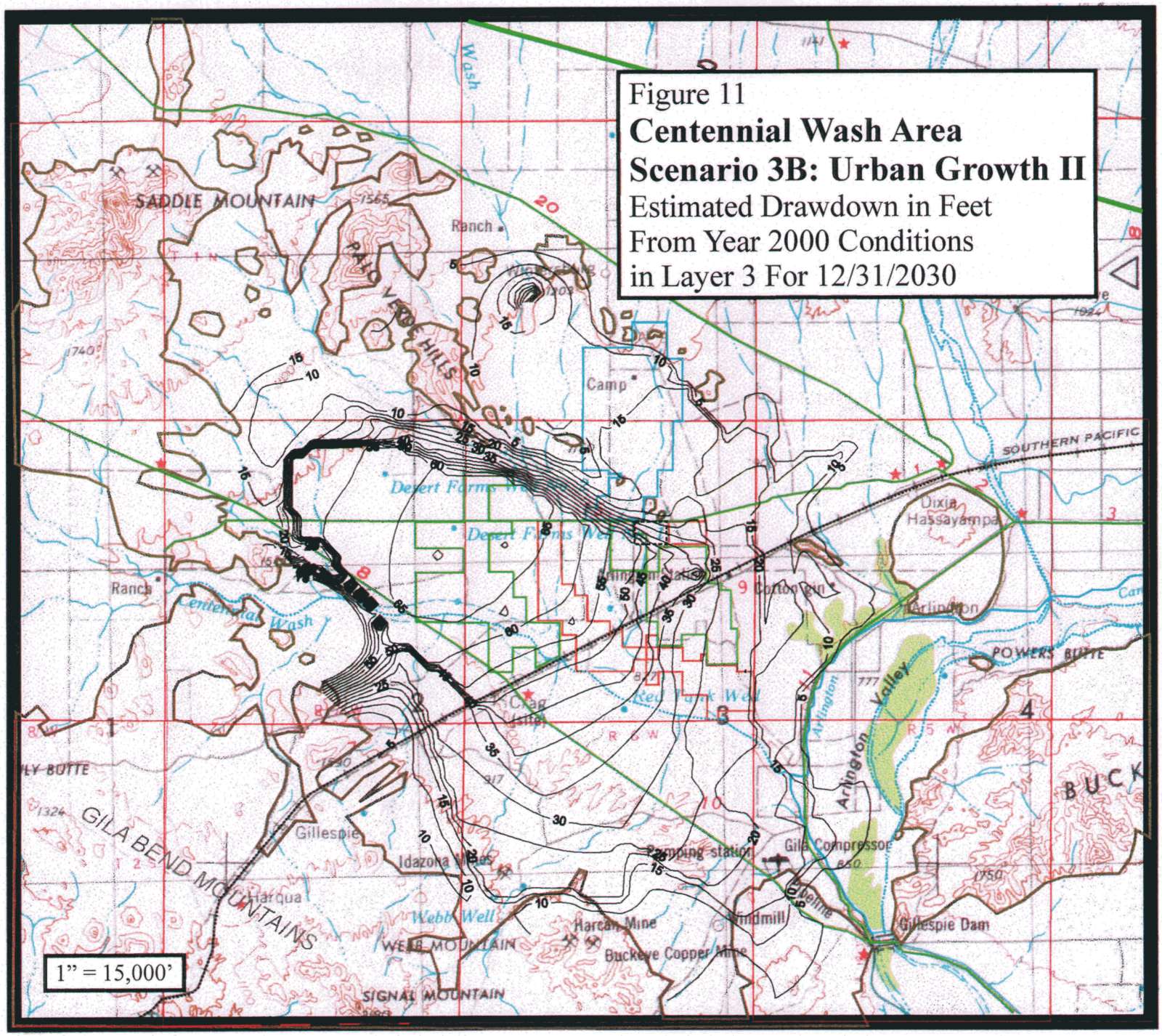


Figure 11
Centennial Wash Area
Scenario 3B: Urban Growth II
Estimated Drawdown in Feet
From Year 2000 Conditions
in Layer 3 For 12/31/2030
SADDLE MOUNTAIN
PALO VERDE HILLS
Ranch
Camp
Desert Farms Well
Centennial Wash
SOUTHERN PACIFIC
Dixie
Hassayampa
Arlington
POWERS BUTTE
Arlington Valley
GILA BEND MOUNTAINS
Gillespie
Harqua
Idazoka Mines
Webb Well
WEBB MOUNTAIN
SIGNAL MOUNTAIN
Harcan Mine
Buckeye Copper Mine
Pumping station
Gila Compressor
Windmill
Gillespie Dam
BUCK
1" = 15,000'

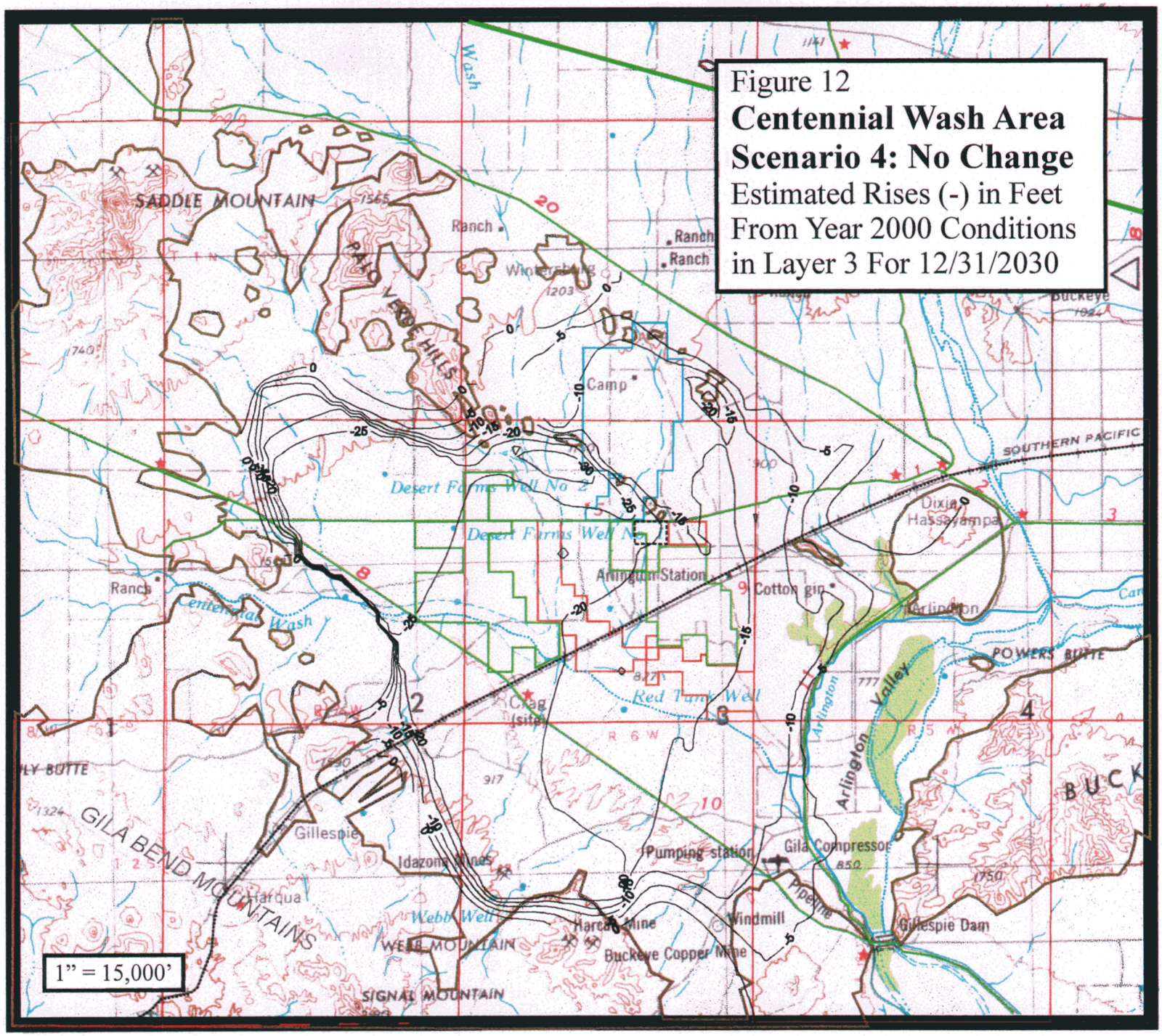


Figure 12
Centennial Wash Area
Scenario 4: No Change
Estimated Rises (-) in Feet
From Year 2000 Conditions
in Layer 3 For 12/31/2030
SADDLE MOUNTAIN
Ranch
Camp
Desert Farms Well No 2
Desert Farms Well No 1
Arlington Station
Cotton gin
Arlington
Dixie
Hassayampa
SOUTHERN PACIFIC
POWERS BUTTE
Centennial Wash
Red Tank Well
Clag (site)
Arlington Valley
Gillespie
Idazoma Mines
Harqua
Webb Well
WEBB MOUNTAIN
Harcuvar Mine
Buckeye Copper Mine
Pumping station
Gila Compressor
Pipeline
Windmill
Gillespie Dam
GILA BEND MOUNTAINS
SIGNAL MOUNTAIN
BUCK
1" = 15,000'

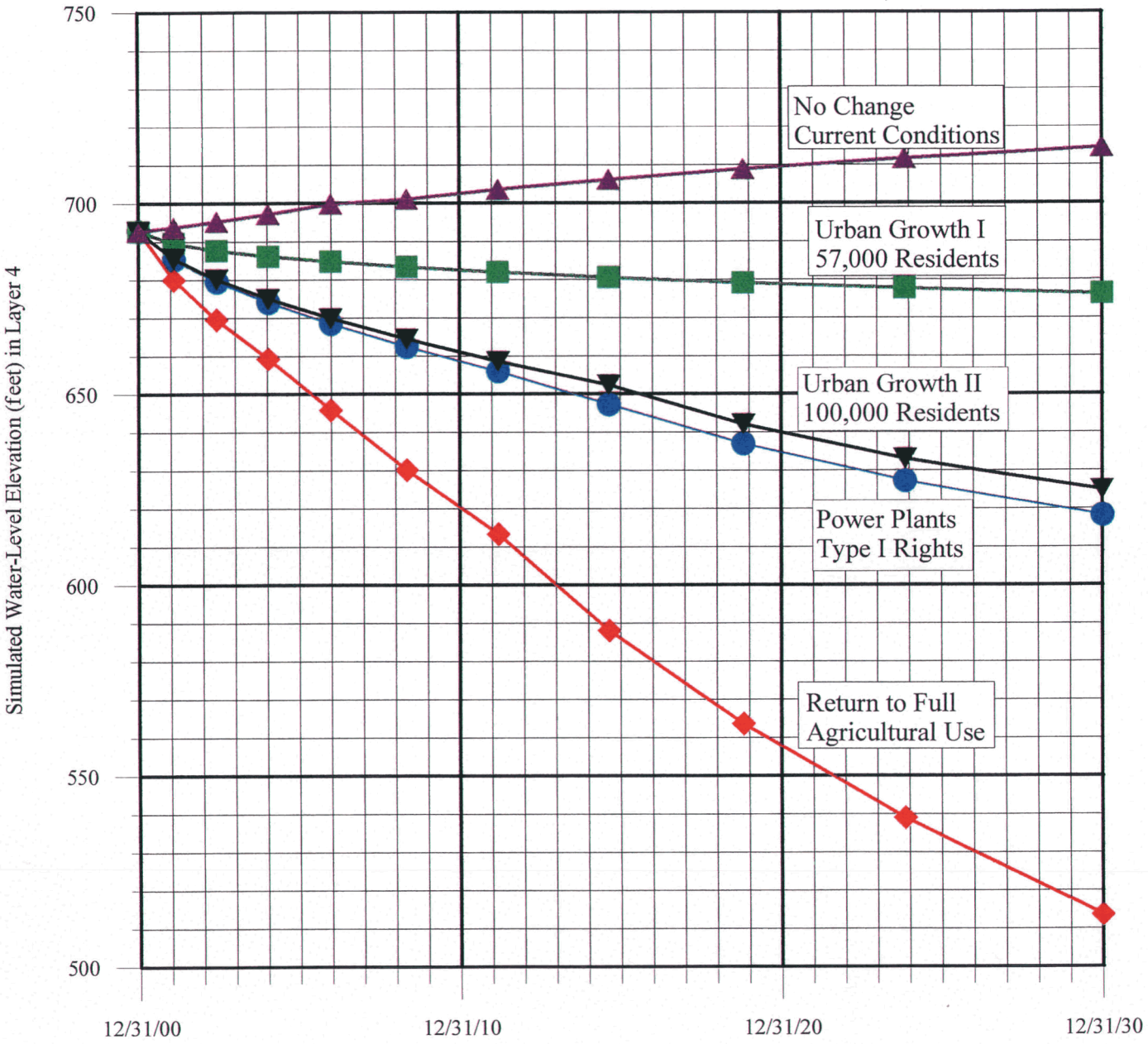


Figure 13 Comparison of Drawdown Projections for the Five Scenarios at (C-01-06) 18 bbb in Layer 4

5

EXHIBIT
A-8
admitted

EVALUATION OF GROUNDWATER RESPONSES TO PUMPING FOR PROPOSED POWER PLANTS IN THE CENTENNIAL WASH AREA, MARICOPA COUNTY, ARIZONA

INTERIM REPORT

Prepared for
Sempra Energy Resources

Prepared by
Peter Mock Groundwater Consulting, Inc.
Phoenix, Arizona

REGISTERED GEOLOGIST
CERTIFICATE NO.
21614
PETER A.
MOCK
Date Signed 4/4/00
ARIZONA, U.S.A.

April 4, 2000

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EXECUTIVE SUMMARY

This interim report presents a current summary of information regarding the groundwater system and a preliminary evaluation of the potential response of groundwater to pumping for three proposed power plants in the Centennial Wash Area. Development and calibration of a groundwater flow model to project responses to pumping for the three proposed power plants will be based on the findings of this report.

The region consisting of the Hassayampa Sub-Basin of the Phoenix Active Management Area was considered in compiling and reviewing relevant reports and data regarding groundwater. Review of that information indicated that focusing efforts on a local study area is appropriate within the Hassayampa Sub-Basin. The local study area is called the Centennial Wash Area.

The geologic framework of the Centennial Wash Area was developed starting from the extensive work conducted for siting of the Palo Verde Nuclear Generating Station and review of drillers', geologists' and geophysical logs collected from the files of the Arizona Department of Water Resources. In order of oldest to youngest, the geologic units identified in the area are:

- Basement Complex – Precambrian granitic and metamorphic rocks
- Bedrock – Tertiary (Miocene) Volcanic-Sedimentary sequence
- Lithologic Zone 1 – Tertiary (Miocene-Pliocene) Indurated Fanglomerate (also called the Red Unit)
- Lithologic Zone 2 – Tertiary-Quaternary Lower Silt, Sand and Gravel Deposits (also called the Lower Alluvial Unit)
- Lithologic Zone 3 – Tertiary-Quaternary (Upper Pliocene) Palo Verde Clay (part of the Middle Alluvial Unit)
- Lithologic Zone 4 – Tertiary-Quaternary Upper Silt Deposits (part of the Middle Alluvial Unit)
- Lithologic Zone 5 – Quaternary Upper Sand and Gravel Deposits (part of the Upper Alluvial Unit)

- Lithologic Zone 6 – Quaternary Younger Fan Deposits (part of the Upper Alluvial Unit)

The principal aquifer system and perched water-table aquifers are hydrostratigraphic units selected from this geologic framework and consideration of available water-level elevation contour maps and hydrographs. The regional, principal aquifer system comprises aquifers in the Volcanic-Sedimentary Bedrock Sequence, the Red Unit, and the Lower Alluvial Unit. Where the Palo Verde Clay of the Middle Alluvial Unit is present, it is a leaky aquitard confining the principal aquifer system. Where the Palo Verde Clay is absent and the Upper Silt Deposits of the Middle Alluvial Unit are present, the Upper Silt Deposits are also included with the principal aquifer system. Where the Palo Verde Clay is present, perched water-table aquifers may develop in the overlying Upper Silt Deposits or Upper Alluvial Unit with water-level elevations tens of feet higher than those of the underlying principal aquifer.

The Basement Complex and the Palo Verde Clay were identified as boundaries to groundwater flow in the Centennial Wash Area. The Basement Complex serves as a substantial boundary to groundwater flow both horizontally at the sides of the area and vertically as a basement to the area. The Basement Complex rises up along the northeast side of the Centennial Wash Area and restricts groundwater flow there. The Palo Verde Clay is not as substantial a boundary to flow as the Basement Complex, but it is expected to substantially slow the flow of groundwater downward from the surface and upward from the principal aquifer system where the Basement Complex rises up in the northwestern part of the Centennial Wash Area.

The available data and interpretations for hydraulic parameters such as transmissivity and hydraulic conductivity for the Centennial Wash Area were compiled and reviewed. The available information for estimating hydraulic parameters is sparse. Efforts are ongoing to collect data and estimate hydraulic parameters in the vicinity of the proposed power plants.

Recharge and discharge components of the groundwater system in the Centennial Wash Area were identified and preliminary estimates were made as data allowed. The recharge components were summarized as:

- Groundwater flow in from adjacent areas,
- Infiltration of precipitation and runoff, and
- Infiltration from agricultural operations;

and included:

- West-bound groundwater flow in from the West Salt River Valley beneath the Gila River channel near Hassayampa,
- Southwest-bound groundwater flow in from the Hassayampa Plain beneath the Buckeye-Salome Road,

- East-bound groundwater flow in from the Harquahala Basin beneath the Centennial Wash channel at Mullen's Cut,
- Direct infiltration of precipitation,
- Infiltration of runoff at mountain fronts,
- Gila River infiltration,
- Hassayampa River infiltration,
- Centennial Wash infiltration,
- Minor tributary infiltration,
- Industrial detention basin infiltration,
- Agricultural leaching requirement, and
- Arlington Canal transmission losses.

The discharge components were summarized as:

- Groundwater flow out to adjacent areas,
- Groundwater flow into the Gila River,
- Evapotranspiration, and
- Wells;

and included:

- Southeast-bound groundwater flow out to the Gila Bend Basin beneath the Gillespie Basalt flow near Gillespie Dam,
- Direct evaporation from the water table,
- Transpiration from phreatophytes,
- Groundwater flow into the Gila River,
- Agricultural pumping,
- Industrial pumping,
- Domestic pumping, and
- Pumping for livestock watering.

The recharge and discharge estimates were assembled into a preliminary groundwater budget and the resulting summary was reviewed. Inspection of the preliminary groundwater budget indicates that the estimated boundary flows and flows to and from the Gila River will require refinement. This conclusion is based on expected overall depletions in storage indicated by water-level data and the assumption that the agricultural water use estimates are relatively accurate, an assumption that should be confirmed

Based on the information available to date, it is concluded that approximately 40,000 acre-feet per year (ac.-ft./yr.) of pumping for agriculture in the Centennial Wash Area from approximately 1950 to 1980 resulted in water-level declines near pumping centers of over 100 feet. During the times of largest drawdowns in the pumping centers, water-level elevations in areas a few miles from the pumping centers fluctuated up and down by only a few feet. Proposed pumping for the power plants is estimated here at 16,000 to

18,000 ac.-ft./yr. Therefore, the response of the groundwater system to pumping for the power plants - water-level declines - may be expected to be a fraction (perhaps one third to half) of that observed in the past in response to agricultural pumping.

The conclusions of this interim report should be tested by refining the water budget components through model calibration and conducting simulations of 30 years of power plant pumping. A model provides for consistent comparison of simulated water level elevations with measured water-level elevations (calibration targets) and therefore is a more severe test of water budget components than a simple, lumped water balance. The available water-level data will provide suitable targets for model calibration.

In developing the model, agricultural water use characteristics of the area during the past 50 years should be further investigated and the relevant water budget component estimates should be refined. Estimates of flow to and from the Gila River should be refined as part of model calibration.

To further support and guide the calibration of the model, additional estimates of hydraulic parameters should be developed through the conduct of aquifer tests in the principal aquifer system at several locations using observation wells, as they are available and access can be obtained. The hydraulic parameter estimates resulting from the aquifer tests can be incorporated into the model during calibration and can serve as additional calibration targets.

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1.0 INTRODUCTION

1.1 Purpose

The goal of the work discussed in this interim report is to qualitatively evaluate the potential response of groundwater to pumping for three proposed electrical power generation facilities (power plants) south of the Palo Verde Nuclear Generating Station (PVNGS) west of Phoenix, Arizona. In support of addressing this goal, the following objectives were selected:

1. Review relevant reports on groundwater for the region surrounding the proposed power plants,
2. Select a local model study area,
3. Review in detail the available reports and data for the local model study area,
4. Characterize the groundwater resources of the local model study area,
5. Qualitatively evaluate the response of the groundwater in the local model study area to pumping for the proposed power plants, and
6. Develop the technical foundation for development of quantitative calculations of groundwater response to the proposed power plant pumping.

This interim report addresses the first five objectives stated above. The development of a computer simulation model of the groundwater in the local model area to address the sixth objective has begun with technical input from the Arizona Department of Water Resources, Maricopa County, and representatives and technical consultants to the proposed power plant companies. The development and results of that model will be presented in a separate document.

1.2 Background on Arizona Groundwater Regulation

The following discussion of potential groundwater use by the three proposed power plants requires some background on terms derived from groundwater regulations in Arizona. This subsection is a preliminary effort at providing definitions of these terms, but does not purport to be a legal analysis. Instead, this subsection is a generalized collection of definitions found in publicly available sources and commonly used in discussions of water use by the proposed power plants. Legal counsel should be consulted for interpretation of Arizona's statutes for a specific situation.

Groundwater rights within Active Management Areas (AMAs) are subject to the Arizona Groundwater Management Act of 1980 (GMA) and are quantified and enforced by the Arizona Department of Water Resources (ADWR). All of the proposed power plants are within the Phoenix Active Management Area (PhxAMA). All of the power plants have acquired rights to pump groundwater through purchase of farmlands with associated groundwater rights.

Irrigation grandfathered rights (IGRs) within the AMAs are calculated by ADWR based on the GMA as follows: "multiply the water duty acres for each farm within the farm unit by the irrigation water duty for the farm unit and divide that amount by the number of irrigation acres in the farm..." (ADWR, 1998 - page 76). Irrigation water duty or water duty is "the amount of water in acre-feet per acre that is reasonable to apply to irrigated land in a farm unit during the accounting period as determined by the [ADWR] director..." [underlining added] (ADWR, 1998 – page 54). An acre-foot (ac.-ft.) is a volume unit commonly used in Arizona that amounts to 325,851 gallons of water. Water duty acres are "...the highest number of acres in the farm, taking rotation into account, which were legally irrigated in any one year in the five years preceding January 1, 1980 ..."[underlining added] (ADWR, 1998 - page 76). The irrigation acres are "...the acres in the farm which were legally irrigated at any time during the five years preceding January 1, 1980..." [underlining added] (ADWR, 1998 – page 76). Note that the water duty changes with the accounting period while the other quantities are fixed based on the data from 1975-1980. ADWR institutes plans to reduce agricultural water use by adjusting the amount reasonable to apply to irrigated land in each 10-year management plan period (1980-1990, 1990-200, etc.).

An IGR can be conveyed for non-irrigation use, specifically an "...industry engaged in the generation of electrical energy for the purpose of electrical energy generation..." (ADWR, 1998, page 86). The right after conveyance is called a Type I non-irrigation grandfathered right (or, informally, a Type I right) and amounts to the lesser of the IGR or ..."three acre-feet per year multiplied by the number of water duty acres in the farm in which the acre to which the right is appurtenant is located divided by the number of irrigation acres in the farm" (ADWR, 1998 – Page 87). Although the applicability of protocols for determining the Type I rights are to be evaluated by legal counsel, the general process is to allow three ac.ft. per acre per year (ac.-ft./ac.-yr.) of farmland purchased by the power companies.

By foreseeing the purchases of agricultural lands for other uses with urban growth, and instructing ADWR to reduce water rights from a typical range of four to six ac.ft./ac.-yr. down to three ac.ft./ac.-yr. upon conveyance, the GMA instituted a long-term plan to reduce groundwater use by agriculture. The GMA, through ADWR, limits the maximum permissible pumping by the proposed power plants to their conveyed Type I rights. With this background in mind, the potential groundwater use by the proposed power plants is summarized below.

1.3 Three Proposed Power Plants

The three proposed power plants would connect to a new switchyard south of PVNGS called the Palo Verde South Switchyard. The three proposed power plants are:

- The Mesquite Power Project proposed by Sempra Energy Resources,

- The Arlington Valley Energy Project proposed by Duke Energy North America, and

- The Combined Cycle Power Plant Project (informally known as the Redhawk Plant) proposed by Pinnacle West Energy Corporation.

All three power plants will be new combined cycle facilities that generate electrical power primarily from combustion of natural gas, but also use residual heat to create steam and generate electrical power from the steam as well. All of the proposed facilities will be built in 500-megawatt (MW) units.

The Mesquite Power Project proposed by Sempra Energy Resources comprises two 500-MW units completed by 2003, depending on the completion of the Palo Verde South Switchyard (Sempra Energy Resources, 2000). The project owns options to purchase approximately 2,990 acres of farmland with approximately 15,000 ac.-ft./yr. of IGR. The conveyance at a rate of 2.67 ac.-ft./ac.-yr. (less than three ac.-ft./ac.-yr. due to the number of acres irrigated during the historical period) would result in a Type I right of 7,990 ac.-ft./yr. Based on operational plans, the proposed project is expected to have a water demand of approximately 7,500 ac.-ft./yr. Pumping on the acquired land for irrigation since 1983 ranged from zero to 3,400 ac.-ft./yr. and averaged 700 ac.-ft./yr. (ADWR, 1999b), an amount that is well below the IGR or conveyed Type I rights.

The Arlington Valley Energy Project proposed by Duke Energy North America comprises two 500-MW units. Maximum estimated water demand at build out is estimated to equal the conveyed Type I rights (ARCADIS Geraghty & Miller, 1999). Duke Energy North America acquired 2,400 acres of farmland with six IGRs. The total of the IGRs for 1999 was 11,200 ac.-ft./yr., which was obtained by applying varying water duties to lands totaling 2,272 acres. Conveyance to a Type I right at three ac.-ft./ac.-yr. would amount to 6,817 ac.-ft./yr. Pumping on the acquired land for irrigation since 1983 ranged from 1,700 ac.-ft./yr. to 7,400 ac.-ft./yr. and averaged 4,000 ac.-ft./yr. (ADWR, 1999b), an amount that is well below the IGR or conveyed Type I rights.

The Combined Cycle Power (Redhawk) Plant proposed by Pinnacle West Energy Corporation comprises four 500-MW units built one at a time and completed between late 2000 and 2007 (Hargis+Associates, Inc., 1999 - page 1). Maximum estimated water demand at build-out is 13,300 ac.-ft./yr. The projected water supply will be 90 to 95 percent effluent purchased from PVNGS (11,970 to 12,640 ac.-ft./yr.). Negotiations for the effluent delivery between PVNGS and Pinnacle West Energy Corporation continue at this writing (April 2000). Pinnacle West Energy Corporation purchased 1,119 acres of farmland with IGRs that will convey to Type I rights amounting to approximately 3,356 ac.-ft./yr. Groundwater demand for the Redhawk Plant is expected to be 660 to 1,330 ac.-ft./yr., given expected effluent deliveries, but permissible maximum under state law will be the Type I right (approximately 3,360 ac.-ft./yr.). Pumping on the acquired land for irrigation since 1983 has ranged from 1 ac.-ft./yr. to 2,500 ac.-ft./yr. and averaged 600 ac.-ft./yr. (ADWR, 1999b), an amount that is well below the IGR or conveyed Type I rights.

Together, the three power plants have acquired 6,509 acres of farmlands with 31,200 ac.-ft./yr. of IGRs. Conversion of these IGRs to Type I rights would result in a maximum permissible groundwater withdrawal by all three plants of 18,167 ac.-ft./yr. Projected actual groundwater demand for the three plants is 15,600 ac.-ft./yr.

In summary, the groundwater use by the three power plants is projected to range between approximately 16,000 ac.-ft./yr. (estimated demand) and 18,000 ac.-ft./yr (maximum permissible under Arizona state law). Pumping on the lands acquired by the power plants since 1983 has ranged from 1,700 ac.-ft./yr. to 11,500 ac.-ft./yr. and averaged 5,100 ac.-ft./yr. (ADWR, 1999b). If irrigated agriculture were to resume at historical levels (1950s, 1960s and 1970s) on the farmlands acquired by the power plants, the groundwater pumping would range between approximately 20,000 and 40,000 ac.-ft./yr.

1.4 Scope

This interim report is based on the data and reports available to Peter Mock Groundwater Consulting, Inc. (PMGC) as of this writing (April 2000). Additional data are expected in the next few months from aquifer testing, water-quality sampling and analysis, water-level measurement and drilling programs initiated by Sempra Energy. Aquifer testing and drilling programs initiated by Pinnacle West Energy Corporation are expected to provide additional data in the next few months as well.

As mentioned above, the Hassayampa Sub-Basin of the PhxAMA is considered a useful area for the regional evaluation of groundwater flow and logical, considered selection of a local model study area. Specifically, the local model study area only needs to enclose an area surrounding the proposed power plant properties out to obvious boundaries to groundwater flow or distances containing distinctive groundwater occurrence and flow conditions. From evaluation of reports and interpretations presented in existing reports for the regional area, a local model study area was selected here and detailed interpretations were limited to that area. For completeness, data within a small margin around the local model study area (one to two miles) were also considered.

Water quality is not considered in this report at this time. However, data were noted in the references reviewed here upon which interpretations could be made at a later time concerning the distribution of inorganic chemical constituents in groundwater.

1.5 Plan of Development

This Section 1 has been an introduction to the work described in this interim report. Section 2 is a discussion of relevant geologic and hydrologic reports from a regional perspective (for the Hassayampa Sub-Basin of the PhxAMA) and selection of a local model study area (the Centennial Wash Area). Section 3 is a geologic framework for the

Centennial Wash Area, which serves as the foundation for the identification of hydrostratigraphic (groundwater flow) units presented in Section 4. Section 5 is a description of the hydrologic boundaries to the Centennial Wash Area while Section 6 provides estimates of hydraulic properties of the hydrostratigraphic units in the Centennial Wash Area. Section 7 provides estimates of inflow and outflow components of the groundwater budget in the Centennial Wash Area, which are used in Section to construct a preliminary, overall groundwater flow budget for the Centennial Wash Area. Section 9 is a discussion of the report as a whole – summary of findings, conclusions drawn, and recommendations for future work, while Section 10 presents citations for documents referred to in Sections 1 – 9.

2.0 REGIONAL SETTING

2.1 Introduction

For this interim report, the extent of regional consideration is defined by the Hassayampa Sub-Basin of the PhxAMA defined by ADWR (Figure 1). To the extent that previous geologic or hydrologic studies investigated and reported on areas including, adjacent to, or overlapping with the Hassayampa Sub-Basin, they were considered relevant to this study. This section on regional setting is divided into subsections on review of relevant studies, geography, geology, climate, surface hydrology, subsurface hydrology, and selection of a local study area.

2.2 Review of Relevant Regional Studies

This subsection presents a review of the primary geology and hydrology studies of the region. There have been numerous studies of areas including or overlapping with portions of the Hassayampa Sub-Basin. However, none focused on the area acquired for the proposed power plants, a situation which requires extraction of relevant information from each study and synthesis for the Hassayampa Sub-Basin. In the subsection, the scope of each relevant study is briefly described, followed by an assessment of the particular relevance of the study to this effort. The review is presented in chronological order based on publication date.

The U.S. Geological Survey (USGS) of the U.S. Department of the Interior conducted the first regional study of groundwater conditions in the Lower Hassayampa Area (Stulik, 1974). The study area for that report is approximately the lower half of the Hassayampa Sub-Basin of the PhxAMA. See Figure 1 for the locations of the Lower Hassayampa Area in relation to the Hassayampa Sub-Basin. As reported in Stulik (1974), the USGS compiled a field inventory of wells in 1968, collected drillers logs, measured water-levels and well discharges during the period 1968 to 1973, and collected water-quality samples for analysis of inorganic constituents. Of particular interest to this study is that the report includes a map of surficial geology and subsurface geologic interpretations by M.E. Cooley, a map of irrigated areas interpreted from a 1968 aerial photograph, a water-level elevation contour map for 1970, and estimates of groundwater pumping separated between what Stulik (1974 – Plate 1) defined as the Centennial and Tonopah-Hassayampa areas. See Figure 1 for the dividing line between these two areas.

Two closely related studies characterized groundwater conditions in a corridor along the Salt and Gila Rivers from 23rd Avenue to Gillespie Dam. Both Water Development Corporation (Halpenny and Greene, 1975) and Water Resources Associates, Inc. (1975) prepared reports for NUS Corporation concerning the potential impacts of water use by the then proposed Palo Verde Nuclear Generating Station (PVNGS) on the regional water resources. Both reports provided water balances for the study corridor for 1974 and

projections of water balances in 5-year intervals forward to the year 2000. Relevant to this study are estimates of surface water flows, effluent discharges from the City of Avondale, City of Tolleson and City of Phoenix 23rd and 91st Avenue Wastewater Treatment Plants, channel seepage losses/gains, consumptive use of crops in Arlington Canal Company lands and discharge to phreatophytes.

The USGS published an update to Stulik's (1974) report (Stulik and Laney, 1976) that is in the typical format of USGS and ADWR "Ground-Water Conditions" map reports. The report covers the USGS Lower Hassayampa Area of Stulik (1974) and presents water-level measurements for 1975, water-level change maps for 1970 – 1975, and specific conductance (related to total dissolved solids) and fluoride measurements for 1975. The report also presents irrigated acreages for 1974 based on Arizona Crop and Livestock Reporting Service data checked in the field by the USGS. A supplement was published for this report containing the basic data used for the report (USGS, 1976).

The Soil Conservation Service (SCS) of the U.S. Department of Agriculture mapped soils over the central part of Maricopa County in the 1960s and 1970s (SCS, 1977). Of relevance to this study are descriptions of surficial geologic materials and aerial photography used as bases for presenting the detailed maps of the soil units. The lands prepared for irrigation in 1973 are visible in the aerial photographs.

Between 1978 and 1980, Fugro (1978, 1980) investigated the geology and groundwater conditions in the vicinity of the then-proposed PVNGS for the Arizona Nuclear Power Project. The scope of their studies extended for tens of miles around the PVNGS. Surficial geology was mapped for the entire Lower Hassayampa Area of Stulik (1974) and beyond. Over 70 borings were drilled to depths of 200 to 600 feet, borehole geophysical logs were run in the boreholes, and gravity and seismic surveys were conducted. The report further summarized interpretations of two pumping tests (of a deep irrigation well and of a shallow test well), interpretations of numerous slug/bail tests of the borings and laboratory tests of permeability for core samples from the borings.

The USGS published a report for the "Hassayampa Area" in 1980 (Sanger and Appel, 1980), but it addressed only the area north and east of the Belmont Mountains. See Figure 1 for the location of the Hassayampa Area as defined by Sanger and Appel (1980). The focus of the study was primarily far to the north of the Hassayampa Plain in the vicinity of the Town of Wickenburg. Six water-level measurements (and observations of three dry holes) for 1976-1977 in the Hassayampa Plain were presented, but were considered insufficient to contour. One water-quality sample in the Hassayampa Plain was analyzed for inorganic constituents.

The ADWR Basic Data Unit assumed the work of preparing groundwater conditions map reports from the USGS in 1980. ADWR began with a study of the Harquahala Basin by Graf (1980). Water-level measurements and results of inorganic water-quality analyses are presented for 1979-1980. That report has significance to this study in that the Harquahala Basin is adjacent to the Hassayampa Sub-Basin on the west and boundary

conditions between the two basins for 1979-80 can be inferred from water-level elevation contour maps.

ADWR's Basic Data unit developed a groundwater conditions map report in 1981 for the Gila Bend Area (Sebenik, 1981). Water-level measurements and results of inorganic water-quality analyses are presented for 1979. Another groundwater conditions map report for the Gila Bend Basin was completed and published by ADWR Basic Data Unit in 1996 (Rascona, 1996). Water-level measurements and results of inorganic water-quality analyses were presented for 1993 along with hydrographs and water-level change maps. These reports have significance to this study in that the Gila Bend Basin is adjacent to the Hassayampa Sub-Basin on the south and boundary conditions between the two basins for 1979 and 1993 can be inferred from the water-level elevation contour maps.

In 1984, Water Development Corporation (Halpenny, 1984) published the first study dedicated solely to the "waterlogging" problem in the vicinity of the Town of Buckeye. The waterlogging problem comprises depths to water of 4 to 10 feet and increasing salinity within Buckeye Water Conservation and Drainage District. The increasing base flow of the Gila River was identified as the major cause of the waterlogging. This report extracted and expanded on previous reports for the Buckeye area by this same author (Halpenny and Greene, 1975, 1977; Halpenny, 1982a,b; Halpenny, 1983) with a focus on the waterlogging problem. Of relevance to this study is the summary of the Buckeye area reports up to 1984 and a December 1983 water-level elevation contour map.

Long (1983) prepared a groundwater conditions map report for ADWR's Basic Data Unit that expanded on the works of Stulik (1974) and Stulik and Laney (1976). This report addressed the entire Hassayampa Sub-Basin of the then newly created PhxAMA. The area also included much of what Sanger and Appel (1980) had called the Hassayampa Area, but excluded the Wickenburg area. See Figure 1 for the locations of these areas relative to the Hassayampa Sub-Basin. Long (1983) presented maps of water-level elevation contours and inorganic water-quality analyses results for 1982, along with hydrographs (1950 to 1982) and a water-level change map for the period 1970 to 1982. The water-level elevation contour map included data points and separately addressed the principal regional aquifer and a regional of shallower groundwater ("perched water") beneath PVNGS. Long (1983) also presented pumping estimates for the Lower Hassayampa area for the period 1973 to 1981. Unlike the previous USGS studies (Stulik, 1974; Stulik and Laney, 1976), irrigated area estimates were not presented. A supplement was published for this report containing the basic data used for the report (ADWR, 1983).

A groundwater conditions map report for the adjacent PhxAMA, minus the Hassayampa Sub-Basin, was published by the ADWR Basic Data Unit using data collected in 1982 (Reeter and Remick, 1986). Of relevance to this study are the plotted individual water-level elevation data points and interpreted contours, which assist in evaluating the flow of groundwater into the Hassayampa Sub-Basin from the east beneath the Gila River channel.

Errol L. Montgomery & Associates, Inc. (1986, 1988) performed a study of waterlogging in the Buckeye area for the PhxAMA of ADWR in the 1980s. The first report (Montgomery, 1986) compiled and evaluated historical data and the second report (Montgomery, 1988) used water budget models to evaluate conditions as of 1985 and project conditions into the future under various scenarios for the area along the Salt and Gila Rivers from 23rd Avenue to Gillespie Dam. The scope of this study was reminiscent of that of the work reported on by Halpenny and Greene (1975) and Water Resources Associates, Inc (1975) in the early 1970s, but the emphasis of the work in the 1980s was on depths to water of 4 to 10 feet in the Buckeye area that were impacting agricultural production and the applicability of a tax on pumping imposed by the Groundwater Management Act of 1980. The study by Montgomery (1986, 1988) was comprehensive and relevant to this study in that water budgets were computed (with detailed groundwater and surface water flow components) for the Arlington area for 1985 conditions. In addition, several dozen shallow piezometers were installed and water-level elevation data were collected in March 1987.

Halpenny and Halpenny (1988) reported on the first comprehensive assessment of groundwater resources in the Hassayampa Plain. See Figure 1 for the location of the alluvium of the Hassayampa Plain investigated by Halpenny and Halpenny (1988). Based on inspection of water-level and stream-gaging data from the USGS and ADWR, and from the findings of nine new test holes (approximately 1200 feet deep) and aquifer tests of three new test wells and an existing well, Halpenny and Halpenny (1988) estimated the flux of that portion of the groundwater flow leaving the Hassayampa Plain east of the Belmont Mountains and south to the Buckeye area. Halpenny and Halpenny (1988) defined the subsurface geology of the Hassayampa Plain for the first time and developed a water-level elevation map for 1987 that they compared to that of Long (1983) and a map developed by the U.S. Bureau of Reclamation in 1945.

Investigations of the Hassayampa Landfill Federal Superfund Site began in the 1980s and remedial action (four wells pumping a total of 7 gallons per minute (gpm) followed by air stripping treatment, followed by deep injection) for volatile organic compounds in shallow groundwater began March 1994. Hydrogeologic data for the Hassayampa Landfill Site are presented in reports by Errol L. Montgomery & Associates, Inc. (1994, 1998). They defined the local geology, ran pumping tests and monitored water levels. This work is relevant to this study in that detailed data are available to assist in interpreting the shallow (less than 300 feet below land surface [bls]) geology and groundwater flow in this area.

The most recent product of the ADWR Basic Data Unit in terms of groundwater conditions maps for the region is that of Hammett and Herther (1995). These maps cover the complete PhxAMA, including the Hassayampa Sub-Basin and present water-level measurements and inorganic water-quality data collected in 1992. A draft set of similar groundwater conditions maps using data from 1997 is being prepared by ADWR at this writing (April 2000).

In summary, there have been substantial studies completed since the 1970s of portions of the Hassayampa Sub-Basin. Each had a specific focus and none focused on the pumping along the north side of Centennial Wash. However, the assembled reports for these studies comprise a foundation for interpreting groundwater flow conditions in this area and selecting a local study area. The remaining subsections of this section extract relevant information from the previous regional studies as necessary to assist in selecting a local study area.

2.2 Geography

A brief overview of geography is provided here to assist the reader in developing a familiarity with the general features of the region. Topography, landmarks, and locations of the proposed power plant properties and named areas are discussed in this subsection. Figure 1 summarizes many of the features discussed in this subsection.

The Hassayampa Sub-Basin is the focus of this study. The Harquahala Basin bounds it on the west, the West Salt River Valley Sub-basin bounds it on the east, and the Gila Bend Basin bounds it on the south. The McMullen Valley Basin and the northern portion of the Hassayampa Basin bound it on the north. The Sub-Basin boundaries are dominated by mountain ranges. The Gila Bend and Buckeye Mountains are on the south, The White Tank Mountains are on the East. The Vulture Mountains form the northern boundary of the Sub-Basin. The Belmont Mountains and Palo Verde Hills traverse the Sub-Basin from the northwest to southeast.

Interstate Highway 10 (I-10) traverses the Sub-Basin from west to east, as does the Buckeye-Salome Road and a major natural gas pipeline. The Gila River, Hassayampa River, Centennial Wash, and Jackrabbit Wash are the primary drainages of the Sub-Basin. Dickey and Winters Washes are a few of the many small tributaries to Centennial Wash.

PVNGS and the three proposed power plants are located in the south central portion of the Hassayampa Sub-basin. The towns of Palo Verde, Hassayampa, and Arlington are also located in the south central area. The towns of Wintersburg and Tonopah are located in the north and west areas of the Sub-basin. The Hassayampa Landfill is located just to the northwest of the Town of Hassayampa. The town of Buckeye is outside of the Sub-Basin on the eastern edge of the map shown in Figure 1.

Study areas of the various investigators described in the previous subsection include the Hassayampa and Lower Hassayampa Areas of the USGS, the Centennial and Tonopah-Hassayampa Areas of the USGS, and the Hassayampa Plain of Halpenny and Halpenny (1988).

2.3 Geology

The geology of the region can be interpreted from surficial mapping and analysis of subsurface data such as drill cuttings within the framework of structural geology principles. The region has experienced dramatic geologic forces moving rocks thousands of feet relative to their starting positions. The time-sequence and typical processes involved in the geologic events is important for gaining an understanding the current distribution of geologic materials at the surface and in the subsurface. Reports by the Arizona Geological Survey (AGS), USGS, Fugro, Water Development Corporation (Leonard Halpenny), and hydroGEOPHYSICS are the basis for the discussion in this section.

The primary subsurface geologic descriptions of the area were presented by M.E. Cooley (Stulik, 1974) and Fugro (1978, 1980). Typical current nomenclature for alluvial sediments developed by the USGS and ADWR from earlier U.S. Bureau of Reclamation definitions for the adjacent East and West Salt River Valley Sub-Basins (see Corkhill and others [1993 – page 16] for a recent synthesis) are also considered relevant and are used for comparison although they are not discussed separately here.

AGS (Reynolds, 1988) developed a current map of surficial geology for Arizona that includes the region of interest here. The Hassayampa Sub-Basin is located in the Basin and Range tectonic province (Kamilli and Richards, 1998) where steep vertical breaks in the earth's crust produce elongated mountain ranges and intervening sediment-filled basins. Figure 2 is a map of surficial geology modified from Reynolds (1988) with updates found in Kamilli and Richard (1998). The White Tank Mountains are aligned north to south while the remaining mountain ranges and groups of isolated rock exposures are typically aligned N40°W. Precambrian rocks (look for ***YXg*** in Figure 2) - primarily granite-gneiss and minor metamorphosed sedimentary types - are exposed in the White Tank Mountains, Belmont Mountains, Buckeye Hills, and portions of the Gila Bend Mountains and Palo Verde Hills. Tertiary rocks (***Tsv***) – primarily igneous extrusive (volcanics: rhyolite to andesite to basalt flows and tuffs) and minor sedimentary rocks (gray arkosic, white tuffaceous and red-brown mixed sediment conglomerates) - dominate the Palo Verde Hills and portions of the White Tank Mountains, Belmont Mountains and Gila Bend Mountains. Quaternary igneous extrusive rocks (***QTb***) – two basalt cones – rise above and are interbedded with fluvial sediments along the Gila River near Hassayampa (the Arlington Basalt Flow) and at Gillespie Dam (the Gillespie Basalt Flow). Exposures of granite and gneiss are key points to note, as they are substantial barriers to groundwater flow in this area. Examples of granite or gneiss exposures are the White Tank Mountains, the southeast extension of the Belmont Mountains at the junction of the Hassayampa Plain and Lower Hassayampa Areas, the south boundary of the Centennial Wash area in the Gila Bend Mountains and the northwest end of the Palo Verde Hills.

M.E. Cooley of the USGS developed the geologic map and organization of geologic units for the Lower Hassayampa Area presented in Stulik (1974 – Page 7 and Plate 1).

Drillers' logs are presented as an appendix with interpreted divisions of the units encountered in each well. At the time of that writing (Stulik, 1974 – page 7), M.E. Cooley divided the geologic materials of the area into:

- Crystalline and consolidated sedimentary rocks
- Volcanic rocks
- Valley-fill deposits
- Stream and flood-plain alluvium

The crystalline and consolidated sedimentary rocks were reported by Stulik (1974) to be dominated by gneiss and granite. The volcanic rocks were reported to be dominated by rhyolitic to andesitic tuffs overlain by andesitic to basaltic flows. The valley-fill deposits were reported to be weakly cemented sand, silt and clay with minor gravel and basalt flows. Consideration of current USGS and ADWR nomenclature would likely result in assignment of Cooley's valley-fill deposits to the Red Unit, Lower Alluvial Unit and Middle Alluvial Unit (see Corkhill and others, 1993). The stream and flood-plain alluvium were reported to be primarily unconsolidated gravel, sand and silt. Consideration of current USGS and ADWR nomenclature would likely result in assignment of the Cooley's stream and flood-plain alluvium to the Upper Alluvial Unit (see Corkhill and others, 1993).

Fugro (1978, 1980) presented surficial geology maps, geophysical surveys and numerous geologic cross-sections for the area in and surrounding the PVNGS property. Figure 3 presents the central portions of the two regional geologic cross sections presented by Fugro (1978). They defined a framework for the geology that is more detailed than the general framework used by the USGS and ADWR for groundwater studies in adjacent alluvial basins: Basement Complex, Red Unit, Lower Alluvial Unit (LAU), Middle Alluvial Unit (MAU), and Upper Alluvial Unit (UAU). See Corkhill and others (1993) for a review of the current USGS and ADWR nomenclature. Fugro's (1980) definitions were based on observations and measurements for over 70 boreholes ranging from 200 to over 600 feet. The measurements included geotechnical parameters, particle size, natural gamma radiation and magnetic orientation reversals. Fugro (1978 – Figure 2.5-19) defined a geologic framework for the vicinity of the PVNGS, as follows in order of decreasing age:

- Basement Complex – Precambrian granitic and metamorphic rocks.

- Bedrock – Tertiary (Miocene) Volcanic-Sedimentary Sequence

- Lithologic Zone 1 – Tertiary (Miocene-Pliocene) Indurated Fanglomerate (Red Unit)

- Lithologic Zone 2 – Tertiary-Quaternary Lower Silt, Sand and Gravel Deposits (LAU)

- Lithologic Zone 3 – Tertiary-Quaternary (Upper Pliocene) Palo Verde Clay (MAU)
- Lithologic Zone 4 – Tertiary-Quaternary Upper Silt Deposits (MAU)
- Lithologic Zone 5 – Quaternary Upper Sand and Gravel Deposits (UAU)
- Lithologic Zone 6 – Quaternary Younger Fan Deposits (UAU)

Halpenny (1984 – page 4-2) notes that depth to bedrock (probably Basement Complex) increases beneath the Buckeye Area from exposures in the Buckeye Hills on the south side of the Gila River to the north and that there is a clay layer between 200-250 and 500-700 feet. This clay is likely the MAU. Water-bearing sands and gravels occur above and below this clay layer. These sands and gravels are likely the UAU and LAU, respectively. Halpenny (1984 – page 4-3) hypothesized a long shallow lake on an east-west axis through the Buckeye Valley and a more northward (2 miles) alignment of the Gila River in the past (page 4-1).

Long (1983) adopted the USGS convention of UAU, MAU, LAU and described their extents based on the Fugro (1978, 1980) work for PVNGS and drillers' logs. Of particular interest is Long's (1983 – Sheet 1) note that the Palo Verde Clay may be present south of PVNGS along Centennial Wash.

Montgomery (1986) applied the division of UAU, MAU and LAU to the Arlington Valley. Their cross-section A- A' interprets the UAU as approximately 100 feet thick, the MAU as approximately 250 feet thick and the LAU as greater than 550 feet thick along the Arlington Canal on the west edge of the Arlington Valley

Halpenny and Halpenny (1988) defined the geology of the Hassayampa Plain with a two-part division: Older Alluvium (***QTs*** – Quaternary-Tertiary Sand, Gravel and conglomerate) and Younger Alluvium (***Qs*** – Quaternary Silt, Sand and Gravel). They note (page 4-9) that in the Hassayampa Plain, both the Younger and Older Alluvium were deposited as "mountain-front outwash" (proximal alluvial fan depositional systems) and that there is not an incised channel in the Older Alluvium aligned with the Hassayampa River and filled with Younger Alluvium. Halpenny and Halpenny (1988) further conclude that this is an indication that the Hassayampa was never a through-flowing stream south of the Vulture Mountains front and that its flow has always sunk into the ground throughout the period during which the Older and Younger Alluvium were deposited. Halpenny and Halpenny (1988 – page 4-10) reported on a distinctive unit above bedrock, but below the Older Alluvium, which he terms "bedrock rubble". This material was characterized by Halpenny and Halpenny (1988 – page 4-10) as fractured mountain-front outwash - highly angular fragments of granite, gneiss, andesite, rhyolite and basalt with very little to no sand and little rounded gravel.

The base of the Older Alluvium is greater than 1,200 feet below land surface at six of the nine test holes reported by Halpenny and Halpenny (1988 – page 4-11), an observation which he reports confirms depth to bedrock model estimates of 1,600 to 3,200 feet bls made by the University of Arizona. Although the Older Alluvium is more consolidated than the Younger Alluvium, it nonetheless produces thousands of gpm of water to wells. The Older Alluvium is a friable gray to light buff conglomerate of rounded gravel and cobbles with some coarse sand and no silt or clay where it is exposed in washes that cross Palo Verde Road in Township 3 North. This is consistent with the geologists' logs of the test holes presented in Halpenny and Halpenny (1988 – Appendix 2). The Younger Alluvium is primarily sand and silt at the surface and in places this material turns into dust so deep that automobiles become stuck in it (Halpenny, 1988-page 4-12). Below 20 to 40 feet, the Younger Alluvium is indistinguishable from the Older Alluvium in drill cuttings (slightly silty/clayey sandy gravel rotary drilling returns). The Older Alluvium is likely LAU and the Younger Alluvium is likely UAU.

Errol L. Montgomery and Associates, Inc. (1994, 1998) defined the shallow geology of the Hassayampa Landfill near the north end of the Arlington Basalt Flow. The Arlington Basalt was encountered between 60 and 80 feet bls, which coincides with the highest water levels at the site. The Palo Verde Clay was encountered at a depth of approximately 260 feet below the site. Between the Arlington Basalt and the Palo Verde Clay, the UAU was divided into an upper Unit A (75-105 feet bls - dominated by clayey silt and silt clay layers) and a lower Unit B (105-260 feet bls – comprising interbedded silt-clay and sandy gravel layers).

The available gravity data for the Centennial Wash area were compiled and evaluated recently by hydroGEOPHYSICS (2000). Figure 4 is a specialized plot of gravity variations across the area called the Complete Bouguer Anomaly (CBA). In general, CBA plots can be used to locate areas where the top of the basement complex (granite-gneiss) is submerged to greater depths beneath less dense materials (sediments and volcanics) relative to other areas. The CBA plot can be thought of as an imprecise, but nevertheless useful, analogy for depth to basement rock. The work of hydroGEOPHYSICS (2000) has been modified with information from Fugro (1978 – Figure 2.5-54) for the Gillespie Dam area that indicates a southward extension of the Centennial Wash basin connecting with the Gila Bend Basin. In general, deep sediment-filled basins are present where the contours of equal gravity variation are more negative (less than –60 milligals) and are termed "lows". The Tonopah Basin Low is the deepest, followed by the West Buckeye Valley Low, the East Hassayampa River Low, and the Centennial Wash Low. The higher points of granite-gneiss occurrence (> -60 milligals) called "highs" are coincidental with the foundations of the White Tank Mountains, the Buckeye Hills, the Gila Bend Mountains, and the northwest end of the Palo Verde Hills. The names of the highs were developed by replacing the term "Mountain" or "Hills" with the term "High" for each mountain or hill exposure. An exception is the Jackrabbit Wash high which appears to be a buried ridge connecting the Belmont High with ridges extending from the Palo Verde High and from the White Tank High. Note that the individual exposed volcanic rock hills (***Tsv***) have little apparent representation in gravity variations. The CBA for this area correlates well with the outcrops of granite-gneiss

(*YXg*) mapped by the AGS (see Figure 2) and reasonable structural arrangements in the subsurface brought about by the mid-Tertiary Orogeny and the Basin and Range Disturbance normal faulting episode.

In summary, the Hassayampa Sub-basin geology is typical of the Basin and Range tectonic province. The Sub-Basin actually contains several geologic structural basins or lows. In the southern part of the Sub-Basin (south of the Buckeye-Salome Road), these basins are relatively shallow compared to the adjacent West Salt River Valley. The shallower nature of these basins within the southern part of the Sub-Basin carries the implication that older rock units, particularly volcanic and conglomerate sequences play an important role in the flow of groundwater to wells. In contrast, groundwater flow to wells in much of the West Salt River Valley occurs in relatively young, unconsolidated sediments that have not been strongly faulted or tilted.

2.4 Climate

Investigators of groundwater resources in the region have briefly discussed climate. A few excerpts are summarized in this subsection.

Stulik (1974 - page 6) characterized the climate of the Lower Hassayampa Area as semiarid based on climatic data from Buckeye for the period 1905 to 1962. Annual precipitation ranged from less than 2 inches to more than 21 inches with an average of 7.5 inches per year.

Halpenny and Greene (1975 – page 2-1) reported average annual rainfall at Buckeye was 7.92 inches/year as of 1964, and divided the year into a dry season (October), a season of winter storms (December to February), a season of spring snow melt (March to April) and a summer rainy season (July to September).

Halpenny and Halpenny (1988 – page 4-1) characterized the climate of the Hassayampa Plain by reporting the range of precipitation reported for Aguila (just northwest of the Hassayampa Plain), 8.8 inch/yr, and for Buckeye (just southeast of the Hassayampa Plain), 7.4 in/yr. Average daily minimum and maximum temperatures are 3 to 4 degrees cooler at Aguila compared to Buckeye.

In summary, the climate of the area is semi-arid with annual precipitation averaging approximately 8 inches per year depending on location with an increase with elevation (to the north and northwest). Precipitation falls primarily as low-intensity, widespread frontal storm fronts in the winter (January to March) and more high intensity, sporadic thunderstorms in the late summer and early fall (July to September).

2.5 Surface Hydrology

This subsection is very general and is divided into discussions of topography, soils, surface flow characteristics, vegetation and land use. The intent of this subsection is to give the reader a brief overview of surficial features. Detailed analyses of surface flows and flooding are not presented here but can be obtained from the Maricopa County Flood Control District.

2.5.1 Topography

Stulik (1974 – page 6) described the Lower Hassayampa area as a gently sloping alluvial plain (elevations 800 to 1400 feet above mean sea level [amsl] surrounded by low, steep-sided mountains (elevations 1,000 to 3,000 feet amsl).

2.5.2 Soils

The Soil Conservation Service (SCS) of the U.S. Department of Agriculture, now the Natural Resource Conservation Service (NRCS), mapped the soils of Maricopa County (SCS, 1977). They defined three primary soils associations: "Soils Formed on Recent Alluvium", "Soils Formed on Old Alluvium", and "Soils of Mountains and Buttes". The SCS Soils Formed on Recent Alluvium correlate to the exposed Upper Sand and Gravel Unit (Lithologic Zone 5 or UAU). The SCS Soils Formed on Recent Alluvium were mapped by the SCS along the Gila River, Hassayampa River, Centennial Wash and the many minor tributaries to these streams. The soils are mapped as sandy loams and gravelly-sandy loams (Carrizo-Brios association) in the streambeds and along the eastern half of the Arlington Valley. Surrounding these associations are loams (Gilman-Estrella-Avondale association) interpreted as floodplains for these surface water features. The SCS Soils Formed on Old Alluvium correlate to the exposed Upper Silt Deposits (Lithologic Zone 4 or MAU) and Lower Silt, Sand and Gravel Deposits (lithologic Zone 2 or LAU). Fugro (1978) inferred a dominance of LAU in the western Centennial Wash area and MAU in the eastern Centennial Wash area. The Soils Formed on Older Alluvium dominate the area and are mapped as loams and gravelly loams (Rillito-Gunsight-Perryville association).

Halpenny (1984 – page 4-3) noted a strong contrast between coarse soils north of the RID canal (spreading detritus from the White Tank Mountains) and silty-clayey soils south of the RID canal.

In general, the soils of the region are dominated by surficial exposures of the Upper Silt Deposits and the Lower Silt, sand and Gravel Deposits with local exposures of the Upper Sand and Gravel Deposits. The Lower Silt, Sand and Gravel Deposits are much

older than the Upper Silt Deposits, which in turn are older than the Upper Sand and Gravel Deposits. Age and development of cement (caliche) horizons in the near surface are closely related.

2.5.3 Surface Flow Characteristics

The characterization of surface flows is relevant here only in terms of the potential for recharge from sustained river flows and short-term flood events as well as the capacity for the channels to collect groundwater under high water table conditions. Relatively steady releases of treated municipal wastewater treatment plant effluent created artificial flow conditions in the Gila River beginning in approximately 1962.

Stulik (1974 – page 6) reported that the Hassayampa River and Centennial Wash were primarily ephemeral (flow only during sustained precipitation events) while the Gila River flowed during part of the year from excess irrigation water (return flows).

Water Resources Associates (1975 – page 6) estimated that the Hassayampa River has a drainage area of 417 square miles and contributed 400 acre feet of flood flows to the Gila River in 1974; Centennial Wash has a drainage area of 1,810 square miles and contributed 800 acre feet of flood flows to the Gila River in 1974; average discharge of the Gila River at Gillespie Dam (Water Resources Associates, 1975 – Table 1) was estimated at 28,340 ac.-ft./yr.

Halpenny and Greene (1975 – Table 2) combined records for the flow below Gillespie Dam, with flows in the Gila Bend and Enterprise Canals to characterize the flows reaching Gillespie Dam for the years 1936 to 1974. The years of 1941, 1965-66 and 1973 included major flood events on the Salt and Verde River system which joined the Gila River just to the east of the Sub-Basin.

Halpenny and Greene (1975 – Table 6) combined the records for the Gila and Santa Cruz Rivers near Laveen to estimate the discharge of the Gila River near the confluence with the Salt Rive for the years 1941 to 1974. 1941, 1955, and 1965-66 were years with large flood flows.

Long (1983 – Sheet 1) noted Jackrabbit Wash as an additional, important ephemeral stream in the area. It drains the Hassayampa Plain and joins the Hassayampa River east of the Belmont Mountains.

Montgomery (1988) compiled and plotted surface water records for the area. They state that the combined flow of the Gila and Santa Cruz Rivers at the Laveen gaging stations represents the surface water inflow to their study area at 23rd Avenue because few losses were believed to occur in the intervening distance. The flows of the Hassayampa at the Box Dam site were summarized for 1947 to 1981 – average was 17,610 ac.-ft./yr. and maximum was 123,400 ac.-ft. in 1980. The Arlington gage for the

Hassayampa is located 1.8 miles upstream from the confluence with the Gila and recorded only maximum flows and for broken periods of time. The Centennial Wash gage was moved in September of 1979 from 4.4 miles west of Arlington to 9.0 miles upstream of Arlington (at the Southern Pacific Railroad bridge). Average annual flow 2,770 ac-.ft./yr. (1961 to 1978 and 1981 to 1983), maximum was 9,230 ac.-ft. in 1978. The plot of the combined flows of the Gila River at Gillespie Dam and the Enterprise and Gila Bend Canals is especially instructive (page 36). The average for 1936 to 1986 was 294,900 ac.-ft./yr., but a steady drop from 1936 to 1962 (attributed to increased reservoir storage upstream) is apparent in the plotted data followed by the steady rise from 1962 to 1986 (attributed to increasing volumes of the effluent releases). Floods in 1941, 1966, 1973, 1978, 1979, 1980, 1983, 1984, and 1985 punctuated the general trends discussed in the previous sentence.

Montgomery (1988 – page 34) compiled, plotted and discussed effluent releases by the City of Phoenix for the 23rd Avenue WWTP and the 91st Avenue WWTP. Effluent releases from 23rd Avenue ranged between 15,000 and 40,000 ac.-ft./yr between 1955 and 1985. Releases were 30,800 ac.ft. in 1986; higher releases were in the mid-1970s and early 1980s. Effluent releases from 91st Avenue increased steadily from zero in 1957 5,000 ac.-ft./yr. in 1955 to148,600 ac.-ft./yr. in 1986. They also reported that the City of Tolleson released 8,200 ac.-ft./yr of effluent in 1986 (page 34). The cities of Goodyear, Avondale and Tolleson were not releasing significant quantities of effluent by 1986 (page 35).

Halpenny and Halpenny (1988 – page 4-1) characterize the Hassayampa River as running over exposed mountain rock until it reaches the "narrows" seven miles downstream from Wickenburg. At the narrows (near the Morristown gage), the River crosses a steep fault at the southern foot of the Vulture Mountains and "virtually all the runoff ... sinks into the bed of the river". Halpenny and Halpenny (1988 – page 4-6) summarized studies of the Hassayampa River from the first half of the 20th century. Flow of the Hassayampa rarely reaches the Gila River near Arlington. Annual discharge of the Hassayampa River at Box Canyon averaged approximately 50,000 ac.ft./yr. for the 27-year period 1916 to 1942 (Halpenny and Halpenny, 1988 – page 4-5) Annual discharges for the 44-year period 1939 to 1982 at the Vulture Mountain fault (assembled by Halpenny and Halpenny from gaging data for Morristown and Box Canyon) ranged from approximately 600 (in 1940) to 123,000 (in 1980) ac.-ft./yr. and averaged approximately 17,000 ac.-ft./yr. Halpenny and Halpenny (1988, page 4-7) note that the drainage area of the Hassayampa Plain can be calculated a the difference between the drainage areas of the Hassayampa River at the gage near Arlington (1470 mi^2) and of the Hassayampa River near Morristown (774 mi^2) or 66 mi^2.

In summary, the Gila River is the largest surface water feature in the Sub-Basin. The flow of the Gila River in the Sub-Basin has been perennial in recorded history, but declined from 1936 to 1962 due to increasing upstream diversion, groundwater pumping and resulting losses from the river. From 1962 to the present, flows steadily increased due to increasing effluent releases. Large flood events have occurred on the Gila River since 1962 that have largely not recharged the aquifer due to high water table conditions.

In contrast, the flows on the Hassayampa River are rare and are essentially lost from the channel before they reach the Gila River. Likewise, flows on Centennial Wash, Jackrabbit Wash, and their tributaries are rare and sink into the ground before reaching the Gila River. Therefore, flood events on the Hassayampa River and the various washes are almost entirely converted to groundwater recharge.

2.5.4 Vegetation

The vegetation of the area outside of the Salt-Gila River corridor or irrigated farmland can be characterized as Lower Colorado River Sonoran Desertscrub. Typical species are palo verde, catclaw acacia, mesquite, desert broom, creosote, ocotillo and brittle bush with sparse to moderately abundant saguaro and cholla cactus (Kamilli and Richard, 1998). The river corridor was originally populated with typical riverine species, but tamarisk (salt cedar) invaded in the early 1900s.

Water Resources Associates (1975 – page 12) reported that a solid stand of phreatophytes (tamarisk) was present in the 1930s from Tempe to Gillespie Dam. Dropping water tables started to kill the tamarisk and reduce the phreatophyte stands starting in the 1940s. By 1958, the stand reached only from Jackrabbit Trail to Gillespie Dam. Effluent flows (starting in 1962) and the flood of 1973 immediately increased water levels near the river and increased phreatophyte water use. Phreatophyte water use for 1974 for the area below Powers Butte was estimated (Water Resources Associates, 1975 – Table 4), based on plant type and acreage for specific areas listed in Table 1. The estimates given in Table 1 indicate the assumption of a consumptive use of 3.7 ac.-ft./ac.-yr.

Table 1 Phreatophyte Water Use Estimates for 1974

Cadastral Location	Phreatophyte Area (acres)	Water Use (ac.-ft./yr.)
C-01-04 19 & 30	927	3508
C-01-05 24, 25 & 36	673	3019
C-01-05 26 & 35	361	1846
C-01-05 27 & 28	460	1600
C-01-05 33 & 34	548	1944
C-02-05 3 & 4	535	1973
C-02-05 9 & 10	497	1413
C-02-05 16	622	1871
C-02-05 21 & 28	289	995
Totals	**4,912**	**18,169**

Halpenny and Greene (1975 – page 6-1) report that tamarisk first appeared in 1929 at Gillespie Dam and spread upstream to Tempe by the late 1940's. Heavy pumping cleared phreatophytes upstream up to approximately 1965. In early 1960s, the phreatophytes were dense from Buckeye Canal heading downstream to Gillespie Dam. They report that the water table was effectively at land surface from the Highway 80

Bridge to Gillespie Dam in the 1960s and this allowed re-establishment of the phreatophytes as tamarisk cannot effectively use groundwater at depths greater than 15 feet bls.

Montgomery (1986) reports that the MCFCD cleared a 1000-foot channel of the Gila River from 91st Avenue to Gillespie Dam of phreatophytes in the early 1980s. The stand of tamarisk continues in places on other side of this 1000-foot channel.

In summary, desert vegetation is sparse and its water use can be neglected. However, phreatophytes along the Gila River, primarily tamarisk, use significant quantities of groundwater. The amount of water used by phreatophytes in the Sub-Basin in 1974 was estimated to be approximately 18,000 ac.-ft./yr., based on a consumptive use rate of 3.7 ac.-ft./ac.-yr. Reports indicate that phreatophytes died back significantly between the 1940s and the late 1960s with declining water tables. Effluent releases starting in 1962 and flood events starting in 1965 brought the water table back up and allowed re-establishment of the phreatophyte stands.

2.5.5 Land Use

Land uses in the region comprise primarily either undeveloped desert or farmland. Farmland in the region has been irrigated by flood irrigation methods since the early 1900s with groundwater and surface water including Gila River water, effluent and irrigation return flows from Buckeye Water Conservation and Drainage District (BWCDD). Because water use is dominated by agricultural use, the character of cropping and farm water applications is the focus of this subsection. Information was only fund on the organized irrigation districts of Buckeye (BWCDD) and Arlington Canal Company (ACC) in published reports. Cropping patterns on the farms of the Palo Verde Hills and along Centennial Wash are assumed to be similar.

Water Resources Associates (1975 – Table 3) estimated that BWCDD cropping in 1974 was dominated by alfalfa (46%), followed by barley (18%), cotton (13%), sorghum (10%) and sugar beets (5%). Subtracting 67,070 ac.-ft./yr. of consumptive use (3.65 ac.-ft./yr. as a weighted average of crop types and acreages) from 134,943 ac.-ft./yr of applied water (53,602 ac.-ft./yr was pumped groundwater in BWCDD) lead Water Resources Associates (1975 – Table 2) to estimate 67,873 ac.-ft./yr of excess irrigation by BIC in 1974. BIC pumped and discharged 15,500 ac.ft of groundwater for drainage in 1974 (Water Resources Associates, 1975 - page 9). The remainder, or 49,400 ac.-ft./yr. would have become recharge to groundwater beneath the BWCDD lands.

Water Resources Associates, Inc (1975 - page 22) estimated the consumptive use for ACC lands in 1974 at 12,800 ac.-ft./yr., based on 3.2 ac.-ft./ac.-yr. on 4,000 acres. The lower consumptive use factor was selected by Water Resources Associates (1975) for ACC because of a lower percentage of alfalfa than BWCDD, whose total consumptive use was estimated at 3.65 ac.-ft./ac.-yr. in 1974.

Halpenny and Greene (1975 – page 5-5) state that ACC never irrigated more than 4,000 acres with diversions of surface water and that the quantity was less than 4,000 acres in 1974. Much of the diverted water is tail water and drainage water from BWCDD. Halpenny and Greene's (1975 – page 5-12) estimates for diversions by ACC "in early days" were 24,000 ac.-ft./yr based on 6 ac.-ft./ac.-yr. on 4,000 acres although no records are available. More recent estimates (Halpenny and Greene, 1975 - page 5-14) of diversions are 1,500 ac.-ft./yr. in recent years.

Long (1983 – sheet 1) reported that surface water deliveries to ACC were less than 5,400 ac.-ft./year although delivery records do not exist.

Montgomery (1986) reported that ACC pumped 2,402 ac.-ft./yr. from 10 wells in 1984. Most of ACC water supply was from surface water diversions from the Gila River, which comprise primarily effluent from the City of Phoenix and drainage water from BWCDD.

Montgomery (1988) developed water balance models for areas, one of which was the ACC area. The 1985 (base case) water balance models for the ACC area (Montgomery, 1988 - page 69) compiled the following estimates: 9,088 total acres; 3,501 irrigated acres; 4,000 phreatophyte acres; 485 river surface acres; no acres with groundwater less than 5 feet bls; and 14,495 ac.-ft./yr. applied irrigation. Groundwater flow into the ACC area at Hassayampa was estimated at 15,900 ac.-ft./yr (Appendix B, page B-2), groundwater flow out of the ACC area to the west was estimated at 18,000 ac.-ft./yr and groundwater flow out of the ACC area to the south was estimated at 1,000 ac.-ft./yr. Seepage tests (Montgomery, 1988 - page 88) indicate 11,880 ac.-ft./yr of ACC canal losses to groundwater in 1985. Excess deep percolation in test plots ranged from 0 to 17 percent of applied water and averaged 8 percent (Montgomery, 1988 - page 89), total deep percolation recharge for 1985 was estimated at 3,600 ac.-ft./yr (Montgomery, 1988 - Appendix B, page B-2). The Gila River carried more than 1,000,000 ac.-ft./yr. of flood flows in 1985, but was estimated to receive 10,000 ac.-ft./yr of groundwater in the ACC area in 1985. Phreatophyte water use for 1985 was estimated at 24,000 ac.-ft./yr. in the ACC area, drains collected or lost less than 500 ac.-ft./yr.

In summary, there are a substantial number of reports of agricultural cropping and water use for the BWCCD and ACC, although detailed records were never kept by either irrigation district. Some of the reports are contradictory.

However, it seems reasonable to say that there have typically been approximately 4,000 acres of land irrigated in the ACC area with a consumptive use of approximately 13,000 ac.-ft./yr. Cropping has been dominated by alfalfa, barley, cotton, sorghum, and sugar beets. Assuming an efficiency of 65%, the total applied water for the ACC area is approximately 20,000 ac.-ft./yr. ACC pumps approximately 2,000 ac.-ft./yr from 10 wells. This leaves a residual of approximately 18,000 ac.-ft./yr. that is supplied from surface water diversions. With approximately 12,000 ac.-ft./yr. of canal seepage losses, total surface water deliveries to the ACC prior to transport in the canal would be 30,000 ac.-ft./yr. Total recharge to groundwater beneath ACC lands can be estimated as the sum

of the difference between applied water and consumptive use (7,000 ac.-ft./yr.) and canal seepage losses (12,000 ac.-ft./yr.). The total estimate is 19,000 ac.-ft./yr. for recharge to groundwater beneath ACC lands. The operations of the ACC since the 1930s are assumed to have remained relatively constant, but the variation in cropping types over time has not been investigated. It appears that cropped acres dropped from approximately 4,000 acres to approximately 3,500 acres between the 1970s and 1980s. The reason for this decrease is not known.

Conditions for the irrigated lands along Centennial Wash and between the Palo Verde Hills are not available, but it is reasonable to assume that cropping types were similar to those of ACC and BWCDD lands. Water application rates and seepage losses in canal transport would be less for farms outside of the ACC because the water supply delivery points (wells) are numerous and scattered throughout the irrigated areas.

2.5.6 Summary

In summary, the region is dominated by open, undeveloped desert with sparse vegetation. The soils are typically loams, except in stream channels, and are therefore generally suitable for farming. Through recorded history, the Gila River in the Sub-Basin has been perennial with declining natural flows being replaced by increasing releases of municipal wastewater treatment effluent since the early 1960s. The tributary rivers and washes to the Gila River are typically dry, but during rare flood events, the water quickly sinks into the channels and recharges the groundwater. Agricultural areas have been planted since the early 1900s in cotton, alfalfa, barley, sorghum and sugar beets and irrigated with groundwater and surface water. Recharge from excess irrigation at a rate of one to two ac.-ft./ac.-yr. (and canal seepages losses in the ACC) contribute significant recharge to groundwater.

2.6 Subsurface Hydrology

This subsection is divided into discussion of available water-level elevation contour maps, discussion of available hydrographs, and interpretations presented by the primary investigators of the region. This subsection is fundamental to selecting a local model study area, since it reviews information from actual measurements of the groundwater system in the region.

2.6.1 Available Water-Level Elevation Contour Maps

The available water-level elevation contour maps for the Sub-Basin typically assume that there is one, regional principal aquifer. As discussed previously, several geologic

units, each comprising an aquifer, may be viewed as a single aquifer system. The exceptions are maps of a limited occurrence of groundwater at elevations tens of feet above the principal aquifer system between the Palo Verde Hills (the "perched zone"). The USGS, ADWR, and Water Development Corporation prepared the maps discussed in this subsection.

The water-level elevation contour map presented by Stulik (1974 – Plate 2) for 1970 indicates southbound groundwater flow from the Hassayampa Plain was splitting, with part turning west and moving to an area of depressed water-level elevations near Tonopah, part turning southeast and moving through and beneath the Palo Verde Hills, and part continuing due south to the Gila River near Buckeye (Figure 5). The portion passing through and beneath the Palo Verde Hills moved towards two areas of depressed water-level elevations: 1) the area between the Palo Verde Hills with a center three miles south of Wintersburg and 2) the area along both the north and south sides of Centennial Wash.

The water-level elevation contour map presented by Stulik and Laney (1974 – Sheet 2) for 1975 indicates the same flow pattern as in 1970 (see previous paragraph) with one difference. The area of depressed water levels in the vicinity of Centennial Wash appeared to be limited to north of Centennial Wash rather than extending south of it as in 1970 (Figure 6). However, because elevation data are not plotted on either the 1970 or 1975 maps, the basis for the differences could not be determined without recreating the maps from the original data. Inspection of both the elevation maps and the water-level change map presented in Stulik and Laney (1976 – Sheet 1) indicates that the water levels just north of, and along the Buckeye-Salome Road (at approximately the 850 feet amsl equipotential contour) remained relatively constant (± 2 feet) between 1970 and 1975 while significant changes were observed to the southeast (10 feet decline) and northwest (20 to 30 feet decline).

The water-level elevation contour map presented by Long (1983 – Sheet 1) for 1982 indicates the same flow pattern as 1975 (see previous paragraph) with one exception. The area of depressed water- level elevations in the vicinity of Centennial Wash had then expanded to a much larger, almost circular area (Figure 7). However, because elevation data are not plotted on either the 1970 or 1975 maps, the basis for the differences could not be determined without recreating the maps from the original data. Inspection of both the elevation maps and the water-level change map presented in Long (1983 – Sheet 2) indicates that the water levels just north of and along the Buckeye-Salome Road (approximately the 850 feet amsl equipotential contour) remained relatively constant (-8 to +3 feet) between 1975 and 1982 while significant changes were observed to the southeast (20 to 45 feet decline) and northwest (50 to 75 feet decline).

Errol L. Montgomery & Associates, Inc. (1988) presented a depth to water map for the corridor along the Salt and Gila Rivers from 23rd Avenue to Gillespie Dam for 1986-1987. Numerous piezometers less than 30 feet deep were installed along the Gila River for this study and water-level measurements from the piezometers were used to construct this map. Depth to water was less than 10 feet near and along the Gila River channel

from east of the confluence with the Hassayampa River to Gillespie Dam. Depths to water in wells decreased to 44 – 62 feet bls in wells along the Arlington Canal. The distance between the two lines of measurements (less than 10 feet and 44 to 62 feet) is approximately 1 mile. Given that the land surface rises 10 to 15 feet between the two lines of measurements, the hydraulic gradient would be 40 to 50 feet per mile or 0.008 to 0.009 between the Gila River and areas of depressed water-level elevations along Centennial Wash.

The water-level elevation contour map presented by Halpenny and Halpenny (1988 – plate 3) covers the area of the Hassayampa Plain and the area east of the Hassayampa River from the east end of the Belmont Mountains to I-10 (Figure 8). Given that there is little to no pumping in the Hassayampa Plain, the sharp bends in the equipotential contours extending northwest along Jackrabbit Wash and North along Hassayampa River may indicate elongated arrangements of distinctively coarse-grained sediments with accompanying larger hydraulic conductivity. The apparent cone of depression near I-10 may be due to pumping along the west end of the RID canal.

The water-level elevation contour map presented by Hammett and Herther (1995 – Sheet 1) for 1992 indicates the same flow pattern as 1983 (see discussion of Long, 1983 above) and 1987 (see discussion of Halpenny and Halpenny, 1988 above) with the exception that the equipotential contours in the Hassayampa Plain are much straighter (less curved) than those presented for 1987 by Halpenny and Halpenny (1988) (Figure 9). The reason for this is not known. Inspection of both the elevation maps and the water-level change map (1982 to 1992) presented in Hammett and Herther (1995 – Sheet 2) indicates that the water levels just north of and along the Buckeye-Salome Road (approximately the 850 feet amsl equipotential contour) remained relatively constant (-2 to +8 feet) between 1982 and 1992 while significant changes were observed to the southeast (1 to 22 feet of increase) and northwest (25 feet of decline to 57 feet of increase).

The water-level elevation contour maps for the immediate vicinity of the Hassayampa Landfill presented by Errol L. Montgomery & Associates, Inc. (1994) indicate flow is due south in both Units A and B of the UAU with horizontal gradients of 0.004 in Unit A and 0.006 in Unit B in October 1993.

The available water-level elevation contour maps typically assume that there is one, regional, principal. In general, the maps resulting from the assumption of a single principal aquifer system appear reasonable in that groundwater flow paths appear to proceed smoothly from recharge to discharge areas. Despite the fact that different study areas and different time periods were considered, a consistent flow pattern is indicated by all of the available water level maps. Of particular interest to this study is the permanence of the 850 feet amsl equipotential contour (along the Buckeye-Salome Road) on the various maps while water level elevations dropped in the central Centennial Wash and Tonopah Desert areas.

2.6.2 Available Hydrograph Data

Building upon the observations from the available water-level elevation contour maps, review of available hydrographs assists in identifying areas where groundwater has distinctive responses over time. Areas with consistent decline and/or buildup patterns are considered to have common geologic and hydrologic constraints and are candidates for separate analysis, while giving consideration to their interactions through their boundaries. In this subsection, the hydrographs presented in various reports are discussed first, followed by review of hydrographs recently created from available historical water-level data.

Hydrographs for the period 1951 to 1973 presented and discussed in Stulik (1974 – pages 9 and 10, Figure 3) indicate periods of continuous declines of two to three feet per year in the Centennial Wash area (see [C-01-07] 15 bbb), and five feet per year in the western part of the Tonopah area (see [B-02-06] 06cbb, [B-02-07] 27aab, and [B-02-07] 29aaa). During these times of continuous declines in the Centennial Wash and Tonopah areas, the water levels in areas to the east and north remained relatively unchanged (see [B-01-05] 8dab, [B-01-06] 03bbc, and [B-02-05] 29dac). Stulik (1974 – page 9) related the magnitude of water-level declines to the magnitude of nearby pumping.

Hydrographs presented in Fugro (1980) indicate that cessation of the irrigation pumping for PVNGS construction in the late 1970s lead to rises in water levels in the principal aquifer and declines in the perched zone.

Water-level elevation hydrographs for wells along the Gila River between Hassayampa and Gillespie Dam presented by Montgomery (1986) indicate rises starting in 1962 and continuing to the time of report preparation (1985). This is coincidental with the rapid increase in effluent releases from the 91st Avenue WWTP. Hydrographs for wells six to eight miles to the northwest of Hassayampa showed slight declines (10 to 15 feet) between the mid 1950s and 1985. Collectively, these data indicate that the increasing quantities of effluent in the Gila River were the source of the water-level elevation rises and the waterlogging.

Figure 10 shows the locations of wells grouped for hydrographs in succeeding figures. The groups by area for hydrographs presented in Figures 11 through 18 are:

- Western Centennial Wash
- Eastern Centennial Wash
- Palo Verde Hills
- Shallow Wells in Palo Verde Hills
- Southern Tonopah Desert
- Arlington Valley
- Hassayampa
- I-10 – Buckeye-Salome Road Corridor

The first five groups are for areas with major pumping centers for agricultural production since the late 1940s. The last three areas surround these areas and indicate the extent to which pumping responses spread outward from the pumping centers in the past.

Each of the hydrographs has the same time axis (January 1, 1940 to December 31, 2000). The limits of the elevation axis scales may differ, but they all have the same vertical scale (20 feet per inch) to allow easy comparison between them.

Figure 11 presents the group of hydrographs for wells selected from the western Centennial Wash area. Steady declines of 100 to 110 feet were measured in wells in this area between approximately 1948 and 1981-1982 (3.2 feet per year), followed by rises of 30 to 50 feet between 1982 and 2000. A slight reduction in the rate of rise may be noted since 1995. Two wells shown on Figure 11 ([C-01-06] 19cbb [168 feet] and [C-01-06] 20aba [280 feet]) are much shallower than the other wells. They experienced approximately 30 feet less drawdown between 1948 and 1982 than the other wells.

Figure 12 presents the group of hydrographs for wells selected from the eastern Centennial Wash area. Steady declines of 30 to 50 feet were measured in wells in this area between approximately 1954 (earliest record) and 1969 (2.7 feet per year), followed by declines of an additional 10 feet between 1969 and 1981-1982 (a reduced rate of 0.8 feet per year). The eastern Centennial Wash area experienced rises of 25 to 35 feet between 1982 and 2000. A slight reduction in the rate of rise is apparent in the data after 1995.

Figure 13 presents the group of hydrographs for three production wells and one deep (490 feet total depth) monitoring well selected from the Palo Verde Hills area. A sporadic, but persistent decline of 105 feet was measured in (B-01-06) 27cbc between approximately 1954 (earliest record) and 1962 (13.1 feet per year), followed by stabilization or partial recovery between 1962 and 1968. Water levels in another well declined 40 feet from1956 to1962 (6.7 feet per year). In 1968, declines of an additional 35 to 50 feet between1968 and 1975 were measured in wells in the area (a reduced rate of 6.0 feet per year). The Palo Verde Hills area experienced rises of 15 to 65 feet between 1975 and 1984. Water level declines resumed from 1984 to 1987-1988 when recovery of 5 to 15 feet was measured. Monitoring well PV-7 showed a different pattern, declining 20 feet between 1973 and 1992 without the fluctuations noted in the production wells.

Figure 14 presents the group of hydrographs of two shallow (20 to 50 feet bls) monitoring wells selected from the Palo Verde Hills area. Measurements of water levels in thee wells commenced with the cessation of irrigation September 1975 on the farmland acquired for the PVNGS. A smooth, decreasing rate of decline is apparent in the hydrographs for these three wells. The water levels in one well (PV-31H) began a seasonal cyclic fluctuation in late 1977 that has been attributed to periodic recharge in a large detention basin constructed at the PVNGS facility.

Figure 15 presents the group of hydrographs for wells selected from the southern Tonopah Desert area. Steady declines of 110 to 125 feet were measured in wells in this

area between approximately 1956 (earliest record) and 1985-1986 (4.1 feet per year), followed by rises of 10 to 20 feet between 1985 and 2000. Two of the wells ([B-01-06] 07 bda1 [340 feet] and [B-02-07] 23bca1 [390 feet]) are relatively shallow, yet water levels declined at a rate similar to that of wells more than twice as deep. One well ([B-01-06] 07abd1 [85 feet]) is much shallower than the other wells. Water levels in this well declined much less (30 feet as opposed to over 100 feet in the other wells) and the water level declines did not begin in this well until after 1970 (as opposed to declines starting before 1956 in the other wells).

Figure 16 presents the group of hydrographs for wells selected from the Arlington Valley area. Steady declines of 20 to 40 feet were measured in wells in this area between approximately 1949 and 1964 (2.0 feet per year), followed by rises of 20 to 30 feet between 1964 and 1968. Water levels dropped as much as 50 feet between 1968 adn1970 before rising abruptly again by 30 to 60 feet between 1970 and 1973. With the exception of another sudden downturn in water levels in 1975-1976, water levels rose to high points that have typically been sustained since 1979. One well in this group ([C-01-05] 17abb1 [110 feet]) is shallower than the other wells, and located farther north. The water level in this well is typically 50 feet higher then the others and its fluctuations are similar to the other wells, but with less magnitude (± 5 feet from 1955 to1998) in fluctuation.

Figure 17 presents the group of hydrographs for wells selected from the Hassayampa area. Steady declines of 15 to 30 feet were measured in wells in this area between approximately 1949 and 1964 (1.5 feet per year), followed by rises of 15 to 20 feet between 1964 and 1975. Water levels in wells in this area have remained relatively steady between 1975 and 2000. Although the wells in this group vary significantly in depth, the responses in terms of water levels have been similar over the period studied here. However, water levels from two wells (Hassayampa Landfill monitoring wells MW-1UA, B) drilled specifically to monitor different depth intervals show that a vertical head difference of 30 feet exists between shallow silt clays and deeper interbedded sands, gravels and silty/sandy clays. The sudden decline in water levels in MW-1UA in March of 1993 is due to commencement of the pumping of 7 gpm from four extraction wells for the remedial action. The water levels in MW-1UB fluctuate up in the winter and down in the summer (± 4 feet), a pattern that is not seen in MW-1UA.

Figure 18 presents the group of hydrographs selected for wells in the area south of Interstate 10 and north of the Buckeye-Salome Road and between the south Tonopah Desert and Hassayampa areas discussed in previous paragraphs. These wells are typically 150 to 400 feet deep. Two are located farther south (closer to the Buckeye Salome Road) and have relatively lower water level elevations. The striking feature of all of the hydrographs in Figure 18 is that the water levels remained relatively steady (fluctuations are ± 5 to10 feet from 1945 to 2000) while large declines (greater than 100 feet) and rises (greater than 50 feet) were occurring in the Centennial Wash, Palo Verde Hills and Tonopah Desert areas. The differences are noteworthy given that the Centennial Wash, Palo Verde Hills and Tonopah Desert areas are only six, three and six miles, respectively, from the center of this well group.

In summary, water-level elevation measurements for wells in the different areas grouped in the hydrographs indicate that pumping in the Centennial Wash, Palo Verde Hills and Tonopah Desert areas resulted in localized drawdowns that did not expand to the Arlington Valley or Hassayampa area or to the corridor between I-10 and the Buckeye-Salome Road, despite their proximity. Within the pumping centers, water level data from some relatively shallow wells indicate much higher water-level elevations and distinct water-level patterns compared to water-level elevations in the deep production wells.

2.6.3 Selected Interpretations

In this subsection, the authors of previous investigations interpret the meaning of the water-level elevation contour maps and hydrographs in their respective reports. These interpretations are presented in order of publication and are summarized at the conclusion of this subsection.

Stulik (1974 – pages 8) interpreted the measured water levels in the area to represent a single water-table aquifer and considered the valley-fill deposits to be the principle aquifer in the area (Stulik, 1974 – page 7). Exceptions noted by Stulik (1974 – pages 8-9) included water levels in shallow wells near Winters Wash. Wells in (B-01-06) 07 appear to be an example of the shallow wells noted by Stulik (1974).

Water Resources Associates (1975) report that water could leave the Gila River channel and recharge groundwater in 1974 from 23rd to 115th avenue (2.5 miles below 91st avenue) and from El Mirage Road to the Buckeye heading (an additional distance of approximately 2.5 miles).

Water Resources Associates (1975 – page 16) report that Gillespie Dam had the effect of raising the water table in the Arlington area. Halpenny and Greene (1975 – page 5-5) report that Gillespie Dam was completed in 1921 and had filled with sediment to the crest by 1924.

Halpenny and Greene (1975 – page 5-14) report that water levels in the Liberty-Buckeye-Hassayampa area declined 37 feet from the 1945 to 1965 and then rose one to 37 feet during the period 1965 to 1973 when flood events locally filled groundwater reservoir.

Halpenny and Greene (1975 – Table 11) report that BWCDD had to start drainage pumping in 1969 at approximately 3,000 ac.-ft./yr. and increased that drainage pumping to approximately 10,000 ac.-ft./yr. in 1970. They further reported that water levels were at land surface in the largest area (well east of Salt-Gila confluence) during 1910-1920. Pumping by Roosevelt Irrigation District (RID – to the east of the Sub-Basin) reduced levels by 1930 to the point that river flows were insufficient for diversion and BWCDD started using wells to supplement surface water deliveries (Halpenny and Greene, 1975 - page 5-14).

Fugro (1980) interpreted the Tertiary Volcanic-Sedimentary Bedrock Sequence as the principal regional aquifer. Water in the Upper Silt Deposits above the Palo Verde Clay was interpreted as perched water of limited extent. Maps of the principal aquifer water-level elevations are similar to those prepared by Stulik (1974) and Stulik and Laney (1976). Fugro (1980 interpreted the principal aquifer to be artesian (confined) beneath the PVNGS site, but that water table (unconfined) conditions existed westward from the west boundary of the site. Maps of the perched water developed by Fugro (1980) indicate an elliptical mound with upper surface ranging from 880 to 920 feet amsl that dissipates in all lateral directions. They measured variable amounts of saturation beneath the Palo Verde Clay that holds up the perched water. Fugro (1980) interpreted the Palo Verde Clay to be a leaky aquitard.

Long (1983 – Sheet 1) reported that groundwater was typically unconfined in the Tonopah Desert, Hassayampa and Arlington areas (and possibly the Centennial Wash area) and confined (for the regional aquifer) and perched above the Palo Verde Clay beneath the PVNGS area. The upper surface of the perched water ranged from 865 to 916 feet amsl in 1982 while the regional aquifer water levels below the perched water ranged from 700 to 800 feet amsl in 1982.

Halpenny (1984 – page 7-1) reported that drainage of high groundwater levels at Buckeye started in 1922 and consisted of open drains. Wells came into use for drainage at Buckeye in the 1930s. Base flow at the Buckeye heading ceased in 1957. Effluent reached the Buckeye heading in 1962.

Halpenny (1984 – page 4-2) characterized Buckeye as being close to the "cork in the bottle" in that groundwater from the Salt River Valley flows toward this area, but the mountains form a constriction or narrows that are made worse, according to Halpenny (1984), by the construction of Gillespie Dam in the early 1920s. Halpenny (1984 – Plate 1) presented a water-level contour map for the Buckeye area for 1983 that showed southward flow to the Gila River near the Hassayampa River and flow around the south end of the White Tank Mountains into the West Salt River sub-basin. Numerous hydrographs for BWCDD wells presented by Halpenny (1984 – Appendix B) show rises of 20 to 70 feet over the period from the early 1960s to the date of the report. The largest rises occurred in early 1966 in response to the 1965-1966 flood event.

Halpenny (1984 – page 7-3) reported that seepage from the Buckeye Canal is not significant downstream from well 3A (far to the west of our study area) based on trenching for PVNGS pipeline which was dry at levels below the nearby invert of the BIC canal.

Halpenny and Halpenny (1988 – page 4-7) pointed out that the key to understanding the groundwater system of the Hassayampa Plain was noting that once the Hassayampa River crosses the fault at the south end of the Vulture Mountains, it encounters deep alluvial fill and essentially all flow sinks in and becomes recharge. Flows reach Arlington three to four days in some years and no days in most years. They presented a

water-level contour map (Halpenny and Halpenny, 1988 – Plate 3) that indicates that flow is primarily south along the course of the Hassayampa River at least as far south as the south end of the White Tank Mountains. An area of depressed water-level elevations is indicated near the west end of the RID canal approximately 4 miles west of Buckeye.

Based on a comparison of a north-south section of the Hassayampa Plain through water-level elevation contour maps for 1945 (by the USBR), 1982 (Long, 1983) and 1987, Halpenny and Halpenny (1988) concluded that groundwater flow has been steady in the Hassayampa plain for at least 40 years and that this is persists despite large recharge events on Jackrabbit Wash and the Hassayampa River.

Errol L. Montgomery and Associates, Inc. (1994, 1998) installed monitoring wells in two vertical intervals of the UAU: an upper Unit A (75-105 feet bls - dominated by clayey silt and silt clay layers) and a lower Unit B (105-260 feet bls – comprising interbedded silt-clay and sandy gravel layers). The water levels in Unit B were approximately 30 feet lower than the water levels in Unit A, indicating downward flow. Water levels in Unit B fluctuated up and down with seasonal pumping while Unit A water levels do not fluctuate with seasonal pumping.

The available interpretations for the Sub-Basin consistently portray most water-level data to represent a single regional principal aquifer. The exception is an isolated perched zone in the vicinity of PVNGS in the Palo Verde Hills area. The principal aquifer is unconfined expect for where it passes through the Palo Verde Hills area and is confined above by the Palo Verde Clay. Water-level elevations were close to land surface early in the 1900s and required localized drains and drainage pumping by BIC and RID to address waterlogging, but large-scale regional pumping drew the water levels down between the 1930s and the 1960s. Large flood events and the increasing release of effluent in the early 1960s locally refilled the groundwater system around the Gila River.

2.6.4 Summary

The available water-level elevation contour maps, hydrographs and reported interpretations provide a consistent basis for interpreting the regional subsurface hydrology of the Hassayampa Sub-Basin. Large declines followed by rises in water-level elevations have been observed in several areas, such as Arlington and Hassayampa, or Centennial Wash, Palo Verde Hills and Tonopah Desert, while water-level elevations along the Buckeye-Salome Road remained essentially constant. Each of the areas of decline and rise have distinct forms in terms of timing and magnitude which reflect the primary causes of the declines and rises: localized pumping of groundwater or flows in the Gila River. Together, the data may be interpreted to indicate that there are restrictions to groundwater flow between the areas of distinctive groundwater responses noted in the past.

2.7 Selection of Local Study Area

Based on the observations condensed in this section, the area shown on Figure 19, bounded by the Salome-Buckeye Road on the northwest is a useful study area for further work in estimating impacts from pumping groundwater for the proposed power plants. This will be called the Centennial Wash Area in this report. The remainder of this report is a detailed analysis of data for the information available within and immediately adjacent to the Centennial Wash Area.

3.0 GEOLOGIC FRAMEWORK

3.1 Introduction

The geologic structure of the Centennial Wash Area serves as the framework for consideration of groundwater flow. The subsurface architecture is evaluated and interpreted here in detail sufficient to define the primary controls on groundwater flow. Specifically, the extents of the following are considered important in controlling groundwater flow at the scale of the Centennial Wash Area:

- Precambrian basement complex (granite-gneiss),
- Tertiary bedrock (conglomerates, sandstones and volcanics) and
- Tertiary to Quaternary unconsolidated to weakly consolidated sediments (Red LAU, MAU and UAU).

In this section, the geology of the Centennial Wash Area is discussed in subsections on sources of data, approach to interpretation, geologic conceptual model, and discussion.

3.2 Sources of Data

The primary sources of data for interpreting the geology of the Centennial Wash area include:

- surficial mapping by the AGS, USGS and Fugro,
- Gravity data in the public record and from PVNGS,
- Drillers' logs on file at the ADWR,
- Geologists' logs by Fugro,
- Borehole geophysical logs for selected Youngker Farms and RID wells on file at ADWR, and
- Borehole geophysical logs for PVNGS boreholes presented by Fugro.

3.3 Approach for Interpretation

The approach taken here to defining the geologic structure of the Centennial Wash Area is to adopt the surficial mapping of the AGS as the most recent interpretation of exposed rocks. Next, the framework and identification of units in boreholes presented by Fugro (1978, 1980) is adopted due to its detail and substantial supporting database. Then, drillers', geologists', and borehole geophysical logs are interpreted working from Fugro's (1978, 1980) definitions outward away from areas where Fugro drilled and inspected core. Finally, the upper surface of basement complex materials in the subsurface is approximated, based on the gravity interpretations of hydroGEOPHYSICS (2000) and elevations of selected outcrops taken from 7.5 minute topographic quadrangle maps of the USGS. Outcrop locations for granite-gneiss and volcanics were transferred

from the AGS maps and outcrops of the LAU were transferred from Fugro (1978) maps to the topographic quadrangle maps to compile additional elevation point data.

3.4 Geologic Conceptual Model

The conceptual model of the geology of the Centennial Wash Area is described in this subsection as a history of the area. Plots of the surfaces for these units are presented and discussed in ascending order as well.

The area is underlain to unknown, but probably very large depths by Precambrian granites, gneisses and schists. These materials comprise the uppermost part of the North American Continent. These materials will collectively be called the Basement Complex in the Centennial Wash Area. The geologic symbol ***YXg*** is given to this material. Figure 20 is a plot of the estimated elevations of the upper surface of the Basement Complex as interpreted from drillers' and geologists' logs, surface outcrops and gravity surveys for the area.

All younger geologic materials were deposited and eroded from the platform of the Basement Complex. If geologic materials of Paleozoic, Mesozoic, or early Cenozoic age were deposited in the Centennial Wash Area, as they were on the Colorado Plateau, they were removed prior to the Tertiary period.

During the early Tertiary period, conglomerates were deposited from erosion of the primarily granitic Precambrian Basement complex. Soon thereafter, a wide variety of ashfall rhyolite tuffs, andesitic flows, breccia and tuffs and basalt flows inundated this area. There was a shift in composition from acidic to basic igneous material as time progressed. A distinctive white sandstone was formed from the earliest ash falls. These extrusive and sedimentary materials of the early to mid Tertiary period will collectively be called the Tertiary Volcanic-Sedimentary Sequence in the Centennial Wash Area and will be given the geologic symbol ***Tsv***. Figure 21 is a plot of the estimated elevations of the top of the Tertiary Volcanic-Sedimentary Sequence interpreted from drillers' and geologists' logs and outcrop exposures in the area.

During the middle to late Tertiary period, conglomerates were formed from erosion of the Precambrian and Tertiary rocks. These conglomerates range from siltstones to strongly-consolidated debris flows, are now red to brown in color, and are correlative with the Red Unit exposed on the head of Camelback Mountain in central Phoenix and Red Mountain east of Mesa. Fugro (1978-1980) named these materials the Tertiary Volcanic Fanglomerate as an indication of the depositional system type they formed in. This material in the Centennial Wash will be called the Tertiary Red Unit in order to conform to the USGS names given in the adjacent West Salt River Valley and will be given the geologic symbol ***Tvfn*** to maintain consistency with the primary work of Fugro (1978-1980). Fugro (1978-1980) also gave this material the designation lithologic zone (LZ)-1, which will also be used here. Figure 22 is a plot of the estimated elevations of

the upper surface of the Red Unit as interpreted from drillers' and geologists' logs for the area.

At the end of the Tertiary period, sand and gravel deposits were widespread throughout central Arizona. These deposits are distinctive from the underlying Red Unit in their relative lack of consolidation and light brown or gray color. A common designation for these weakly to unconsolidated deposits is the Lower Alluvial Unit (LAU). Fugro (1978, 1980) also gave these deposits the designation LZ-2, which will also be used here. Some time during the deposition of the LAU, the Basin and Range Disturbance began and created the basins present to this day. The LAU appears to be dominated by proximal alluvial fan depositional systems. Fugro (1980) noted that the LAU is at land surface in the western Centennial Wash area. Figure 23 is a plot of the estimated elevations of the upper surface of the LAU as interpreted from drillers' and geologists' logs and surface exposures in the area.

A sharp break is present between the LAU and overlying, predominantly fine-grained deposits commonly designated as the Middle Alluvial Unit (MAU). Previous studies have also called this unit the Middle Fined-Grained Unit, but this term has been replaced by MAU to allow a more complete characterization. In the Centennial Wash Area, the MAU is divided into the lower Palo Verde Clay and the Upper Silt Deposits. Fugro (1978, 1980) gave these deposits the designations LZ-3 for the Palo Verde Clay and LZ-4 for the Upper Silt Deposits. The Palo Verde Clay contains substantial clay sediments and a notable lack of coarse-grained interbeds. The Upper Silt Deposits is a stack of clayey silts, sandy silts, sandy clays, sands, and gravels. The Upper Silt Deposits are at land surface over much of the central and eastern portions of the Centennial Wash Area. The MAU was deposited in a closed basin (no through-flowing streams) and comprised distal alluvial fan (Upper Silt Deposits) and lacustrine/playa (lake or salt flat) (Palo Verde Clay) depositional systems. Sometime during the deposition of the MAU, the Basin and Range Disturbance normal faulting slowed, and near the end of the time in which the MAU was deposited, through-flowing stream drainage developed. Figure 24 is a plot of the estimated elevations of the upper surface of the Palo Verde Clay as interpreted from drillers' and geologists' logs for the area.

Deposits above the MAU are commonly ascribed to the Upper Alluvial Unit (UAU). Over much of the Centennial Wash Area, the UAU occurs as isolated deposits incised into the MAU. Along the coarse of the Gila and Hassayampa Rivers and along the course of the Centennial, Jackrabbit, Winters, Dickey and other Washes, sands and gravels are common and distinguish the UAU from the underlying MAU. The UAU comprises distal alluvial fan and fluvial depositional systems. Fugro (1978. 1980) called these the Upper Sand and Gravel Deposits and gave these deposits the designation LZ-5.

Together, the UAU, MAU and LAU are given the geologic symbol ***QTbf*** to maintain consistency with Fugro (1978, 1980) and emphasize that they are fill for the basins created by the Basin and Range Disturbance normal faulting.

Two additional geologic materials that are of less interest since they occur above the water table are the Quaternary basalt flows (remnant lava cones) in the UAU near Hassayampa (the Arlington basalt flow) and at Gillespie Dam (the Gillespie basalt flow). These materials are given the designation ***Qb***. Fugro (1978, 1980) designated as LZ-6 proximal alluvial fan deposits forming aprons in limited areas around exposed rock knobs. These materials are given the geologic symbol ***Qsu***.

3.5 Discussion

Geologic units have been defined for the Centennial Wash Area from existing reports and detailed review of drillers' and geologists' logs, surface exposure maps, and geophysical surveys. The Basement Complex has a variable depth of occurrence with a notable rise to mountain outcrops and shallow occurrence beneath the northwestern end of the Palo Verde Hills. The Tertiary Volcanic-Sedimentary Sequence is draped over the basement complex over most of the area, except where the basement complex is exposed in mountains or along the Gila River. The Red Unit apparently is restricted to the area in and surrounding the Palo Verde Hills. The LAU appears to be present over much of the Centennial Wash area and is present at land surface in the western Centennial Wash area. The MAU is present primarily in the eastern Centennial Wash Area where it is present at land surface. The UAU is present in isolated locations in the Centennial Wash area. The UAU is thickest along the Gila River.

4.0 HYDROSTRATIGRAPHIC UNITS

4.1 Introduction

The geologic units require evaluation with respect to how groundwater flows within them. In this section, hydrostratigraphic units are selected from the framework of geologic units described in the previous section. Hydrostratigraphic units are volumes of distinctive groundwater flow regimes and have distinctive hydraulic conductivity distributions derived from their internal architecture.

4.2 Sources of Data

Data considered in this section are the water-level contour maps and hydrographs discussed in Section 2, the geological conceptual model of Section 3 and the geologic unit upper surface maps discussed in Section 3.

4.3 Selection of Hydrostratigraphic Units

The Basement Complex is considered a substantial barrier to groundwater flow and its relatively shallow occurrence beneath the Palo Verde Hills has an important effect on groundwater flow by restricting the area open for flow and propagation of changes in water-level elevations. The Volcanic-Sedimentary Bedrock Sequence would be expected to be less of a barrier to flow than the underlying Basement Complex, but more so than the overlying moderately to weakly consolidated sediments. The sedimentary and volcanic components of the Volcanic-Sedimentary Bedrock Sequence would be expected to have similar groundwater flow characteristics due to the strong consolidation of the sedimentary components. The LAU would be expected to have the highest potential hydraulic conductivity of the basin fill sediments; certainly more than the Red Unit due to the relatively weak consolidation of the LAU compared to the Red Unit. The Palo Verde Clay and Upper Silt Deposits would be expected to confine groundwater flowing beneath and restrict recharge moving down from above.

In this section, groundwater flow is inferred from the water-level elevations and their position relative to the surface separating geologic units. The LAU, Red Unit, and the Volcanic-Sedimentary Bedrock Sequence are interpreted to comprise the principal regional aquifer system in the Centennial Wash area. Multiple aquifers may be present within the principal aquifer system which together account for most of the groundwater flow through the area. In the Arlington Valley, the UAU is also a part of the principal aquifer system.

The principal aquifer is unconfined, expect where the Palo Verde Clay is present below the piezometric surface of the principal aquifer. Where the Palo Verde Clay is

present in such a position, the principal aquifer system is considered a leaky confined aquifer and the Palo Verde Clay is considered a leaky aquitard. Groundwater above the Palo Verde Clay in the Upper Silt Deposits or UAU has been investigated, particularly by Fugro (1978, 1980), and appears to be a localized unconfined aquifer.

4.4 Discussion

Based on the water level maps and hydrographs presented in Section 2, groundwater in the principal aquifer system since the 1960s has had a water table or piezometric surface ranging from approximately 850 feet amsl along the Buckeye-Salome Road to less than 700 feet near Centennial Wash. Prior to the 1950s, water levels near Centennial Wash were between 760 and 770 feet amsl and the lowest point was approximately 720 feet amsl near Gillespie Dam. The water table in the unconfined aquifers above the Palo Verde Clay has had a range of approximately 800 to over 900 feet amsl since the 1970s.

The piezometric surface of the principal aquifer system, as represented by water-level elevations in wells, is above the top of the LAU throughout the area where the Palo Verde Clay has been identified. Therefore, the principal aquifer system is considered confined wherever the Palo Verde Clay is present. Based on inspection of the currently available drillers' and geologists' logs, and consideration of geologic structures, the Palo Verde Clay is not present beneath the two lines of volcanic rock outcrops of the Palo Verde Hills or in the western Centennial Wash area where the LAU outcrops.

The interpretations of groundwater flow presented in Section 2.0 are considered representative of the principal aquifer system. There may be variations in flow among the aquifers within the principal aquifer system, but data are not available to isolate and characterize such differences. Characterization of flow between aquifers within the principal aquifer system is probably not be necessary to predict groundwater responses to pumping for the proposed power plants.

In general, flow in the principal aquifer system moves southwestward into the Centennial Wash Area from a line roughly paralleling the Buckeye-Salome Road. Prior to the late 1940s, the flow continued southward and entered the Gila River or passed through the area near Gillespie Dam into the Gila Bend Basin. Since the 1940s, pumping for farms in the Palo Verde Hills and along Centennial Wash collected a substantial portion of the flow and also caused water to reverse its path and flow from the Gila River towards the wells along Centennial Wash.

In general, flow in the Upper Silt Deposits spreads laterally in several directions until sufficient area is developed to allow flow downward into the Palo Verde Clay. Flow in the UAU along the Gila River generally follows the alignment of the Gila River, but also provides for flow to or from the Gila River.

5.0 BOUNDARIES TO GROUNDWATER FLOW

5.1 Introduction

The arrangement of distinctive geologic materials in the Centennial Wash Area, particularly the Basement Complex, exerts a strong control on the flow of groundwater. Stulik (1974 – Plate 1) considered all rock outcrops to be boundaries to the valley-fill sediments, which he considered the principal aquifer in the area. Stulik (1974 – Plate 1) presented contours of equal thickness of valley-fill deposits. Depths to the base of the valley fill deposits interpreted by Stulik (1974) range from less than 300 feet around exposed rock to more than 1200 feet in a large area including Centennial Wash and the Arlington Valley. Reassessment of the water-level contour maps indicates that occurrences of the Volcanic-Sedimentary Bedrock Sequence may not represent barriers to groundwater flow in the Centennial Wash Area. For this work, the Volcanic-Sedimentary Bedrock Sequence is included in the principal aquifer system.

In this section, the controls of the Basement Complex on groundwater flow in the Centennial Wash Area are briefly reviewed from the available data. Specifically, information on the horizontal and vertical extents of the Basement Complex is compared with the water level elevation maps. A similar comparison is made with respect to vertical flow in the case of the Palo Verde Clay.

5.2 Vertical Boundaries

The upper surface of the basement complex (see Figure 20) is considered a bounding surface for groundwater flow. Of particular interest is the rise of this surface from sea level to over 500 feet beneath the Palo Verde Hills. This ridge of high basement complex is coincidental with closely-spaced contours of equal water-level elevations on the water-level contour maps for 1970, 1975, 1982, and 1992. As groundwater is forced through a thinner cross section, the hydraulic gradients would be expected to increase as seem in the Centennial Wash Area.

The Palo Verde Clay also represents a substantial barrier to groundwater flow, but not as substantial as the basement complex. The large vertical differences between water-level elevations above and below the Palo Verde Clay indicate the restriction imposed by the Palo Verde Clay on vertical groundwater flow. The occurrence of the Palo Verde Clay is coincidental with the rise in the basement complex. The Palo Verde Clay further narrows the cross section for flow passing south and west beneath the Palo Verde Hills.

5.3 Horizontal Boundaries

The west and south edges of the Centennial Wash Area form a corner for the PhxAMA as a whole. As Halpenny (1984) noted, this area can be thought of as the cork (actually more like the neck) of the bottle comprising the groundwater system of the western PhxAMA viewed as a whole. Groundwater flow is laterally restricted from locations where the top of the Basement Complex rises above the water level elevations in the principal aquifer system. Such restriction occurs around the edges of the Centennial Wash Area selected here with the exceptions of:

- the alignment of the Buckeye-Salome Road and the northeast end of the Arlington Valley and
- a two to three-mile long gap directly south-southwest of Gillespie Dam.

5.4 Discussion

The primary boundaries to groundwater flow in the Centennial Wash area are the Basement Complex and the Palo Verde Clay. Contrary to some earlier studies, the Volcanic-Sedimentary Bedrock Sequence in general is currently not considered to present a barrier to groundwater flow in the Centennial Wash Area.

6.0 HYDRAULIC PROPERTIES ESTIMATES

6.1 Introduction

The extents to which water can move through or be stored in a hydrostratigraphic unit are quantified with the parameters hydraulic conductivity and specific storage/specific yield, respectively. These parameters are typically estimated from field and laboratory tests, but they also can be estimated from literature summaries and model simulations.

6.2 Sources of Data

Data for estimating hydraulic parameters are limited at this time for the Centennial Wash Area. Stulik (1974), Fugro (1980) and Halpenny (1984) compiled and summarized specific capacity data for wells in the principal aquifer system. Fugro (1980), ARCADIS Geraghty & Miller (1999) and Hargis+Associates, Inc. (2000) reported on aquifer tests in the principal aquifer system. Fugro (1980) also reported on the results of slug/bail and laboratory permeameter tests. Sempra Energy Resources and Pinnacle West Energy Corporation are conducting additional aquifer testing at this writing (April 2000) to develop additional hydraulic parameter estimates for the Centennial Wash Area.

6.3 Approach for Interpretation

Horizontal hydraulic conductivity (K_H) can be estimated by dividing the transmissivity by the saturated thickness of the well at the time of the test. Transmissivity can be estimated from analysis of an aquifer test, slug test, or bail test, or from a rough, approximate relationship between specific capacity and transmissivity (transmissivity in gallons per day per foot ([gpd/ft] equals specific capacity in gallons per minute per foot of drawdown [gpm/ft] multiplied by 2000 – [Driscoll, 1986 – page 1021]). Vertical hydraulic conductivity (K_V) and K_H can be estimated from laboratory permeameter tests on oriented core samples. Aquifer test estimates are significantly better than estimates based on slug tests, bail tests, or the relationship between specific capacity and transmissivity. In the absence of any field data, K_H can be estimated from literature-reported ranges for similar geologic materials. However, the reported ranges for K_H are very large (several orders of magnitude for a given material)

Specific storage (S_S) can be estimated by dividing the storage coefficient (S_C) by the saturated thickness of the well at the time of the test. Storage coefficient can be estimated from analysis of an aquifer test. Specific yield (S_Y) can be estimated from analysis of an aquifer test. In the absence of field data, S_S and S_Y can be estimated from literature-reported ranges for similar geologic materials. Compared to K, the storage parameters have much smaller reported ranges for a given material.

To the extent that data are presented in the available reports, the interpretations of the authors are reviewed here. Otherwise, the reported values are summarized.

6.4 Hydraulic Conductivity

Stulik (1974 – page 8 and Table 1) presented specific capacity data for the area that range from one to 86 gpm/ft. Transmissivity estimated for this specific capacity range using the approximation (Driscoll, 1986 – page 1021) ranges from 2,000 to 190,000 gpd/ft. These values probably represent the principal aquifer system or parts of the principal aquifer system over a broad area.

Fugro (1980) summarized data for existing wells in the vicinity of the PVNGS site as having pumping capacities of 400 to 2,800 gpm and specific capacities averaging 35 gpm/ft. Average transmissivity estimated from specific capacity is approximately 70,000 gpd/ft. These values probably represent the principal aquifer system within a few miles of the PVNGS site.

A 24-hour aquifer test (Fugro, 1980 – page 20) was conducted in irrigation well (B-01-06) 34abb and the reported results included an estimated specific capacity of 55 gpm/ft at 2,360 gpm and a transmissivity of 100,000 gpd/ft. Assuming a saturated thickness of 1000 feet (the well is perforated from 250 to 1235 feet bls) and converting units leads to a K_H estimate of 13 ft/d. These values probably represent the principal aquifer system at the PVNGS site. Fugro (1978 – Appendix 2I) also reported on a multi-well aquifer test run in sands of the UAU at the PVNGS site between 20 and 40 feet bls. Fugro (1978) interpreted the test results to estimate transmissivity at 4,000 gpd/ft. Assuming a saturated thickness of 18 feet, Fugro (1978) estimated K_H at 30 ft/d. These values probably represent the coarser parts of the UAU at the PVNGS site.

Fugro (1980 – pages 21 to 22,) further summarized the results of slug and bail tests or laboratory permeability tests for the vicinity of the PVNGS site as follows:

Upper Sands, Gravels and Silt Deposits (UAU, LZ-5): K_H of 1.3 ft/d.
Upper Silt Deposit (MAU, LZ-4): $K_H = 0.0013$ ft/d, $K_V = 0.00013$ ft/d
Palo Verde Clay (MAU, LZ-3) $K_H = 0.0013$ ft/d, $K_V = 0.0007$ ft/d

Halpenny (1982a – Table 5) reviewed well data for the Buckeye Irrigation Company (BIC), calculated specific capacities, and evaluated the specific capacity data. He cautioned (Halpenny, 1982a - page 3-16) that specific capacities decrease with time due to well encrustation although aquifer properties remain constant. He also noted that the relationship between the perforated interval and the water table. The use in this case of January water levels for static and pumping water levels during July or August lead to excessive drawdown estimates, and that therefore specific capacities may be higher. Nevertheless, specific capacities for many wells are in the 100 to 300 gpm/ft range, which is exceptionally high. Transmissivity estimated for this specific capacity range

using the approximation (Driscoll, 1986 – page 1021) ranges from 200,000 to 300,000 gpd/ft. Assuming a saturated thickness of 200 feet for the BIC wells and converting units, K_H estimates would range from 130 to 200 ft/d. These estimates probably represent the UAU north of the Gila River near Buckeye. Specific capacities are lower (Halpenny, 1982a – Table 5), 20 to 60 gpm/ft, along the BIC canal for 4 miles east of the Hassayampa River. Transmissivity estimated for this specific capacity range using the approximation (Driscoll, 1986 – page 1021) ranges from 40,000 to 120,000 gpd/ft. These estimates probably represent an unknown combination of the UAU and MAU west of Buckeye.

ARCADIS Geraghty & Miller (1999 – Appendix A) reported on pumping tests conducted November 29 and 30, 1999. The tests were 24 hours in duration and were conducted on Duke wells 4-1 (C-01-06 21CBB2) and 4-2 (C-01-06 21BCB). Their results are as follows:

Well 4-1: At 1,530 gpm, drawdown was 41.5 feet, which yields a specific capacity of 37 gpm/ft. Application of the Cooper-Jacob (1946) semi-log straight-line method to the drawdown data from 1 to 450 minutes resulted in a transmissivity estimate of 109,000 gpd/ft. Application of Theis (1935) Recovery Method to the recovery data from one to 490 minutes resulted in a transmissivity estimate of 86,000 gpd/ft. Until combined drawdown and recovery analysis of this test is conducted, the recovery-based estimate of 86,000 gpd/ft is preferred. The well is open from 229 to 1012 feet bls and the static water level at the time of the test was approximately 170 feet (above the top of the perforations), so the saturated thickness can be assumed to be 783 feet. Dividing transmissivity by saturated thickness yields a K_H estimate of 14.7 ft/d. However, water production is likely limited to intervals beneath the Palo Verde Clay. Estimated depth to the top of the LAU at this well (see Figure in Section 3) is 270 feet bls. The saturated thickness beneath the Palo Verde Clay in this well is then estimated at 740 feet. The estimate for K_H beneath the Palo Verde Clay is 15.4 ft/d. Therefore, the K_H estimate of 15 ft/d developed by ARCADIS Geraghty & Miller Inc (1999 - Table A1) is reasonable.

Well 4-2: At 1,530 gpm, drawdown was 74.1 feet, which yields a specific capacity of 21 gpm/ft. Application of the Cooper-Jacob (1946) semi-log straight-line method to the drawdown data from 7 to 250 minutes resulted in a transmissivity estimate of 62,000 gpd/ft. Application of Theis (1935) Recovery Method to the recovery data from 5 to 340 minutes resulted in a transmissivity estimate of 78,000 gpd/ft. Until combined drawdown and recovery analysis of this test is conducted, the recovery-based estimate of 78,000 gpd/ft is preferred. This well is open from 350 to 980 feet bls and the static water level at the time of the test was approximately 170 feet (above the top of the perforations) so the saturated thickness can be assumed to be 630 feet. Dividing transmissivity by saturated thickness yields a K_H estimate of 16.6 ft/d. The top of the perforations is below the estimated bottom of the Palo Verde Clay. Therefore, the K_H estimate of 16.4 ft/d developed by ARCADIS Geraghty & Miller Inc (1999 Table A3) is reasonable

The results of the two tests by ARCADIS Geraghty & Miller (1999) probably represent the principal aquifer system beneath the Duke Energy property.

Hargis+Associates, Inc (2000) reported on the March 8, 2000 6-hour pumping test of well (C-01 –06) 23adb on the Redhawk property. At 1,875 gpm, drawdown was 97 feet, which yields a specific capacity of 19 gpm/ft. Application of the Cooper-Jacob (1946) semi-log straight-line method to the drawdown data from 8 to 80 minutes resulted in a T estimate of 55,000 gpd/ft. Application of Theis (1935) Recovery Method to the recovery data from 20 to 180 minutes resulted in a transmissivity estimate of 48,000 gpd/ft. Until combined drawdown and recovery analysis of this test is conducted, the recovery-based estimate of 50,000 gpd/ft is preferred. The well is perforated from 140 to 930 feet bls and the 1986 depth to water of 180 feet bls is assumed as an estimate of the static water level, so the saturated thickness can be assumed to be 750 feet. Dividing transmissivity by saturated thickness yields a K_H estimate of 9 ft/d. However, water production is likely from materials beneath the Palo Verde Clay. Estimated depth to the top of the LAU at this well (see Figure in Section 3) is 270 feet bls. The saturated thickness beneath the Palo Verde Clay in this well is then estimated at 660 feet. The estimate for K_H beneath the Palo Verde Clay is 10.1 ft/d. Therefore, the range of K_H estimates given by Hargis+Associates, Inc. (2000) – 6 to 12 ft/d - is reasonable. These results probably represent the principal aquifer system beneath the Redhawk property, but longer testing would be useful for confirming the results of this short test.

6.5 Storage

A 24-hour aquifer test (Fugro, 1980 – page 20) was conducted in irrigation well (B-01-06) 34abb and the resulting estimate for S_C was 0.005. Assuming a saturated thickness of 1000 feet and converting units leads to a S_S estimate of 10^{-6} cubic feet water per cubic foot sediments per foot drawdown (ft^{-1}).

Fugro (1978 – Appendix 2I) also reported on a multi-well aquifer test run in the UAU (Upper Silts, Sands and Gravel Deposits) between 20 and 40 feet bls. Fugro (1978) interpreted the test results with the Theis (1935) method to find a S_C (or S_Y) ranging from 0.008 to 0.013, average 0.01. Reinterpretation of this test with modern water-table aquifer test analysis methods would likely clarify the confusion and find a lower S_C and a higher S_Y.

6.6 Discussion

Transmissivity of the principal aquifer system in the Centennial Wash Area may range between 2,000 and 190,000 gpd/ft and average 70,000 gpd/ft. This summary is based on a rough approximation from specific capacity data, but has been confirmed in a preliminary manner by the results of four single-well aquifer tests: 100,000 gpd/ft, 86,000 gpd/ft, 78,000 gpd/ft and 50,000 gpd/ft). Horizontal hydraulic conductivity of the principal aquifer system estimated from the four available aquifer tests ranges from 10 to 17 ft/d. Specific storage of the principal aquifer system was estimated from one aquifer test at 10^{-6} ft^{-1}. Additional, longer-term (one to seven days) aquifer tests with observation wells are needed to improve the support for estimating transmissivity and hydraulic

conductivity in the area of the proposed power plants. Such tests are planned for the spring of 2000.

The K_H of the Palo Verde Clay appears to be very low, but as expected for these geologic materials: 10^{-3} ft/d, and the K_V of the Palo Verde Clay appears to be one half the K_H. These values were based on core tests that sample a small volume. Therefore, there may be substantial variability to the Palo Verde Clay above or below the values found to date.

The reported values of hydraulic conductivity for the Upper Silt Deposits are surprisingly similar to those for the Palo Verde Clay: 10^{-3} ft/d for K_H and 10^{-4} ft/d for K_V. The Upper Silt Deposits were tested with slug/bail tests for K_H and core tests for K_V. As with the Palo Verde Clay, the Upper Silt Deposits may have substantial variability at volumes larger than those sampled at PVNGS.

A group of slug/bail tests of the UAU at PVNGS resulted in an average K_H of 1.3 ft/d. There is one aquifer test based value for the K_H of the UAU at PVNGS: 30 ft/d. These results indicate significant variability in the UAU at PVNGS. The specific yield reported for the one available aquifer test is unrealistically low, as was stated by the report authors (Fugro, 1978).

7.0 RECHARGE AND DISCHARGE ESTIMATES

7.1 Introduction

This section compiles the available information for the flow of water to and from the groundwater system in the Centennial Wash Area. The groundwater system includes all groundwater in the Centennial Wash Area including the principal aquifer system and perched zones. No distinction is made between locations within the Centennial Wash Area.

All of the estimates made here are preliminary and subject to revision, based on review of this report and the water budget, as well as during model calibration to match historical water-level elevation distributions and changes. This section is intended as a first approximation of groundwater flow in the Centennial Wash Area.

In this section, the term recharge includes the following components or categories of inflows to groundwater:

- West-bound groundwater flow in from the West Salt River Valley, beneath the Gila River channel near Hassayampa
- Southwest-bound groundwater flow in from the Hassayampa Plain beneath the Buckeye-Salome Road
- East-bound groundwater flow in from the Harquahala Basin beneath the Centennial Wash channel at Mullen's Cut
- Direct infiltration of precipitation
- Mountain front infiltration of runoff
- Gila River infiltration
- Hassayampa River infiltration
- Centennial Wash infiltration
- Minor tributary infiltration
- Industrial detention basin infiltration
- Agricultural leaching requirement
- Canal transmission losses

The magnitude of the individual recharge components has changed in the Centennial Wash Area over time. Currently, the largest recharge components in the Centennial Wash Area are the groundwater inflow from the Hassayampa Plain, agricultural leaching requirement, canal transmission losses and Gila River infiltration.

In this section, the term discharge includes the following components or categories of outflows from groundwater:

- Southeast-bound groundwater flow out to the Gila Bend Basin beneath the Gillespie Basalt flow near Gillespie Dam

- Direct evaporation from the water table
- Transpiration from phreatophytes
- Groundwater flow into the Gila River
- Agriculture pumping
- Industrial pumping
- Domestic pumping
- Pumping for livestock watering

The magnitude of the individual discharge components has changed in the Centennial Wash Area over time. Currently, the largest discharge components in the Centennial Wash Area are agricultural pumping and transpiration by phreatophytes.

7.2 Sources of Data

Data to estimate recharge and discharge components in the Centennial Wash Area come from a variety of sources. The studies by the USGS, ADWR and consulting firms reviewed in Section 2 are the primary sources of recharge and discharge estimates and supporting data.

7.3 Approach for Interpretation

Where available, estimates of recharge and discharge components are extracted from the sources discussed above. Other estimates are made based on methods described with the estimates in the following subsections. In all cases, simple methods for estimating recharge or discharge components are employed here which have been used in similar studies of adjacent basins in Central Arizona.

The recharge and discharge estimates are combined in the next section – Section 8.0 Water Budget. Within the framework of a water budget, the estimates of each recharge or discharge component can be compared with each other and their changes can be reviewed over time.

7.4 Recharge Estimates

The recharge components listed at the beginning of this section are described in detail in this subsection. The recharge components have been grouped for further discussion as follows:

- Groundwater flow in from adjacent areas,

- Infiltration of precipitation and runoff, and

- Infiltration from agricultural operations.

7.4.1 Groundwater Flow in from Adjacent Areas

Groundwater flow into the Centennial Wash Area includes:

- West-bound groundwater inflow from the West Salt River Valley, beneath the Gila River channel near Hassayampa
- Southwest-bound groundwater inflow from the Hassayampa Plain beneath the Buckeye-Salome Road
- East-bound groundwater inflow from the Harquahala Basin beneath the Centennial Wash channel at Mullen's Cut

In general, groundwater flow is estimated by applying Darcy's Law to estimates for transmissivity, horizontal hydraulic gradient and cross-sectional width. Where gradients have changed with time, those changes are investigated from water-level elevation maps in the following discussions.

Westbound groundwater inflow from the West Salt River Valley, beneath the Gila River channel near Hassayampa can be estimated from water-level elevation contour maps prepared by ADWR. Reeter and Remick (1986 – sheet 1) present water-level elevation data for 1982 useful for estimating the flow of groundwater. The line of flow between the West Salt River and Hassayampa Sub-Basins appears in 1982 to be only one mile wide and extends up from the exposed rock of the Buckeye Hills at Powers Butte. The flow direction appears to be due south in the area north of this line, which indicates no flow between the Sub-Basins north of this line. The data points indicate a west-southwest gradient of 35 feet per mile (0.007) beneath the Gila River channel across a line extending one mile north from Powers Butte. Water levels for the same walls measured in 1992 (Hammett and Herther, 1996 – Sheet 1) indicate a gradient in the same direction of 56 feet per mile (0.011).

Using the gradient estimated from Reeter and Remick (1986 – Sheet 1) and assuming a section width of one mile and transmissivity of 300,000 gpd/ft for sediments beneath the Gila River channel (see Section 6) results in an estimate of 12,400 ac.-ft./yr. of flow across this line in 1982. Using the 1992 gradient estimated from Hammett and Herther (1996 - Sheet 1) results in an estimate of 19,500 ac.-ft./yr. Errol L. Montgomery & Associates, Inc. (1988 - Appendix B, page B-2) estimated groundwater flow into the ACC area near Hassayampa to be 15,900 ac.-ft./yr. in 1985. ADWR (Correll and Corkhill, 1994 – Figure 16) estimated flow out of the West Salt River Valley Sub-Basin at Arlington to be 3,000 ac.-ft./yr., but did not provide the basis for their estimates. Based on the use of data described above, an estimate of 16,000 ac.-ft./yr. groundwater flow into the Centennial Wash Area at Hassayampa is considered more accurate at this time.

Halpenny and Halpenny (1988 – page 4-45) present a calculation for the portion of groundwater flow moving from the Hassayampa Plain directly south towards the Buckeye area. The cross section is in Township 2 North, Ranges 4 and 5 West, is seven miles long (east to west) and is approximately 3 miles north of I-10 at Palo Verde Road. The estimate is 32,000 ac.-ft./yr and Halpenny and Halpenny (1988, page 4-45) note that this estimate is similar to that made by Montgomery & Associates (1988 page 75, line 50) of 26,500 ac.-ft./yr without the benefit of the testing data collected by Halpenny and Halpenny (1988). Inspection of the maps used by Halpenny and Halpenny (1988 – plate 3) in comparison to water –level contour maps of broader coverage indicate that this estimate does not account for groundwater leaving the Hassayampa Plain for the Tonopah Desert or to pass through the Palo Verde Hills. Therefore, although it initially appears to account for all groundwater flow out of the Hassayampa Plain, this estimate does not apply to the Centennial Wash Area.

Southwest-bound groundwater inflow from the Hassayampa Plain beneath the Buckeye-Salome Road can be estimated from gradients indicated on the maps shown in Figures 5 to 9. The water-level contour maps indicate horizontal gradients along the Buckeye-Salome Road as follows: 1970 – 40 to 120 feet per mile (0.008 to 0.022), 1975 – 70 feet per mile (0.013), 1982 -30 to 70 feet per mile (0.006 to 0.013), 1992 – 50 feet per mile (0.009). The variability in these estimates arises primarily from the assumptions made by the authors in contouring. A value of 50 feet per mile (0.009) appears reasonable to estimate the gradient along this line. The line is 10 miles long and the closest transmissivity estimate for the principal aquifer system is 100,000 gpd/ft for a well at the PVNGS site. The resulting flow estimate is 53,300 ac.-ft./yr.

East-bound groundwater inflow from the Harquahala Basin beneath the Centennial Wash channel at Mullen's Cut can be estimated from water-level elevation contour maps prepared by ADWR. The water level elevation contour map for 1979-1980 presented by Graf (1980 – sheet 1) indicates that water in the Harquahala Basin in 1980 was flowing westward from Mullen's Cut. Therefore, as of 1980, regional groundwater flow was not moving from the Harquahala Basin to the Lower Hassayampa Basin. Prior to development of areas of depressed water level-elevations in both the Harquahala and Centennial Wash Areas, groundwater flowed from the Harquahala Basin into the Centennial Wash Area at a rate of approximately 200 ac.-ft./yr. (Mason, 2000). This amount probably slowly decreased to zero between the 1940 and the 1960s.

7.4.2 Infiltration of Precipitation and Runoff

Direct infiltration of precipitation is estimated from the average annual precipitation, the surface area above the groundwater system, and an estimate of the fraction of precipitation that becomes groundwater recharge for the local climate and soils conditions. The average annual precipitation is 8 inches per year; the surface area of soils above the groundwater system is approximately four townships (144 square miles). The fraction of precipitation that becomes groundwater recharge is estimated at 0.001 based on the work in the Ajo, Arizona area by Liu and others (1995) and a 50:50 mix of old and

young soil surfaces. The resulting estimate is less than 100 ac.-ft./yr. (61 ac.-ft./yr.), which can be neglected at this time.

Mountain front recharge is the sum of the precipitation that falls on exposed rock, escapes evaporation, and runs off into the contact with the unconsolidated sediments at the mountain fronts. Although mountain front recharge is probably concentrated at the mouths of canyons, it is typically estimated as a basin-wide total or an average rate per mile of mountain front. The USGS (Frethey, 1985 – Table 1) has estimated that mountain front recharge in the West and Central ("Storage-Depletion") Basins of Arizona ranges from 50 to 5,000 ac.-ft./yr per basin. In other reports from that same USGS work, a statistical relation between total mountain front recharge flux and total precipitation flux was developed, but only for basins with average rainfall greater than eight inches per year (Anderson and Others, 1992 – page B33). Basins with less than eight inches of recharge per year were arbitrarily assumed to have negligible mountain front recharge in that all precipitation was consumed in soil moisture deficits and evapotranspiration (Anderson and Others, 1992 – page B33).

Since the Centennial Wash Area has average annual precipitation very near the USGS threshold, a relatively small amount of mountain front recharge may be present. Given that the Centennial Wash Area has characteristics similar to other West and Central Basins, a total value of 300 ac.-ft./yr. (in the lower end of the range of the USGS estimates) for the entire area seems reasonable. Given that the Centennial Wash Area has approximately 30 miles of mountain front, the average mountain front recharge estimate is 10 ac.-ft./yr. per mile of mountain front. This compares to 20 ac.-ft./yr. per mile of mountain front estimated by the USGS (Hanson and Benedict, 1994) for the Tucson Mountains, which are relatively low in elevation and precipitation is larger (12 inches per year). No closer studies for mountain front recharge are known at this time

Infiltration from the Gila River has changed over time in the Centennial Wash Area. As noted previously, flows in the Gila River declined from the late 1930s to 1962 when effluent releases increased flow dramatically up to the present. Prior to groundwater pumping for irrigation in the Centennial Wash Area, the Gila River was a gaining stream and infiltration is assumed negligible. This situation changed by the late 1960s. Based on review of the available water-level contour maps, the Gila River started losing water from a point approximately eight miles north of Gillespie Dam southward some time before 1970 and this situation persists to this day. The rate of infiltration from the Gila River in the Centennial Wash Area has not been rigorously estimated at this time, because sporadic gaging records indicate larger flows at Gillespie Dam than at the Confluence with the Salt, even in years with no releases on the Salt. Because both stage in the river and surrounding groundwater elevations play a role in determining infiltration, model calibration is a promising method for estimating this value. As an initial set of estimates, the infiltration of the Gila River within the Centennial Wash Area may have ranged from zero in 1940 to some rate less than the pumping in the Centennial Wash Area (10,000 to 40,000 ac.-ft./yr.).

Infiltration from the Hassayampa and River and Centennial Wash cannot be directly estimated at this time from the available gaging data. Upstream and downstream gaging stations are not located to allow calculation of losses in the Centennial Wash Area on an event-by-event basis. As noted in Section 2, flood flows are rare on these streams and they have significant distances on alluvial fill to cover before entering the Centennial Wash Area. As an initial set of estimates, the infiltration of either the Hassayampa River or Centennial Wash within the Centennial Wash Area may have ranged from zero in most years to 500 ac.-ft./yr. in years with flood events.

There are many minor tributaries to the Hassayampa River and Centennial Wash in the Centennial Wash Area. Because their drainage areas are so much smaller, the sum of infiltration from these minor tributaries is probably much less than the infiltration on the Hassayampa River or Centennial Wash, and will be neglected at this time.

Detention basins were constructed at the PVNGS to protect the facilities from flooding. These basins fill during recharge events and infiltration is sufficient to cause water-level rises in shallow piezometers (see Section 2). The total volume infiltrated from these basins is probably small, however and will be neglected at this time

7.4.3 Infiltration from Agricultural Operations

Infiltration associated with agricultural operations in the Centennial Wash Area can be divided into agricultural leaching requirement and transmission losses in delivering agricultural water.

Stulik (1974 – Plate 1) presented the areas of irrigated agriculture transferred from a 1968 aerial photograph. No mention is made of crop types or patterns. However, Stulik (1974 – page 9) estimated irrigation pumping quantities at 95,000 ac.-ft./yr. for 1969 on more than 24,000 acres and apportioned 50,000 ac.-ft./yr. to the Tonopah-Hassayampa area and 45,000 ac.-ft./yr. to the Centennial Wash area. Stulik (1974 – page 9) further noted that extensive agricultural development began in the early 1950s and irrigated lands reached 24,000 acres by 1960.

As a first approximation, the groundwater pumping volumes can be used to estimate the volume of water applied for irrigation in the Lower Hassayampa Area. Total application of four ac.-ft./ac.-yr. (total pumping divided by acres from Stulik, 1974) at an estimated efficiency (consumptive use of crop per unit ground surface area divided by total applied water per unit ground surface area) of 75% leaves 25% or 23,750 ac.-ft./yr. for agricultural leaching requirement. Applying the apportionment by area (47% to the Centennial area) to the agricultural leaching requirement yields an estimate of 11,200 ac.-ft./yr of recharge from agricultural leaching requirement in the Centennial Wash and Palo Verde Hills areas in 1969. The agricultural leaching fraction from 4,000 acres at ACC adds another 7,000 ac.-ft./yr. for a total of 18,200 ac.-ft./yr. in 1969.

Fugro (1980) estimated infiltration of the agricultural leaching requirement for the PVNGS property in 1972 (prior to construction) from the following data and assumptions: 2,150 acres were cultivated, 7,550 ac.-ft./yr. was applied, the consumptive use of cotton is 41 inches per year, precipitation is 6.2 inches per year. The resulting estimate for agricultural leaching requirement was 200 ac.-ft./yr. for 1972, but this rate amounts to 3% recharge or 97% efficiency. Such a high efficiency would result in salt build up and could not be maintained, so it is questionable. Different estimates for agricultural leaching requirement were presented in Fugro (1978): The average application rate for the period 1966 to 1972 was 6,000 ac.-ft./yr., which was applied to an average of 1,500 acres. At 25% leaching requirement, the total infiltration would be 1,500 ac.-ft./yr., and represents a more sustainable farming practice. This later estimate is considered more acceptable than the first estimate presented in this paragraph.

Long (1983 – Sheet 1) estimated that 22,500 acres were irrigated in 1982 in the Lower Hassayampa area, which is down slightly from 24,000 acres reported to be in production by 1960.

Although excess deep percolation in test plots ranged from 0 to 17 percent of applied water and averaged 8 percent (Montgomery, 1988 - page 89), total deep percolation recharge for 1985 was estimated at 3,600 ac.-ft./yr (Montgomery, 1988 - Appendix B, page B-2), a quantity which is closer to 25% and more in line with most other estimates. The infiltration from agricultural leaching requirements probably averages approximately one ac.-ft./ac.-yr. and irrigated acreages can be used to estimate the total agricultural leaching requirement.

Water transmission losses are related to the size and character of the transmission system and the distance over which the water is transmitted. The Arlington Canal is considered the only significant source of transmission losses for the agricultural fields in the Centennial Wash Area. Seepage tests conducted on the Arlington canal by Montgomery (1988 - page 88) indicate 11,880 ac.-ft./yr of ACC canal losses to groundwater in 1985. For approximately seven miles of Arlington Canal with an average wetted width of ten feet, this estimate converts to an instantaneous infiltration rate of 3.8 ft/d, which is a high rate – approximately ten times the average rate for unlined canals in the Salt River Project (Corkhill and others 1993 – Page 62, table 8). Since this estimate is based on actual seepage tests, it is considered accurate.

7.5 Discharge Estimates

The discharge components listed at the beginning of this section are described in detail in this subsection. The discharge components have been grouped for further discussion as follows:

- Groundwater flow out to adjacent areas,
- Groundwater flow into the Gila River,

- Evapotranspiration, and
- Wells.

7.5.1 Groundwater Flow out to Adjacent Areas

Southeast-bound groundwater flow out to the Gila Bend Basin beneath the Gillespie Basalt flow near Gillespie Dam can be estimated from water-level elevation contour maps prepared by ADWR. Water level maps for the Gila Bend Basin in 1979 and 1993 presented in Sebenik (1981) and Rascona (1996), respectively, indicate regional groundwater flow passes beneath the Gillespie Basalt flow and Gillespie Dam and moves eastward to pumping wells arranged on a north-south line for two townships at the northern boundary of the Gila Bend Basin. The gradients on the east side of the inflow area southeast of Gillespie Dam were 0.006 in 1979 (Sebenik, 1981 – sheet 1) and 0.012 in 1993 (Rascona, 1993 – sheet 1).

Using the gradient estimated from Sebenik (1981 – sheet 1) and assuming a section width of three miles and transmissivity of 10,000 gpd/ft for sediments beneath the Gila River channel (drillers logs indicate much less coarse sediments than at Hassayampa) results in an estimate of 1,000 ac.-ft./yr. of flow across this line in 1979. Using the gradient estimated from Rascona (1993 – sheet 1) results in an estimate of 2,400 ac.-ft./yr. Groundwater flow out of the ACC area to the south was estimated at 1,000 ac.-ft./yr. by Errol L. Montgomery & Associates, Inc. (1988 - Appendix B, page B-2), which is one order of magnitude smaller than the above estimates. Aquifer tests of the full aquifer system thickness to the southeast of Gillespie Dam would be needed to support or refine the estimates developed in this paragraph.

The water-level change map shown in Sebenik (1979 – sheet 2) indicates the inflow area of the Gila Bend Basin near Gillespie Dam experienced water-level rises of 30 feet between 1973 and 1979. The hydrographs for irrigation wells near the inflow area shown in Rascona (1996 – sheet 2) – (C-03-05 02CBB) dropped through the late 1950s and early 1960s, then rose steadily 90 feet from 1965 to 1974 at which point the water level was 20 feet bls. Water levels in another well near the inflow area to the Gila Bend Basin (C-02-04 26 CBA) rose steadily from 1965 to 1981 at which point the water level was 80 feet bls. Water levels in both these wells have since fluctuated about the points they rose to. In summary, the saturated thickness and gradients increased at the boundary between the Hassayampa Sub-basin and the Gila Bend Basin decreased during the 1950s and early 1960s and then increased between 1965 and the late 1970s. Therefore, groundwater flow out of the Hassayampa Sub-Basin probably followed a similar pattern.

7.5.2 Evapotranspiration

Evapotranspiration estimates for the Centennial Wash Area can be divided into direct evaporation from the water table and transpiration from phreatophytes. Direct evaporation from the water table is neglected for the Centennial Wash Area since the water table is typically deeper than ten feet bls. Evapotranspiration associated with agriculture is substantial, but it occurs well above the water table and is already accounted for in the consumptive use estimates discussed elsewhere.

Estimates of transpiration by phreatophytes for 1974 in the Centennial Wash Area was extracted from Water Resources Associates (1975 – Table 4). The estimate of 18,200 ac.-ft./yr. from 4,900 acres of phreatophytes was based on the assumption of a consumptive use of 3.7 ac.-ft./ac.-yr. Water use by 4,000 acres of phreatophytes in the ACC area for 1985 was estimated by Montgomery (1988 - Appendix B, page B-2) at 24,000 ac.-ft./yr. This estimate assumed a consumptive use of six ac.-ft./ac.-yr. If the 1974 estimate is refined with consumptive use of six ac.-ft./ac.-yr, the 1974 phreatophyte water use is 29,400 ac.-ft./yr. The lower consumptive use estimate is preferred as it likely is more accurate is representing the density of phreatophytes in the area.

7.5.3 Groundwater Flow into the Gila River

As noted in the previous section, water-level elevation contours since the 1970s have indicated flow into the Gila River (commonly called base flow) from a point approximately eight miles north of Gillespie Dam. Before commencement of pumping for irrigation on the Centennial Wash Area in the 1940s, groundwater primarily flowed to the Gila River from the west and northwest.

The rate of groundwater flows into the Gila River in the Centennial Wash Area has not been rigorously estimated at this time, because the sporadic gaging records do not allow unambiguous separation of base flow. Because both the stages in the river and the surrounding groundwater elevations play a role in determining the base flow, model calibration is a promising method for estimating this value. As an initial set of estimates, the flow of groundwater into the Gila River within the Centennial Wash Area may have ranged from tens of thousands of ac.-ft./yr. in 1940 to some rate of perhaps one-third to one-half that value since the 1940s.

7.5.4 Wells

There are four general categories of pumping from wells in the Centennial Wash Area: agricultural, industrial, domestic and stock watering. Since 1983, well owners have been required to report pumping volumes by well for all wells in AMAs pumping more than 35 gpm. Therefore, detailed records are available on a well-by-well basis since 1983. This threshold excludes most domestic wells. Agricultural pumping prior to 1983

is typically estimated based on irrigated acres, crop type and estimated consumptive use and farm efficiency values. Industrial pumping is assumed to include only PVNGS. Domestic pumping can be estimated based on the number of residences or population and estimated consumptive use values.

Stulik (1974 – page 9) estimated agricultural pumping quantities for the entire Lower Hassayampa Area during 1969 at 95,000 ac.-ft./yr. on more than 24,000 acres. Stulik (1974 – page 9) further apportioned 50,000 ac.-ft./yr. – 53% - to the Tonopah-Hassayampa area and 45,000 ac.ft./yr. – 47% - to the Centennial area. Stulik's (1974) Centennial area is essentially the same as the Centennial Wash Area considered here. Stulik (1974 – page 9) estimated pumping quantities for domestic and stock watering to be less than 100 ac.ft/yr. Stulik (1974 – page 9) further noted that extensive agricultural development began in the early 1950s and irrigated lands reached 24,000 acres by 1960.

Industrial pumping for PVNGS was estimated as an increase from zero in the 1960s to a current use estimate of approximately half of the average on-site agricultural use in the seven years ending in 1972 reported by Fugro (1980): 6,000 ac.-ft./yr.

The USGS frequently publishes pumping estimates by area in Arizona. Anning and Duet (1994) is the most recent such summary. It contains pumping estimates for the Lower Hassayampa Area as provided in the first two columns of Table 2.

Table 2 Estimated Pumping in the Lower Hassayampa Area (USGS)

Year	Pumping Total (ac.ft./yr.)	Only Centennial Wash Area
<Prior to 1973>	<Included with Salt River Valley>	<Included with Salt River Valley>
1973	91,000	41,600
1974	89,000	40,700
1975	94,000	43,000
1976	98,000	44,900
1977	84,000	38,400
1978	63,000	28,500
1979	64,000	29,000
1980	74,000	33,700
1981	87,000	39,800
1982	70,000	31,800
1983	48,000	21,400
1984	72,000	32,700
1985	60,000	27,100
1986	31,000	13,400
1987	40,000	17,700
1988	41,000	18,100
1989	47,000	21,000
1990	42,000	18,600

Apportionment of these total pumping estimates to only the Centennial Wash Area can be made by subtracting the pumping by ACC (2,400 ac.-ft./yr.) and then multiplying by the proportion reported by Stulik (1974) of 47%. The results of applying the proportion of 47% to the USGS estimates are also shown in Table 2.

ADWR (1999b) provides files containing the reported pumping to the public over the Internet. These data were reviewed and totals for the Centennial Wash Area and for the three power plants were extracted and summarized in Table 3. In general, pumping has declined since 1983. The wells acquired with the power plant properties accounted for approximately 1/3 of the reported pumping in the Centennial Wash Area since 1983. Comparison for the time periods of overlap between Table 2 (USGS estimates and constant 47% split for the Centennial Wash Area) and Table 3 (ADWR reports for wells in Centennial Wash Area) indicates the differences range between 10 and 40 percent. Therefore, the earlier USGS estimates and constant split appear reasonable.

Table 3 Reported Pumping in the Centennial Wash Area (ADWR)

Year	Pumping Total (ac.ft./yr.)	Only Power Plant-Acquired Wells (ac.-ft./yr.)
1984	25,246	10,413
1985	24,574	11,462
1986	18,702	8,218
1987	18,485	8,058
1988	20,069	7,325
1989	13,837	6,172
1990	15,264	5,424
1991	11,235	3,573
1992	8,504	1,706
1993	7,634	2,228
1994	8,850	2,431
1995	9,468	3,311
1996	9,421	3,885
1997	9,733	3,199
1998	9,372	2,906
15-year Average	14,026	5,354

7.6 Discussion

Estimates by previous investigators or data to make estimates are available for most of the recharge and discharge categories in the Centennial Wash Area. The groundwater inflow and outflow estimates appear to be relatively large, but have less supporting data than other large components such as pumping estimates. The usefulness of the estimates can be tested by comparing them in a simple groundwater budget (Section 8) and in a groundwater flow model that can be calibrated to available water-level data and aquifer test estimates of transmissivity.

8.0 WATER BUDGET

8.1 Introduction

The recharge and discharge component estimates of the previous section are summarized, totaled and compared in this section. As with its components, this water budget is a preliminary effort subject to refinement with additional analysis.

The water budget lumps the entire groundwater system of the Centennial Wash Area together and neglects any restrictions in groundwater flow between sinks and sources within the area. That is, the water budget does not consider the time it takes for inflows to flow towards and interact with outflows. A groundwater model would take these restrictions into account.

8.2 Water Budget

The water budget consists of a summation of inflows and outflows and their difference, which is defined to be the change in storage. The change in storage calculated in this way cannot be compared to individual field measurements such as water-level changes because individual water-level changes do not reflect the averaging across the entire volume of groundwater in the Centennial Wash Area assumed in the water budget. Nevertheless, a water budget is a useful first step in assembling and reviewing individual hydrologic estimates for an area. General patterns of declines or rises in water-level elevations noted in hydrographs would be expected to be represented in the water balance as negative or positive changes in storage, respectively.

Table 4 presents the preliminary groundwater budget for the Centennial Wash Area. The inflows, outflows, and changes in storage are briefly discussed in the following subsections. Reductions were made to the groundwater inflow estimates at Hassayampa (down from 16,000 to 4,000 ac.-ft./yr.) and along Buckeye-Salome Road (down from 50,000 to 10,000 ac.-ft./yr.) in order arrive at negative changes in storage as would be expected from the review of the hydrographs discussed in Section 2.

8.2.1 Inflows

Estimated total groundwater inflows for the Centennial Wash Area ranged from 34,000 ac.-ft./yr. in the 1940s to 56,000 ac.-ft./yr. in the 1970s and currently are approximately 44,000 ac.-ft./yr. The largest components have consistently been the agricultural leaching requirement, infiltration from the Arlington Canal, and groundwater inflow along the Buckeye-Salome Road.

Table 4 Centennial Wash Area Preliminary Groundwater Budget

(all inflows, outflows and change in storage values are in acre-feet per year)

	1940s	1950s	1960s	1970s	1980s	1990s
Arlington Valley Irrigation (ac.)	4,000	4,000	4,000	4,000	3,500	3,000
Centennial Wash Irrig. (ac.)	0	5,200	5,200	5,200	5,200	1,500
Palo Verde Hills Irrig (ac.)	0	1,500	1,500	1,500	0	0
Mullen's Cut Irrigation (ac.)	0	600	600	600	600	300
Total Irrigated Area (ac.)	4,000	11,300	11,300	11,300	9,300	4,800
Avg. Crop Consumptive Use	3.30	3.30	3.30	3.30	3.30	3.30
Avg. Farm Efficiency	0.60	0.60	0.60	0.60	0.70	0.75
Phreatophyte Area (ac.)	6,000	4,000	2,000	5,000	4,000	4,000
Phreatophyte Consump. Use	3.7	3.7	3.7	3.7	3.7	3.7
Population	200	200	200	200	200	200
Mountain Front (miles)	30	30	30	30	30	30
Annual Precipitation (in.yr)	8	8	8	8	8	8
Inflows						
Groundwater at Hassayampa	4,000	4,000	4,000	4,000	4,000	4,000
Groundwater at Buckeye-Salome Rd.	10,000	10,000	10,000	10,000	10,000	10,000
Groundwater at Mullen's Cut	200	150	100	0	0	0
Mountain Front Infiltration	281	281	281	281	281	281
Gila River Infiltration	0	0	4,000	6,000	8,000	8,000
Hassayampa River Infiltration	100	0	0	100	100	100
Centennial Wash Infiltration	200	0	0	200	200	200
Agricultural Leaching Requirement	7,000	23,060	23,060	23,060	14,328	7,230
Arlington Canal Infiltration	12,000	12,000	12,000	12,000	12,000	12,000
TOTAL	33,781	49,491	53,441	55,641	48,909	41,811
Outflows						
Groundwater at Gillespie Dam	2,000	1,500	1,000	1,500	2,000	2,000
Phreatophytes	22,200	14,800	7,400	18,500	14,800	14,800
Flow to Gila River	10,000	10,000	10,000	10,000	10,000	10,000
Agricultural Pumping	2,400	39,250	39,250	39,250	26,914	9,000
Industrial Pumping	0	0	0	1,000	2,000	3,000
Domestic Pumping	243	243	243	243	243	243
Pumping for Livestock Watering	122	122	122	122	122	122
TOTAL	36,965	65,915	58,015	70,615	56,079	39,165
Change in Storage (Inflows-Outflows)	-3,183	-16,423	-4,573	-14,973	-7,170	2,647
relative % difference	-9.00%	-28.46%	-8.21%	-23.72%	-13.66%	6.54%

8.2.2 Outflows

Estimated total groundwater outflows for the Centennial Wash Area ranged from 35,000 ac.-ft./yr. in the 1940s to 72,000 ac.-ft./yr. in the 1970s and currently are approximately 47,000 ac.-ft./yr. The largest components have consistently been agricultural pumping, phreatophyte transpiration and flow to the Gila River.

8.2.3 Changes in Storage

Estimated total changes in groundwater storage for the Centennial Wash Area (using this preliminary water balance) ranged from essentially zero in the 1940s to 17,000 ac.-ft./yr. in the 1950s and currently are approximately 3,000 ac.-ft./yr. The calculated changes in storage are not consistent in value during the 1950s, 1960s and 1970s as would be expected for the relatively consistent declines noted in the hydrographs in Section 2.

8.3 Discussion

Review of the preliminary water budget for the Centennial Wash Area indicates that some of the recharge and discharge components developed in Section 7 should be refined. Water budget components associated with irrigated agriculture should be verified, such as irrigated acres, consumptive use, and farm efficiencies. With these numbers set, the groundwater inflows at boundaries and to and from the Gila River should be adjusted to achieve consistent negative changes in groundwater storage (deficits) for the 1950s, 1960s, and 1970s as indicated by the hydrograph responses in the Centennial Wash Area. An example is the reduction in the boundary flows suggested by the water balance and discussed at the beginning of this section.

The results of testing preliminary recharge and discharge estimates by comparing them in the water balance points out the need to build a groundwater model that can be used to not only check the water balance, but check the simulated water-level elevations associated with estimated water budget components. The revisions suggested here can be incorporated into the model as it is built and calibrated.

9.0 DISCUSSION

9.1 Conclusions

Based on the information available to date, it appears that approximately 40,000 ac.-ft./yr. of pumping for agriculture in the Centennial Wash Area from approximately 1950 to 1980 resulted in water-level declines near pumping centers of over 100 feet. During the times of largest drawdowns in the pumping centers, water-level elevations in areas a few miles from the pumping centers fluctuated up and down by only a few feet.

Proposed pumping for the power plants is estimated here at 16,000 to 18,000 ac.-ft./yr. Therefore, the response of the groundwater system to pumping for the power plants - water-level declines - may be expected to be a fraction (perhaps one third to half) of that observed in the past in response to agricultural pumping.

9.2 Recommendations

The conclusions of this interim report should be tested by refining the water budget components through model calibration and conducting simulations of 30 years of power plant pumping. A model provides for consistent comparison of simulated water level elevations with measured water-level elevations (calibration targets) and therefore is a more severe test of water budget components than a simple, lumped water balance. The available water-level data will provide suitable targets for model calibration.

In developing the model, agricultural water use characteristics of the area during the past 50 years should be further investigated and the relevant water budget component estimates should be refined. Estimates of flow to and from the Gila River should be refined as part of model calibration.

To further support and guide the calibration of the model, additional estimates of hydraulic parameters should be developed through the conduct of aquifer tests in the principal aquifer system at several locations using observation wells, as they are available and access can be obtained. The hydraulic parameter estimates resulting from the aquifer tests can be incorporated into the model during calibration and can serve as additional calibration targets.

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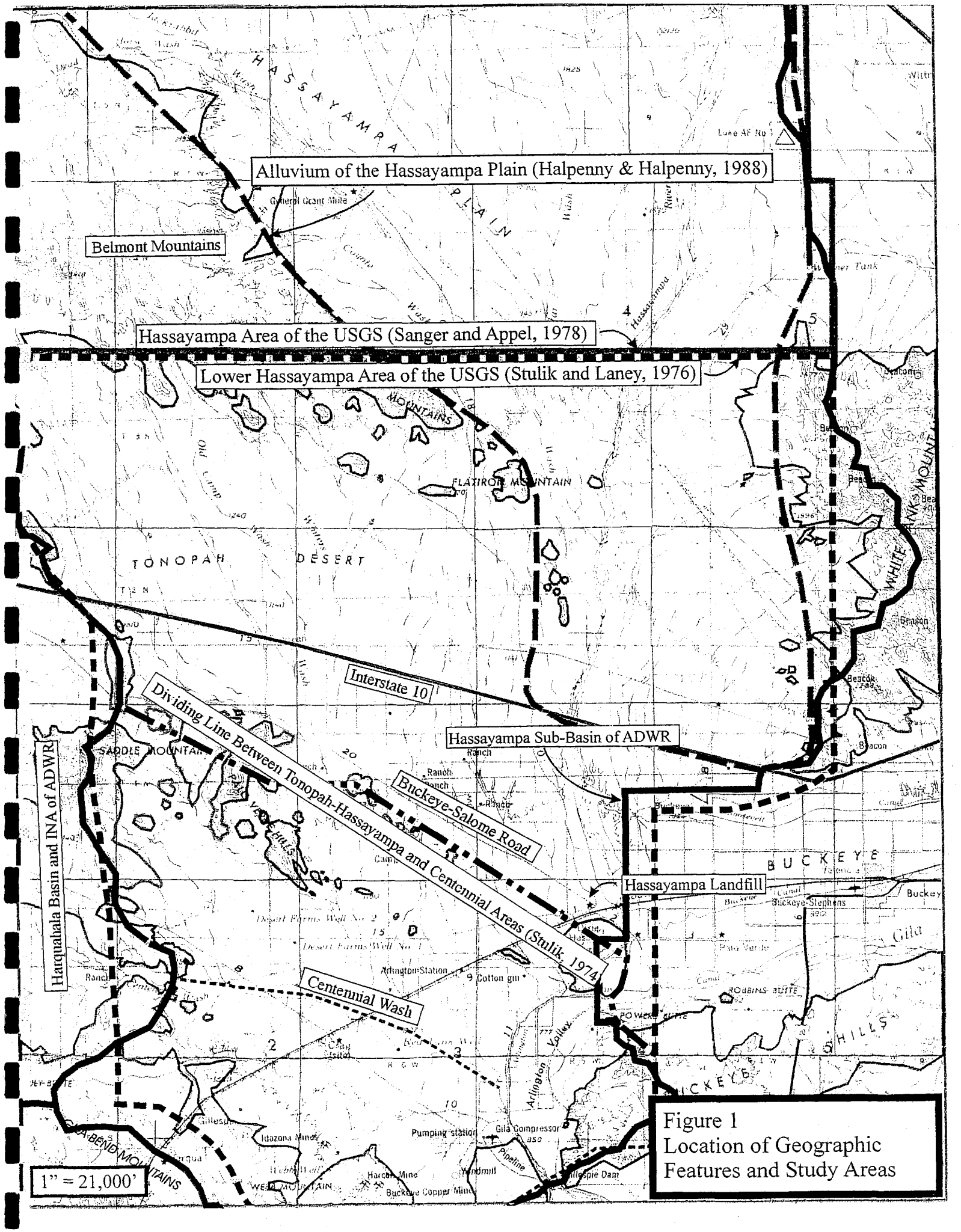
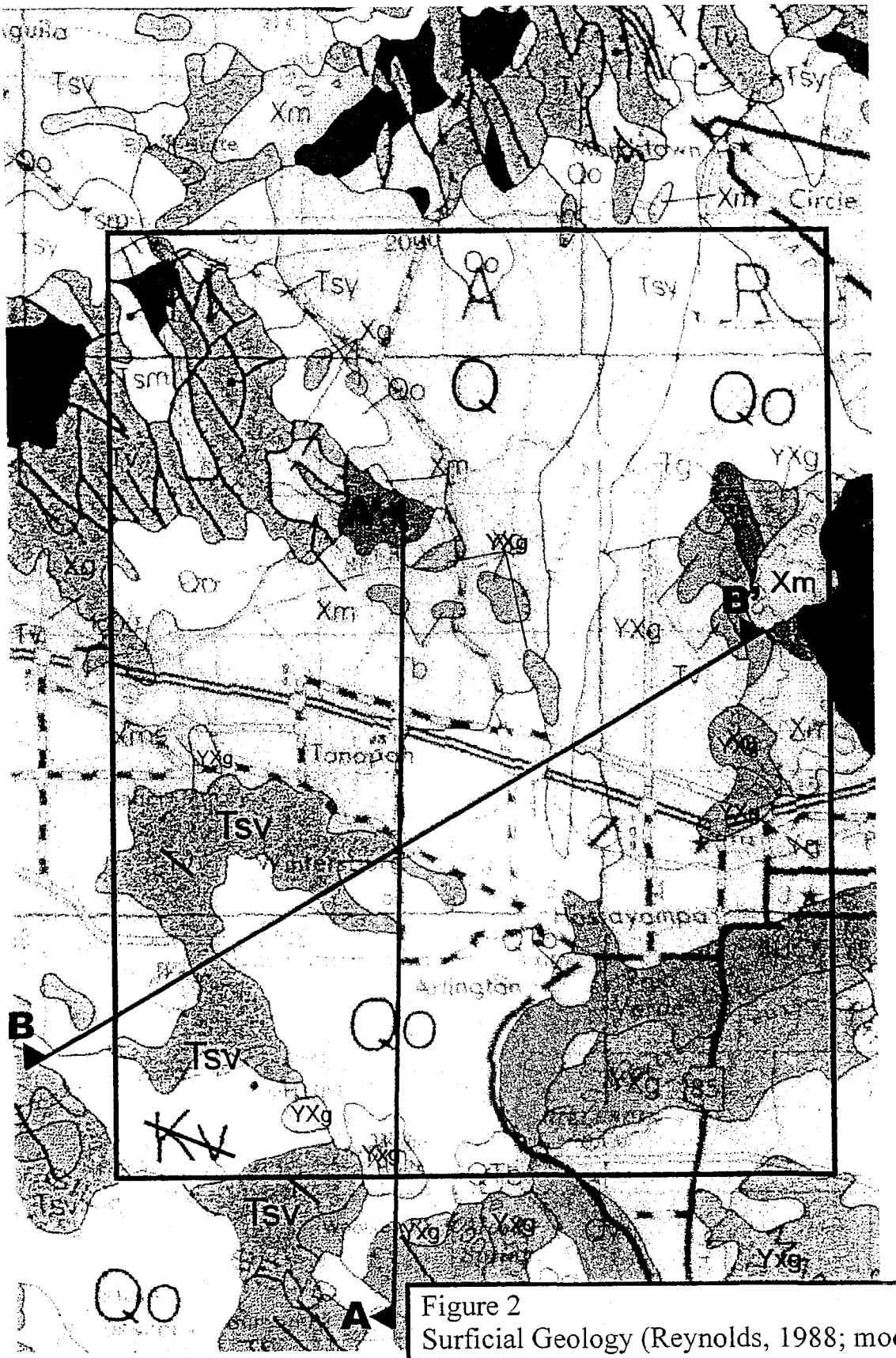
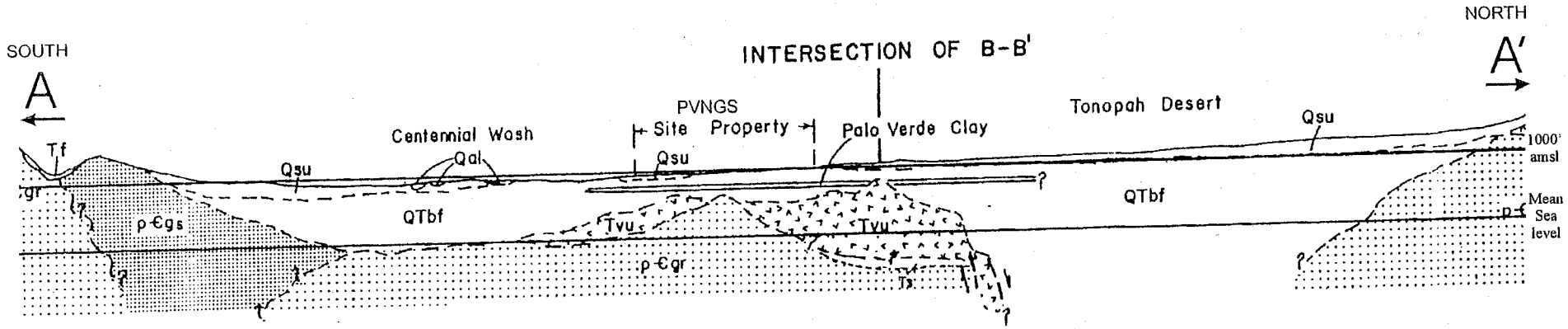


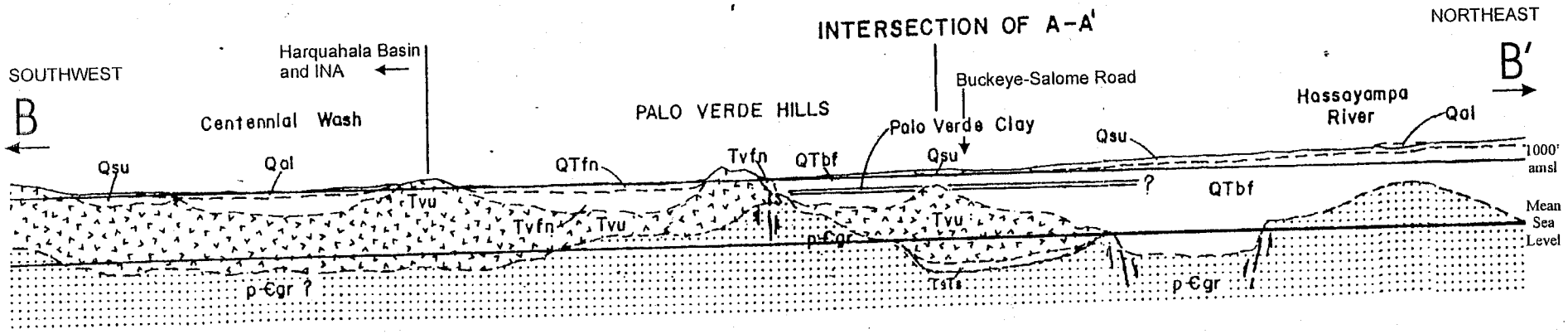
Figure 1
Location of Geographic Features and Study Areas



1" = 35,200'

Figure 2
Surficial Geology (Reynolds, 1988; modified from Kamilla and Richard, 1998) and Locations of Geologic Cross-Sections (Fugro, 1978)





0 10,000 20,000
Horizontal Scale in Feet

Correlations:
pCgr: Precambrian granite and gneiss
Ts: Tertiary tuffaceous sandstones and arkosic conglomerates
Tvu: Tertiary Volcanics
Tvfn: Red Unit
QTfn: LAU
QTbf: MAU
Qsu, Qal: UAU

Figure 3
Regional Geologic Cross-Sections
(Modified from Fugro, 1980 - Figure 2.5-8)

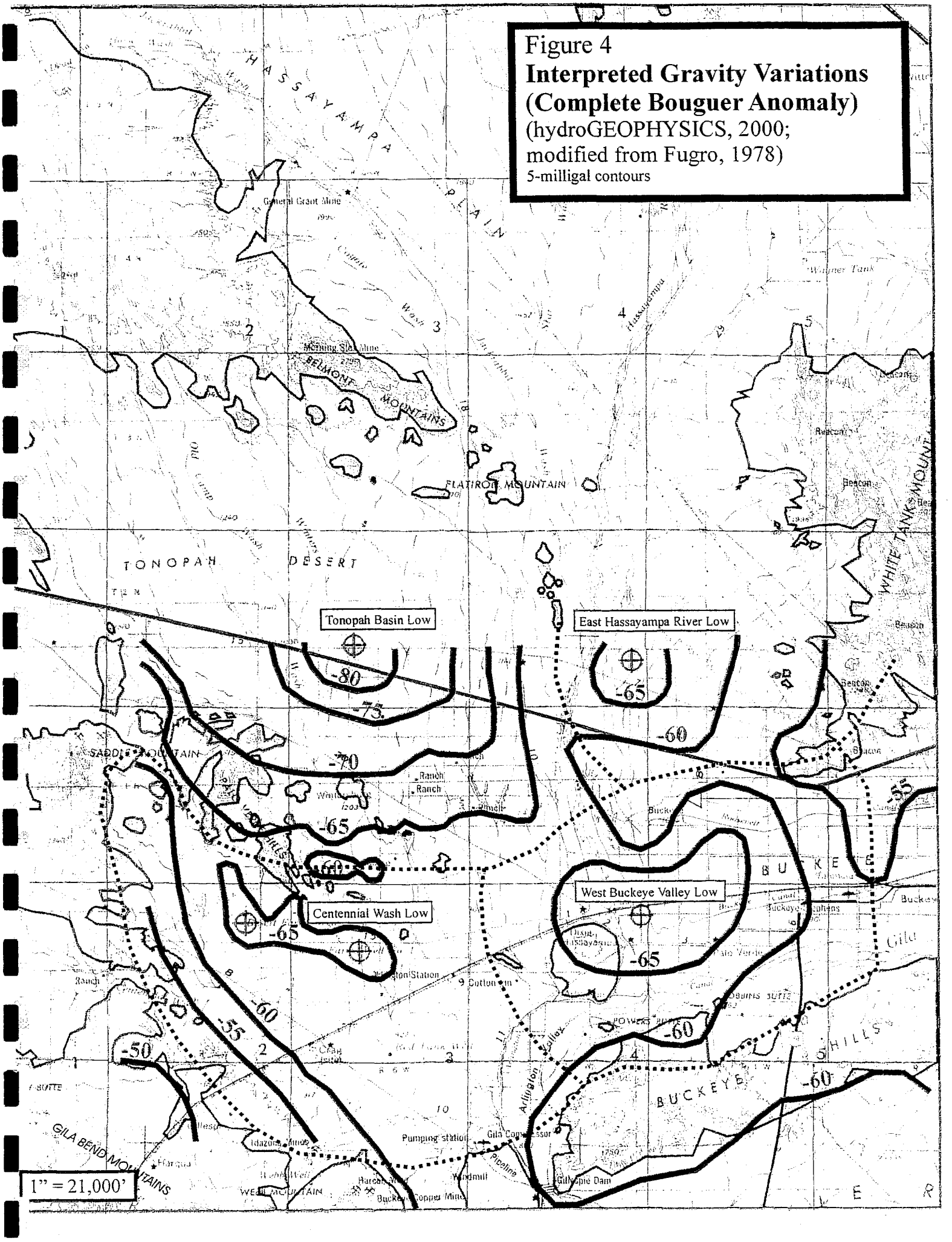


Figure 4
Interpreted Gravity Variations
(Complete Bouguer Anomaly)
(hydroGEOPHYSICS, 2000;
modified from Fugro, 1978)
5-milligal contours
HASSAYAMPA PLAIN
BELMONT MOUNTAINS
FLATIRON MOUNTAIN
TONOPAH DESERT
WHITE TANK MOUNTAINS
SADDLE MOUNTAIN
BUCKEYE HILLS
GILA BEND MOUNTAINS
Tonopah Basin Low
East Hassayampa River Low
West Buckeye Valley Low
Centennial Wash Low
-80
-75
-70
-65
-60
-55
-50
1" = 21,000'

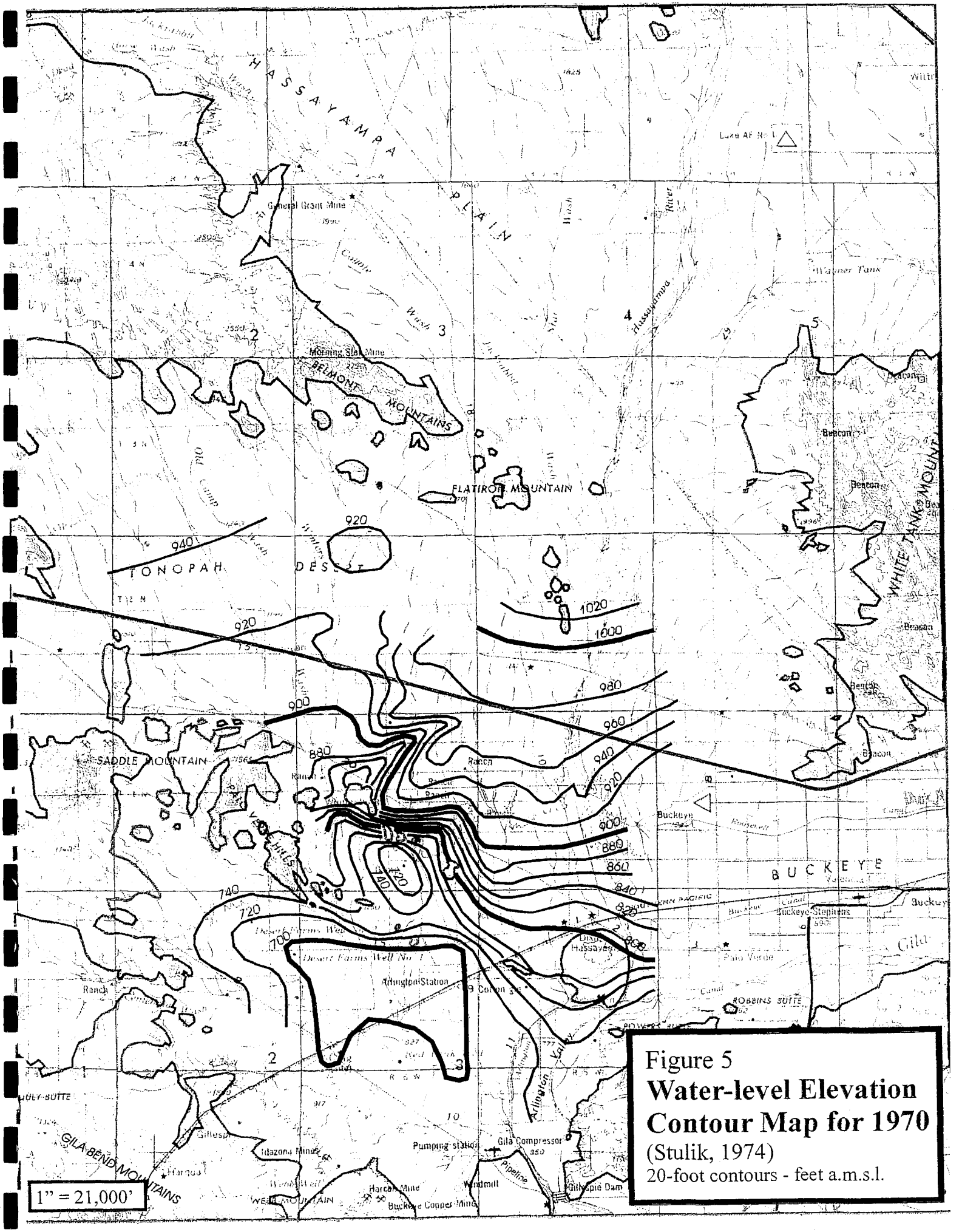


Figure 5
Water-level Elevation Contour Map for 1970
(Stulik, 1974)
20-foot contours - feet a.m.s.l.

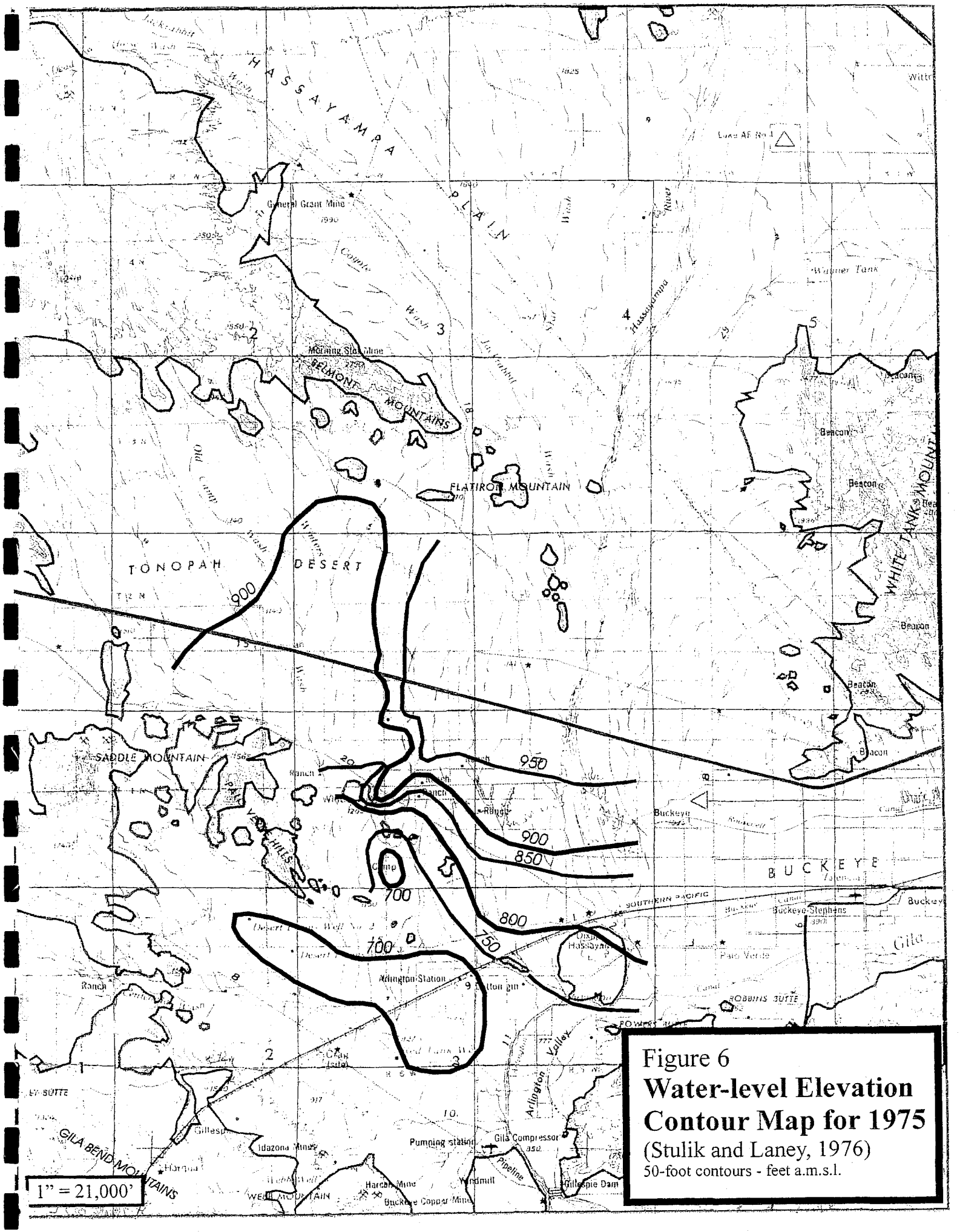


Figure 6
Water-level Elevation Contour Map for 1975
(Stulik and Laney, 1976)
50-foot contours - feet a.m.s.l.

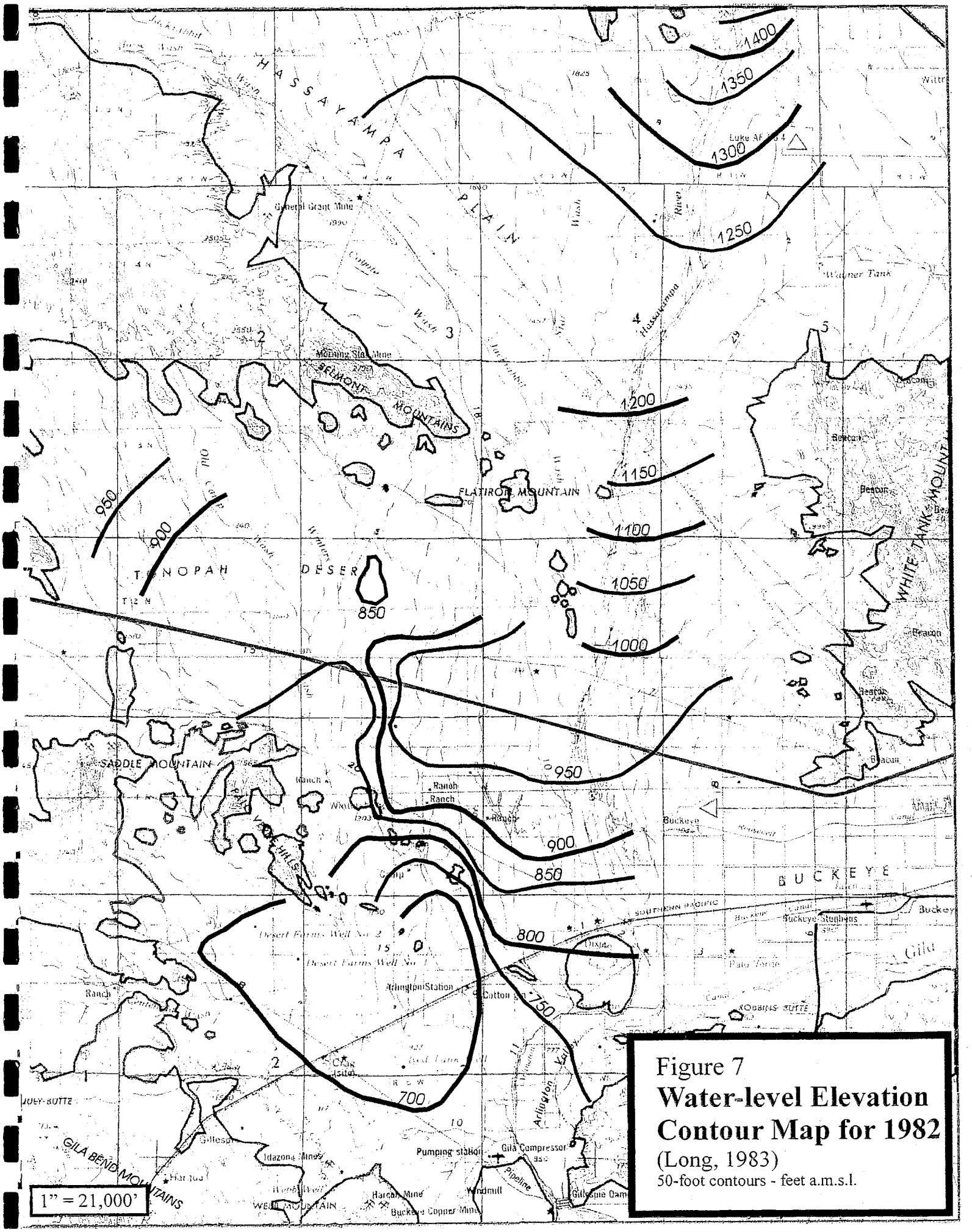


Figure 7
Water-level Elevation Contour Map for 1982
(Long, 1983)
50-foot contours - feet a.m.s.l.

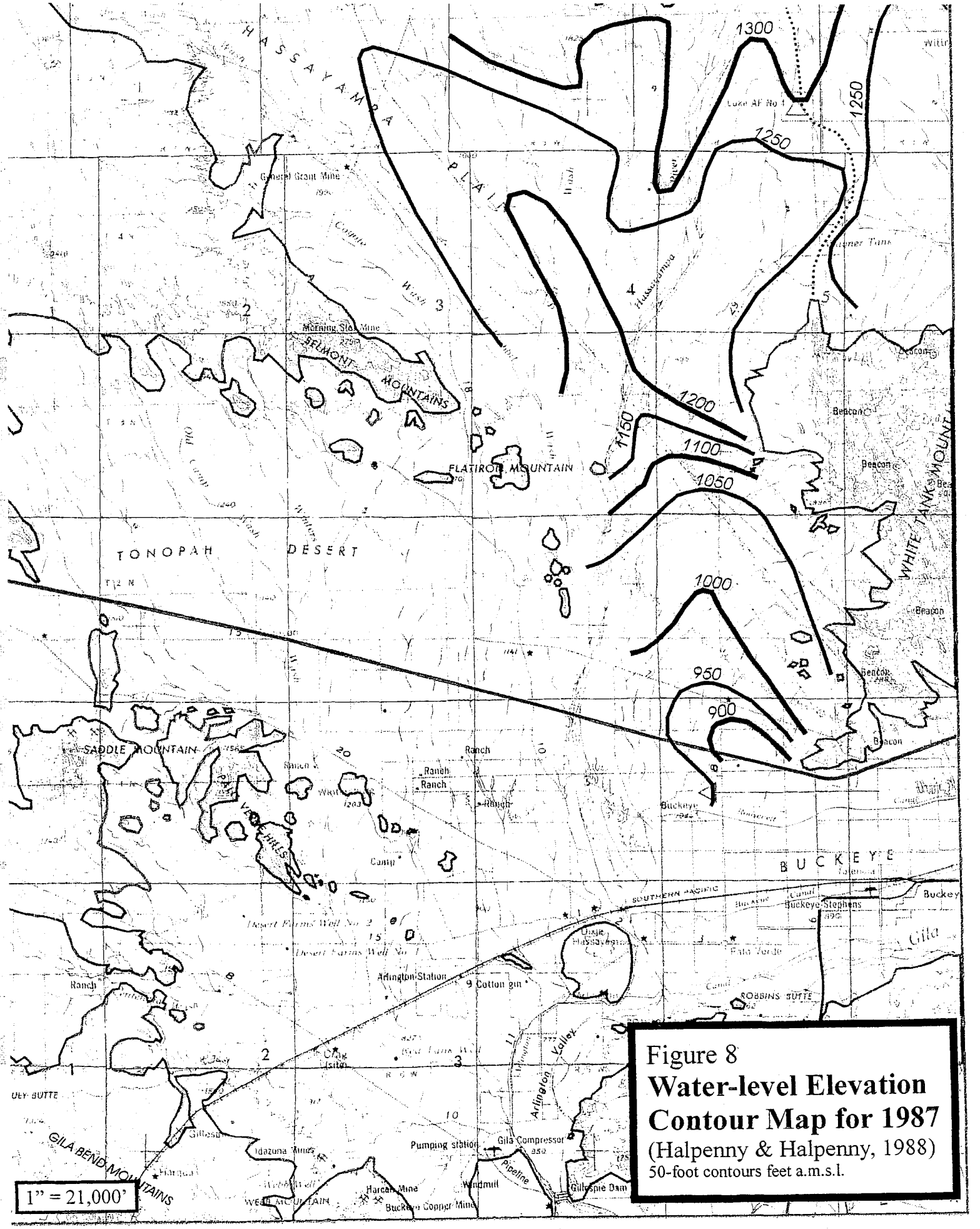


Figure 8
Water-level Elevation Contour Map for 1987
(Halpenny & Halpenny, 1988)
50-foot contours feet a.m.s.l.

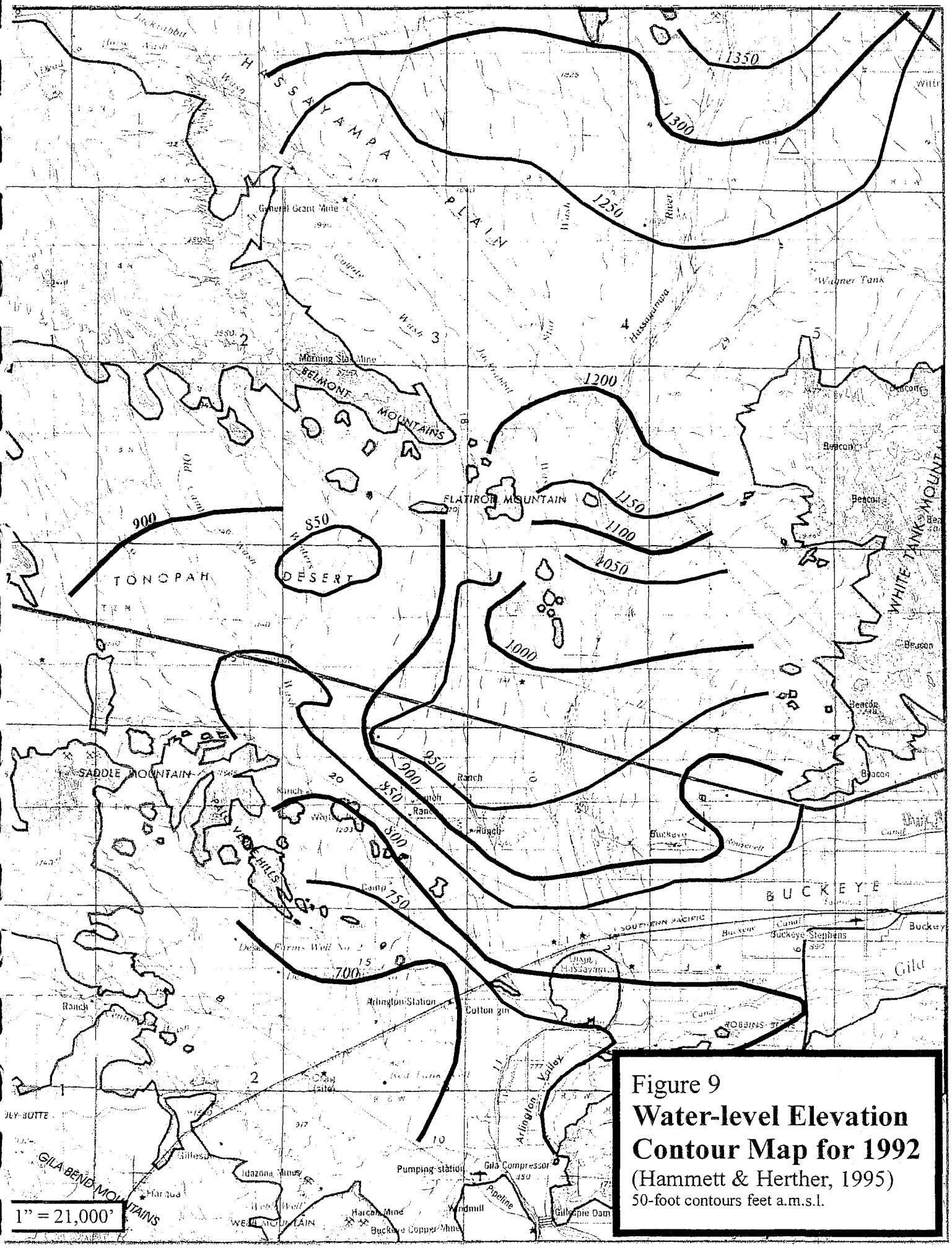


Figure 9
Water-level Elevation Contour Map for 1992
(Hammett & Herther, 1995)
50-foot contours feet a.m.s.l.

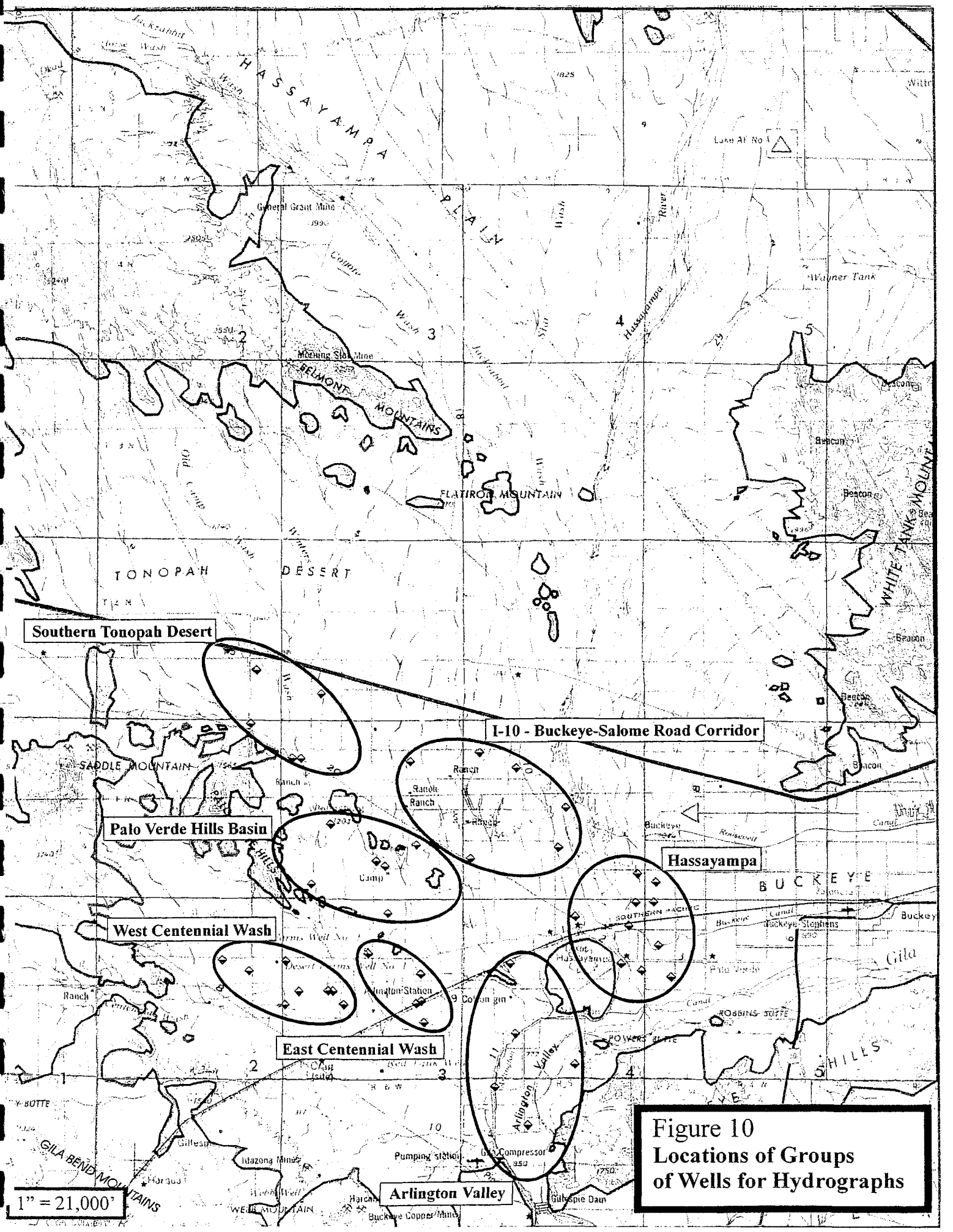


Figure 10
Locations of Groups of Wells for Hydrographs

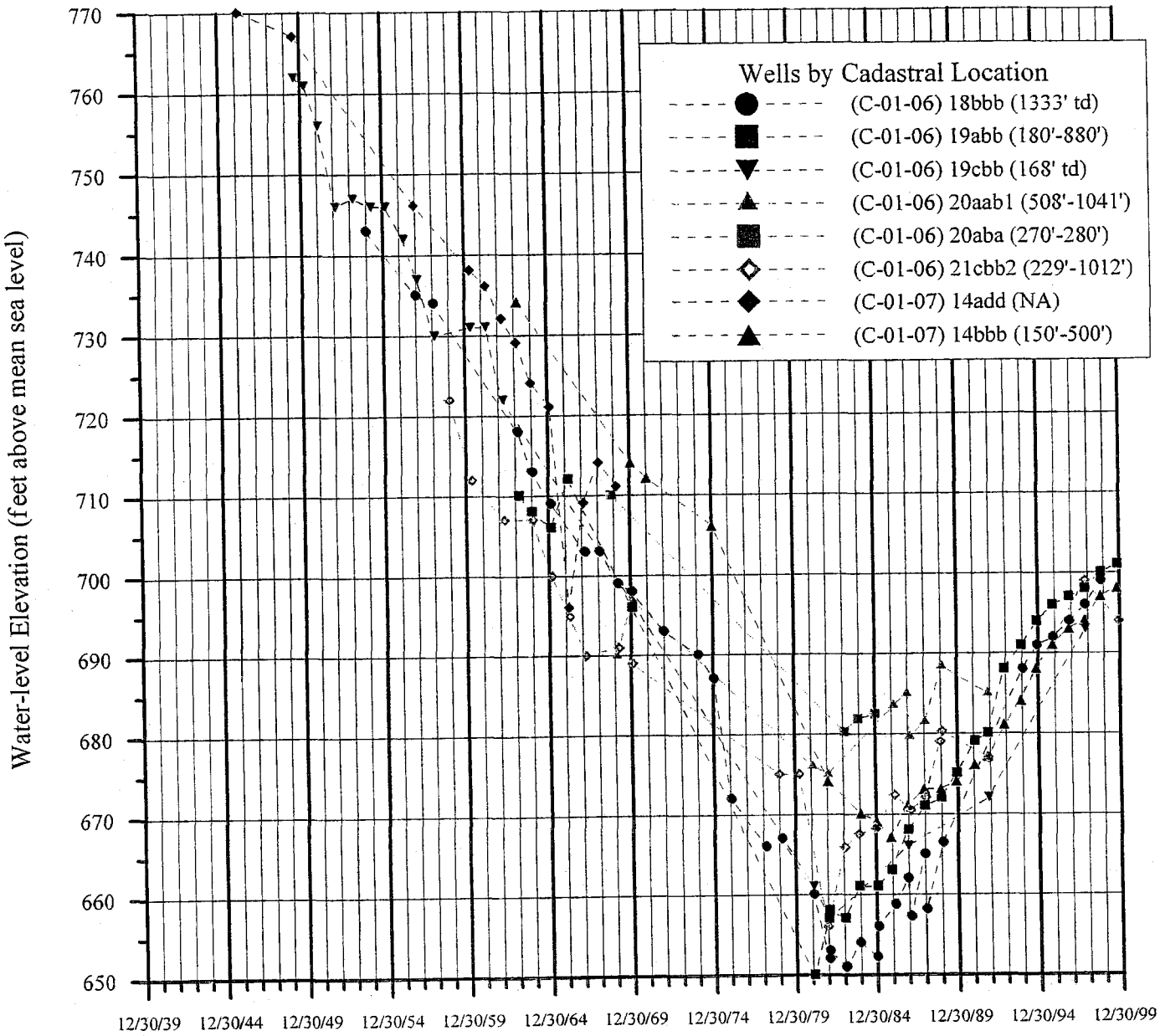


Figure 11 Hydrographs for Wells in the Western Centennial Wash Area

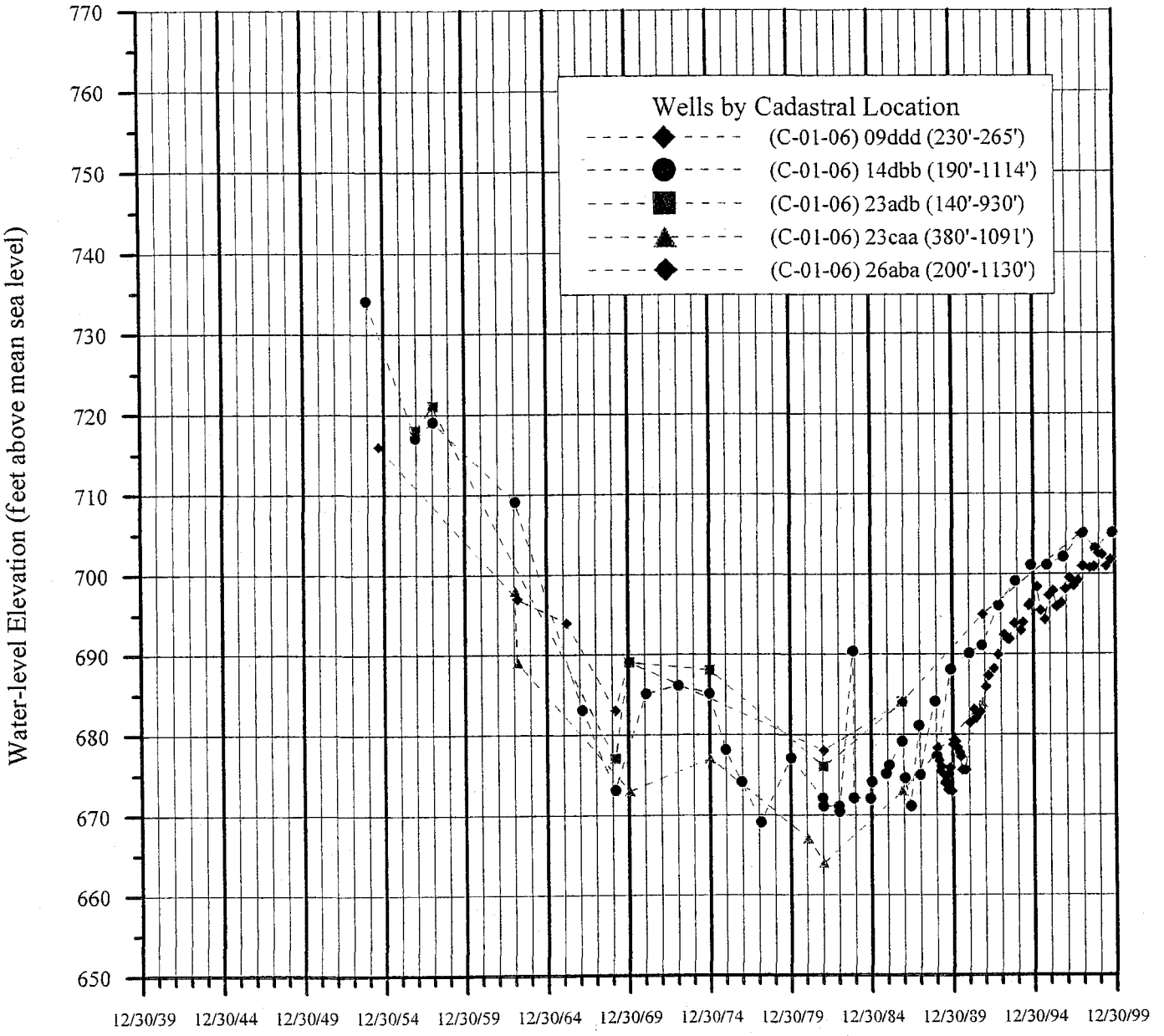


Figure 12 Hydrographs for Wells in the Eastern Centennial Wash Area

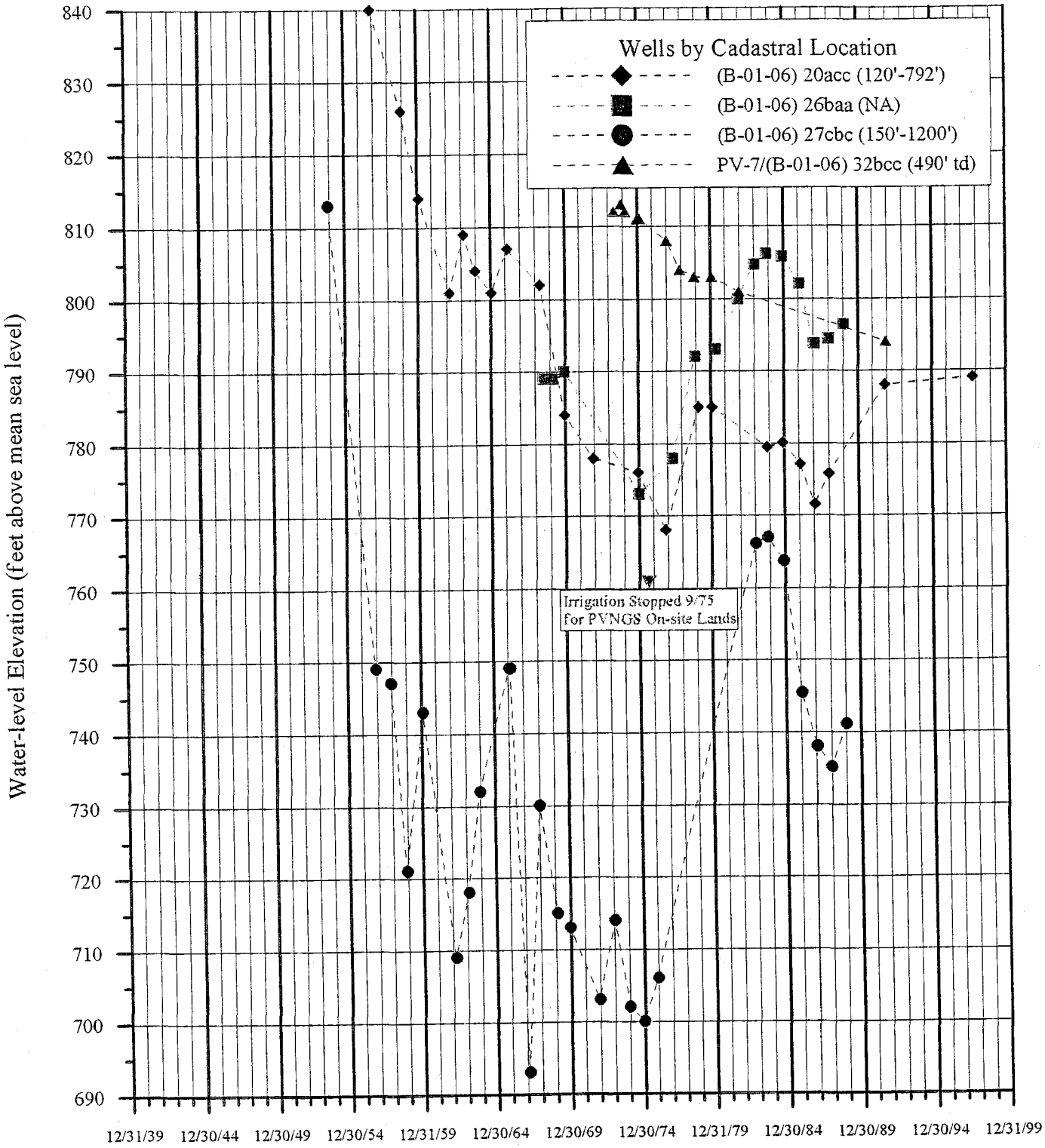


Figure 13 Hydrographs for Deep Wells in the Palo Verde Hills Area

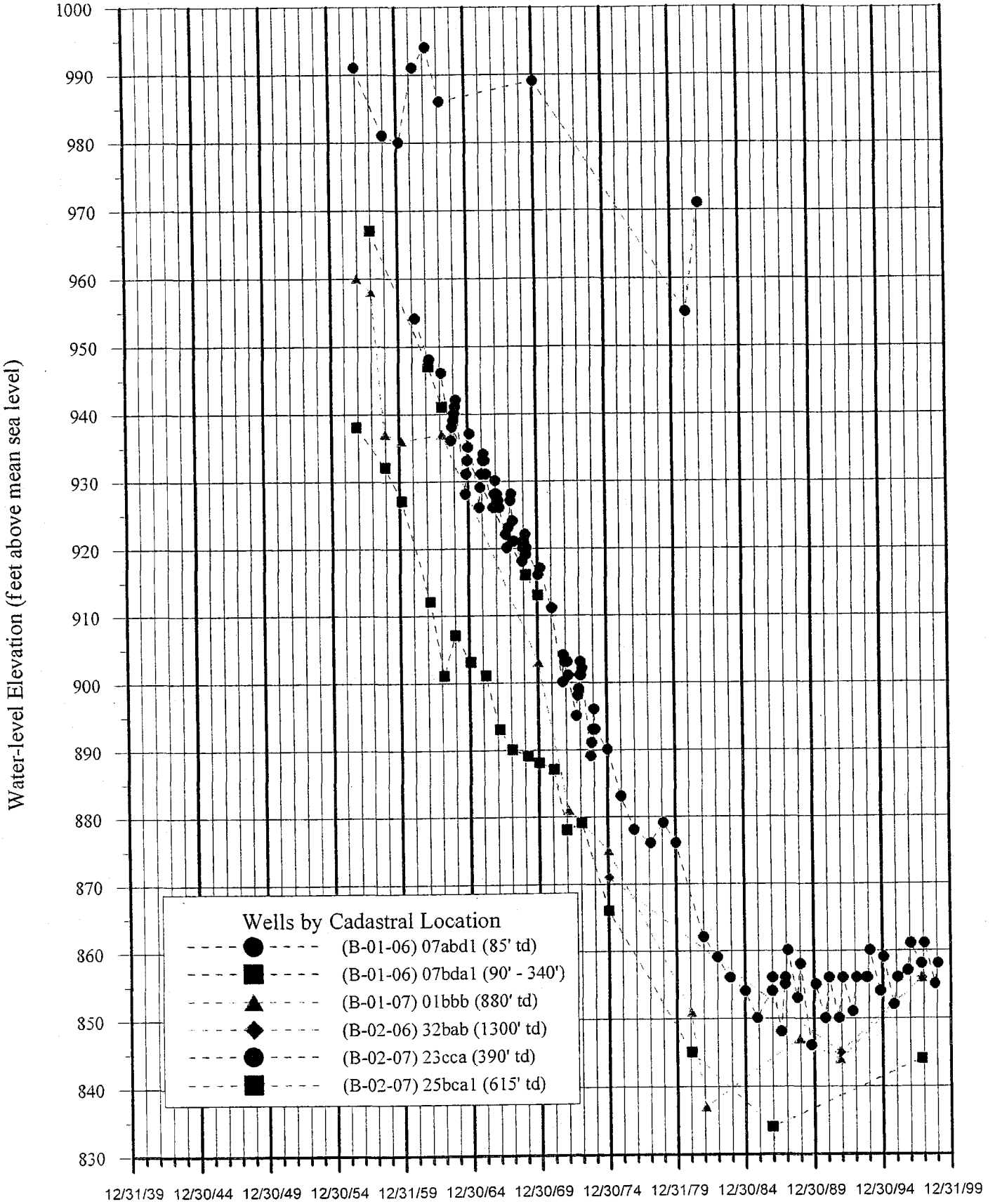


Figure 15 Hydrographs for Wells in the Southern Tonopah Desert Area

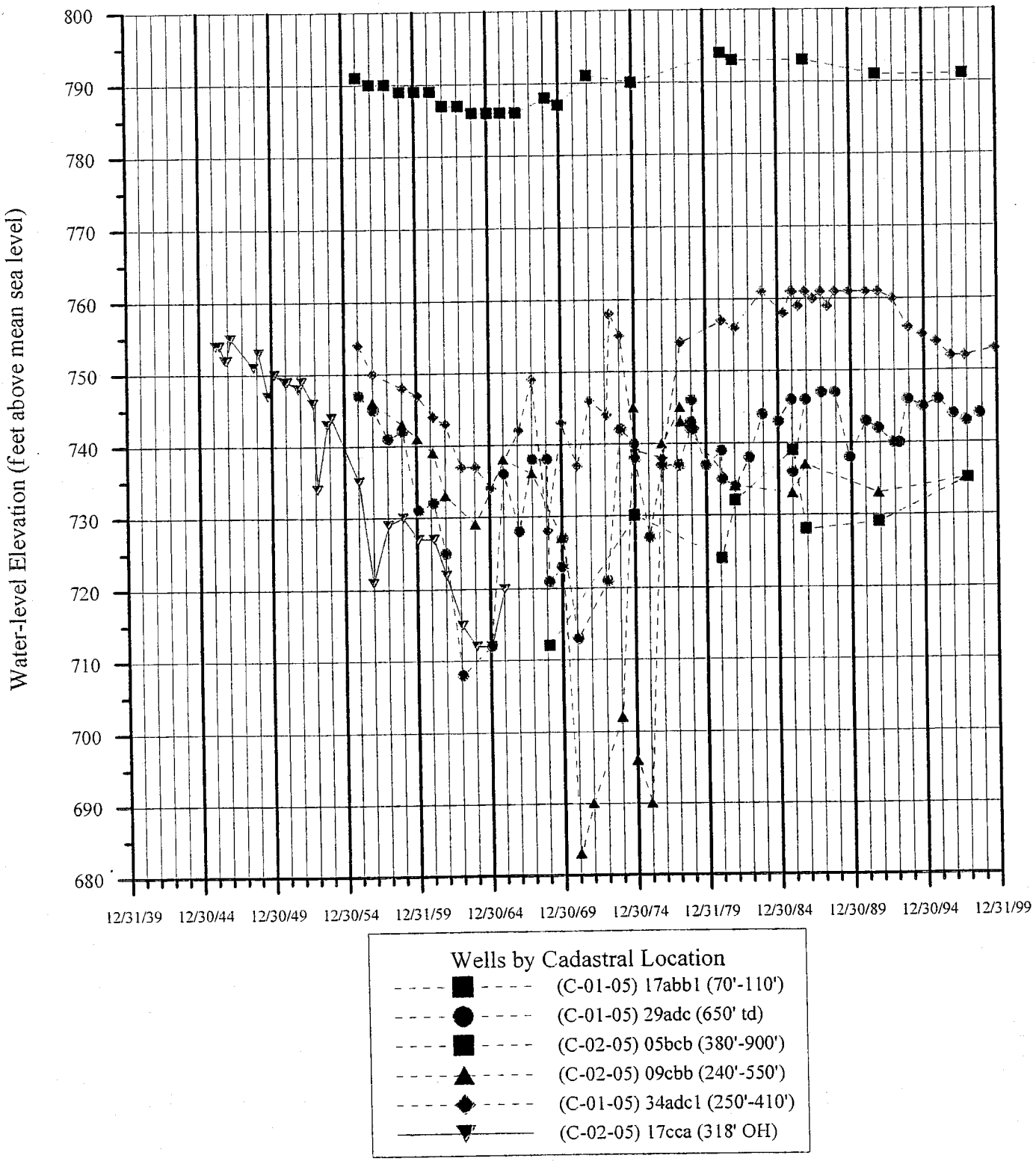


Figure 16 Hydrographs for Wells in the Arlington Valley Area

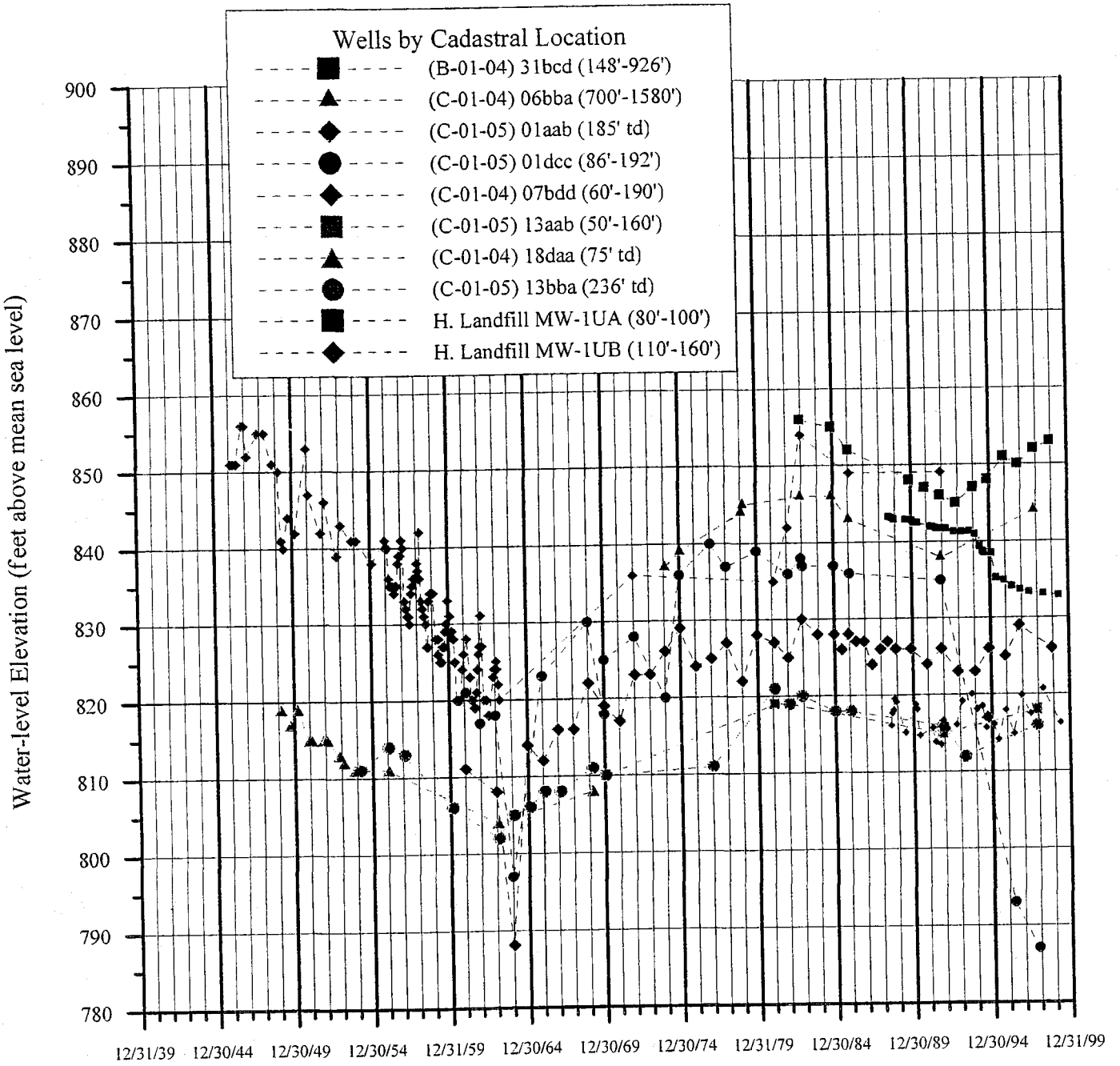


Figure 17 Hydrographs for Wells in the Hassayampa Area

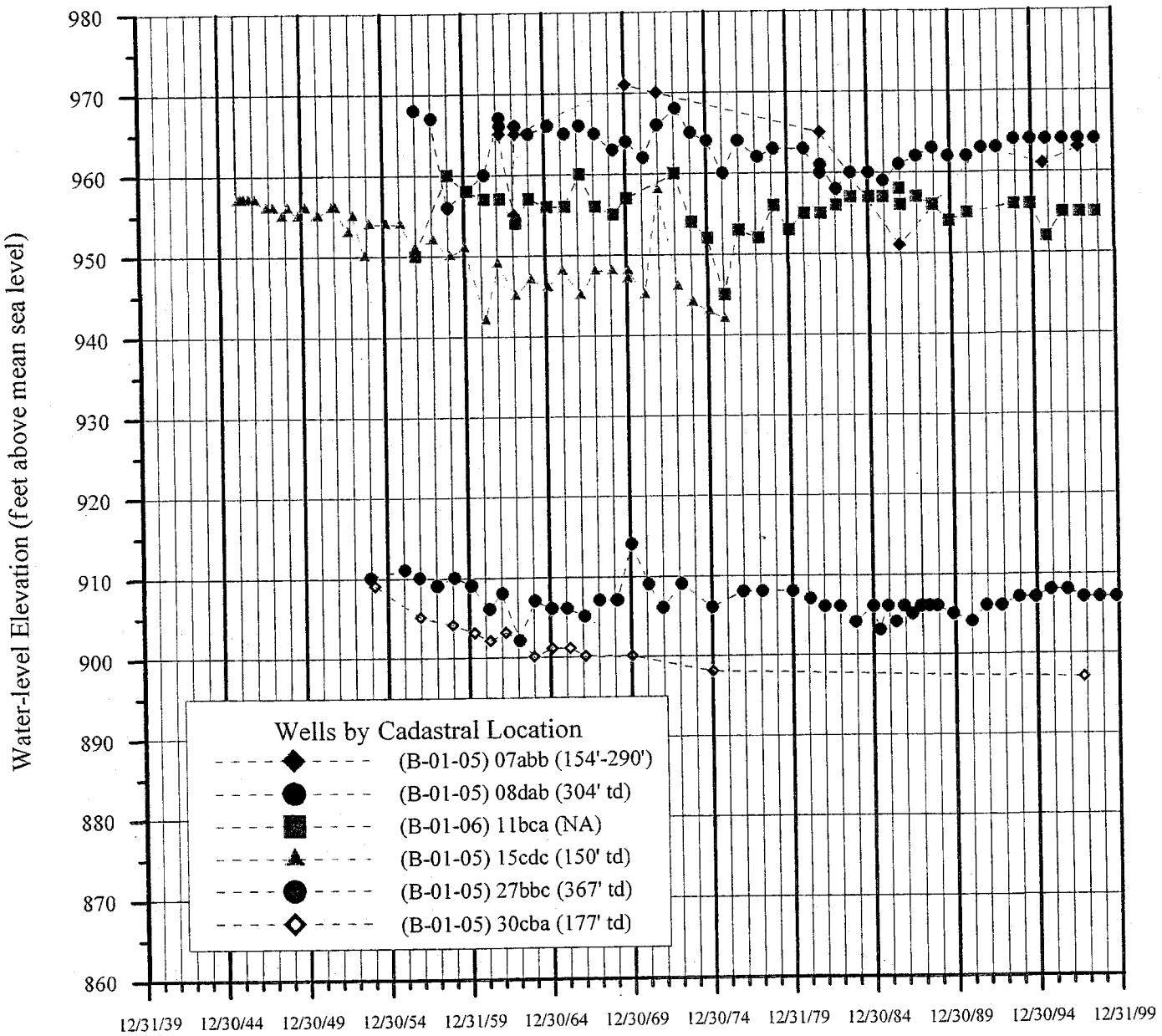


Figure 18 Hydrographs for wells in the I-10 - Buckeye-Salome Road Corridor

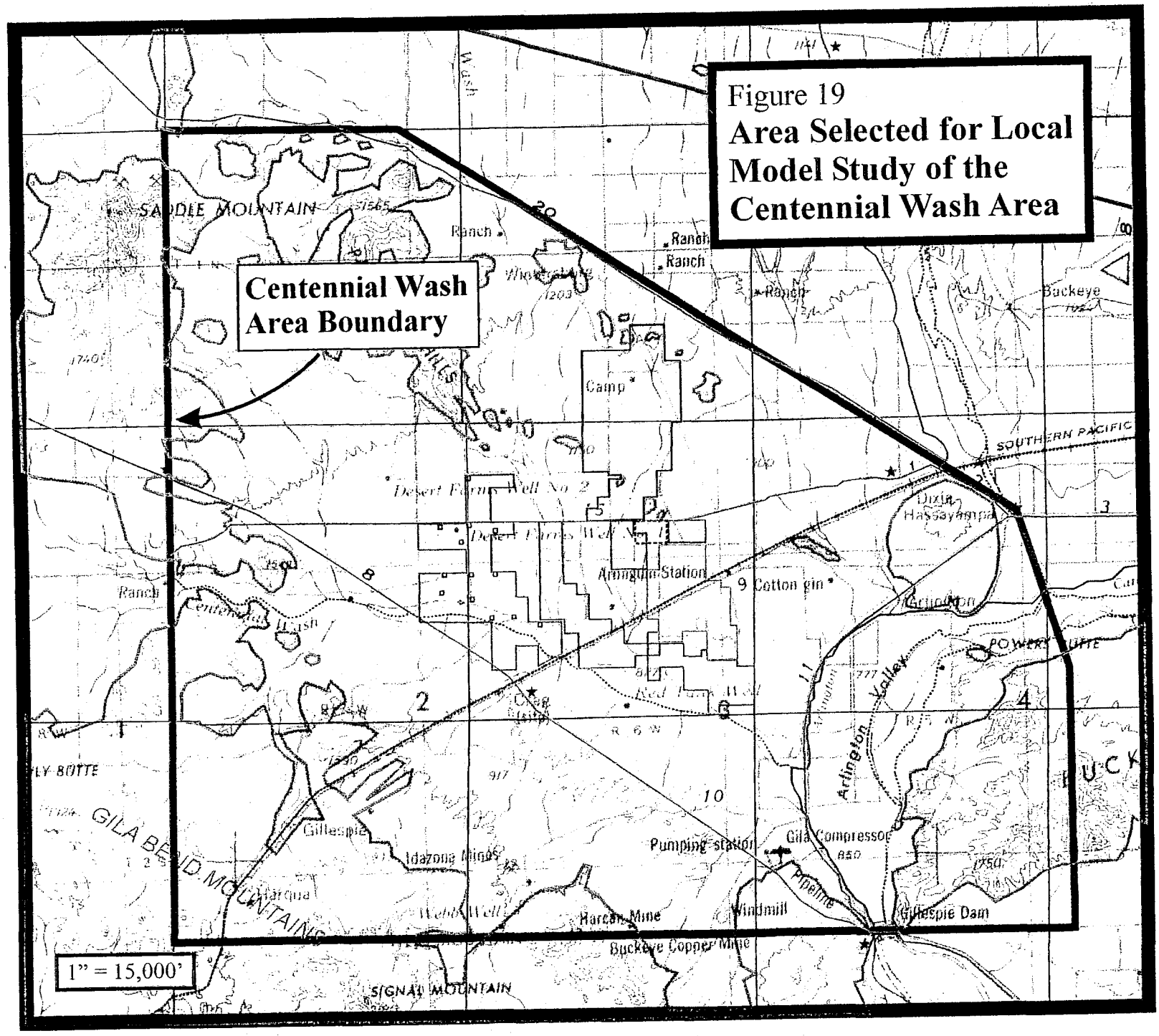


Figure 19
Area Selected for Local Model Study of the Centennial Wash Area

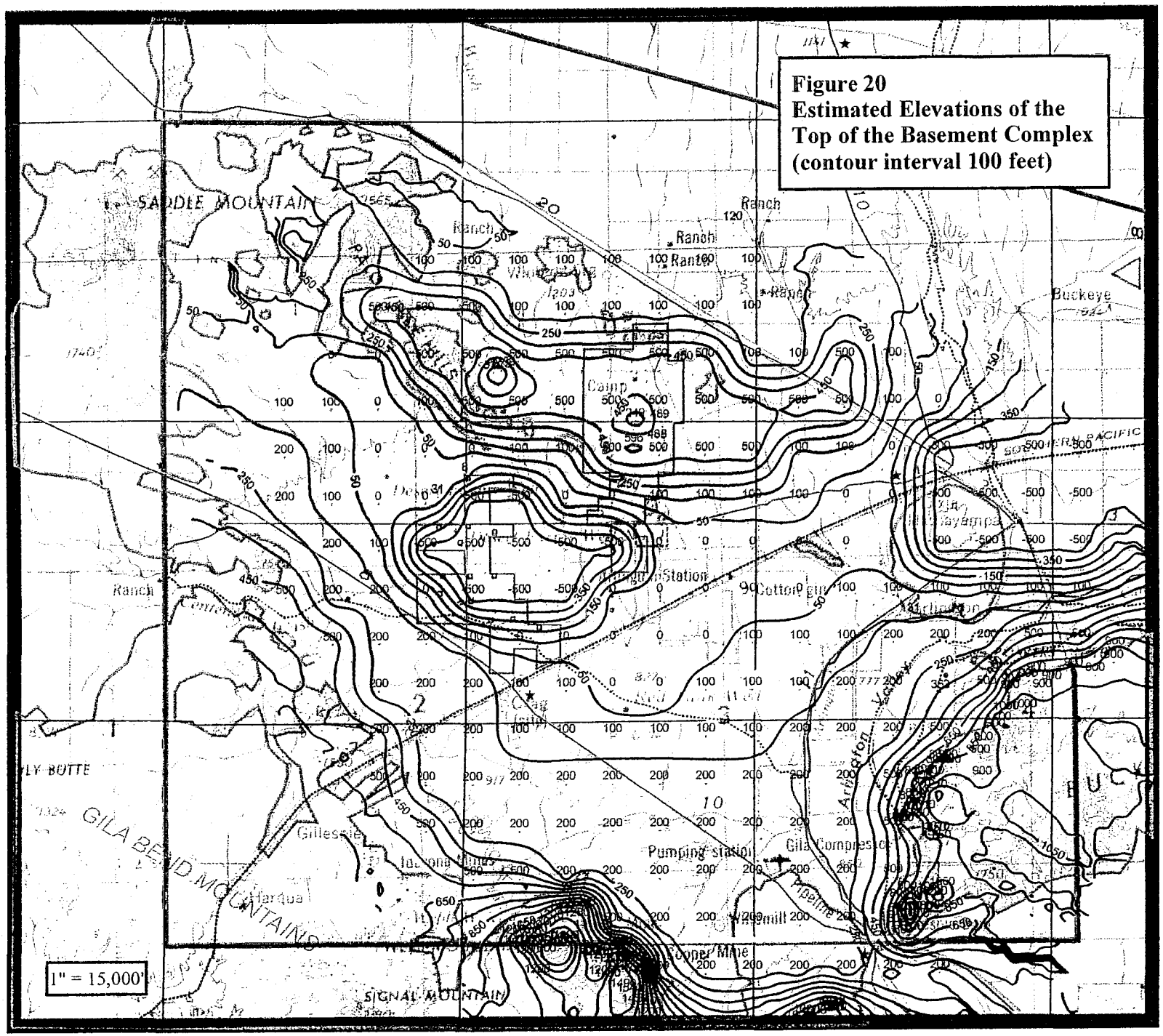


Figure 20
Estimated Elevations of the Top of the Basement Complex (contour interval 100 feet)

T_pCGr.srf

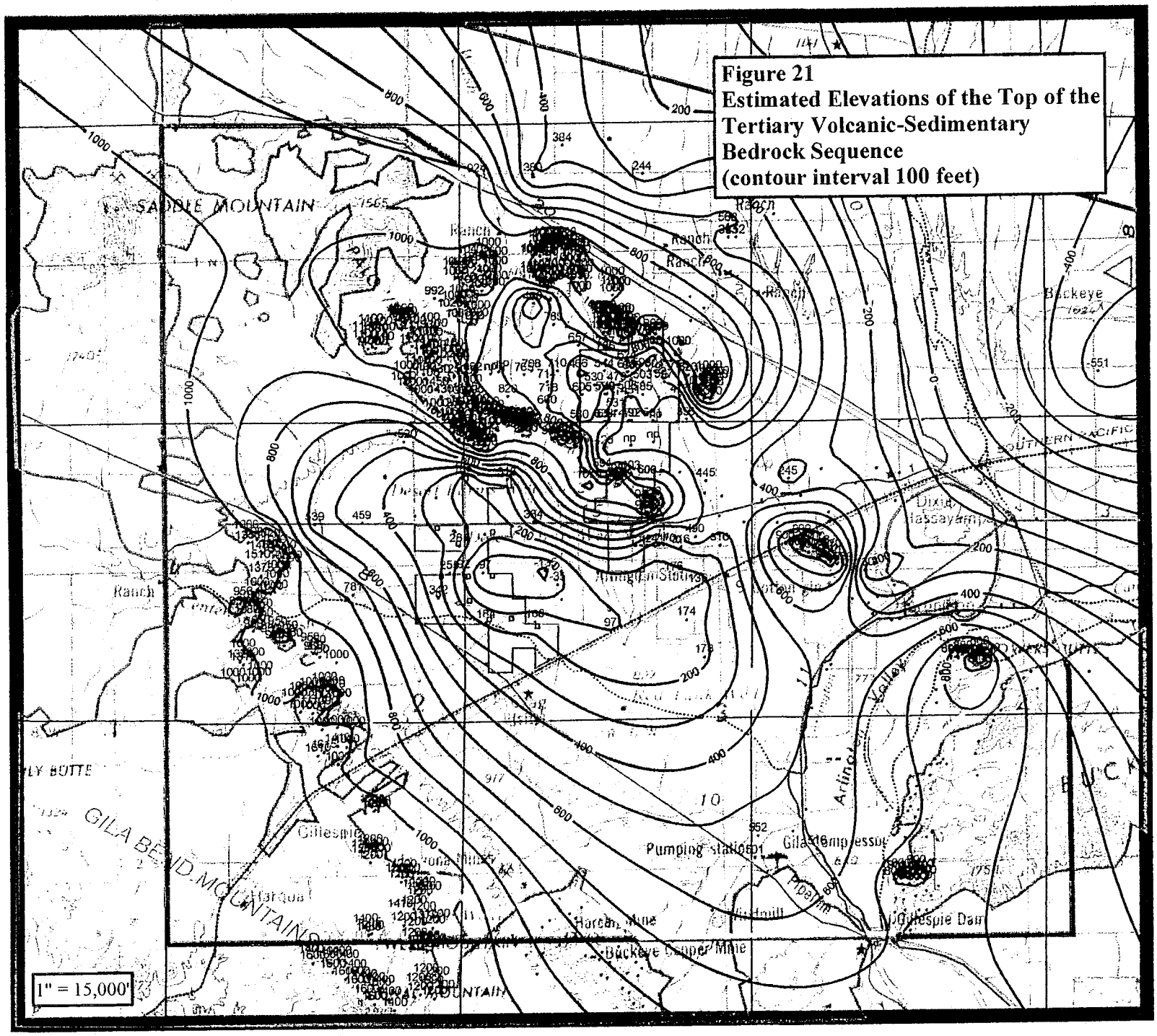


Figure 21
Estimated Elevations of the Top of the Tertiary Volcanic-Sedimentary Bedrock Sequence (contour interval 100 feet)

T_Tv.srf

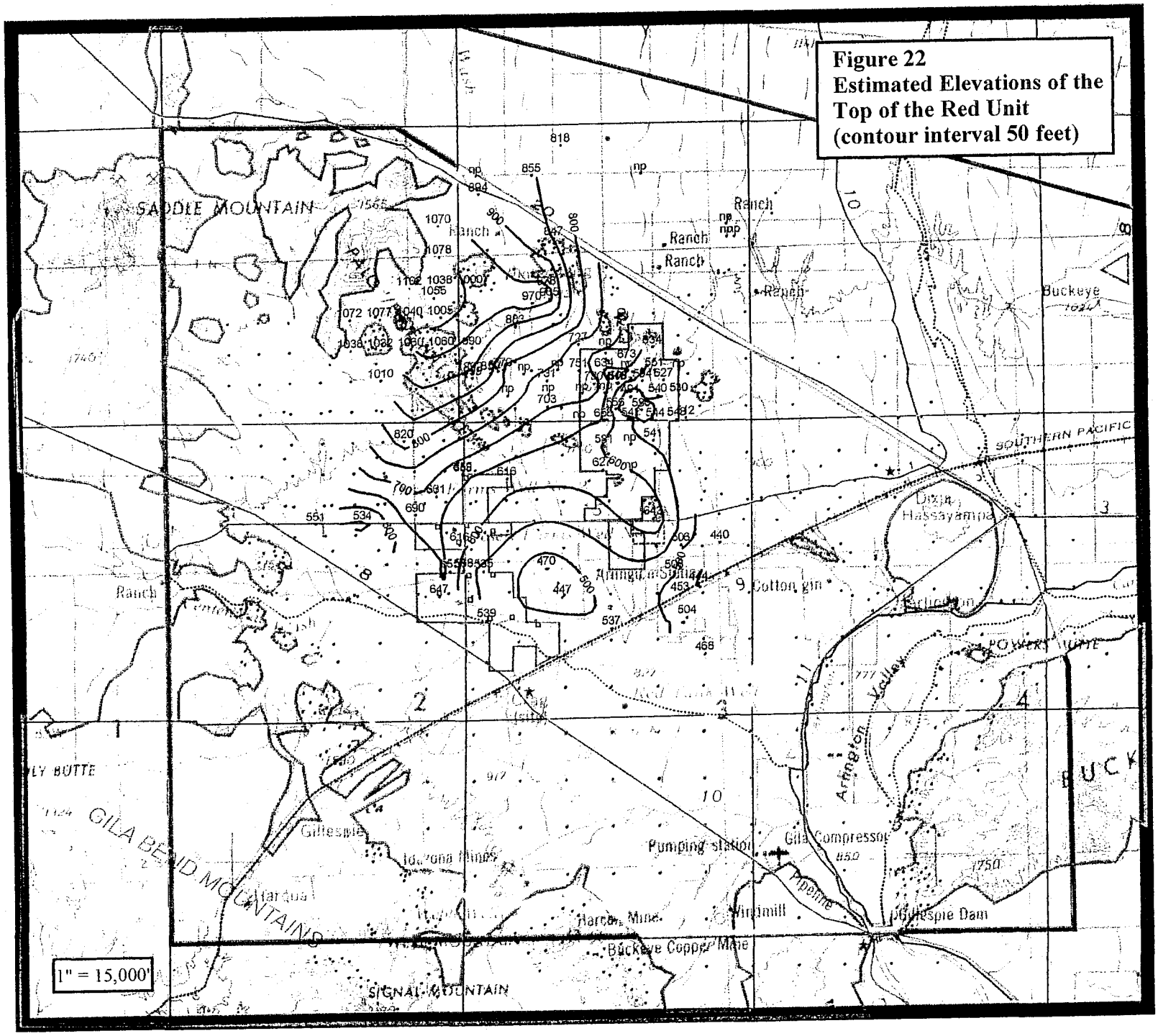


Figure 22
Estimated Elevations of the Top of the Red Unit
(contour interval 50 feet)

T_Tvfin.srf

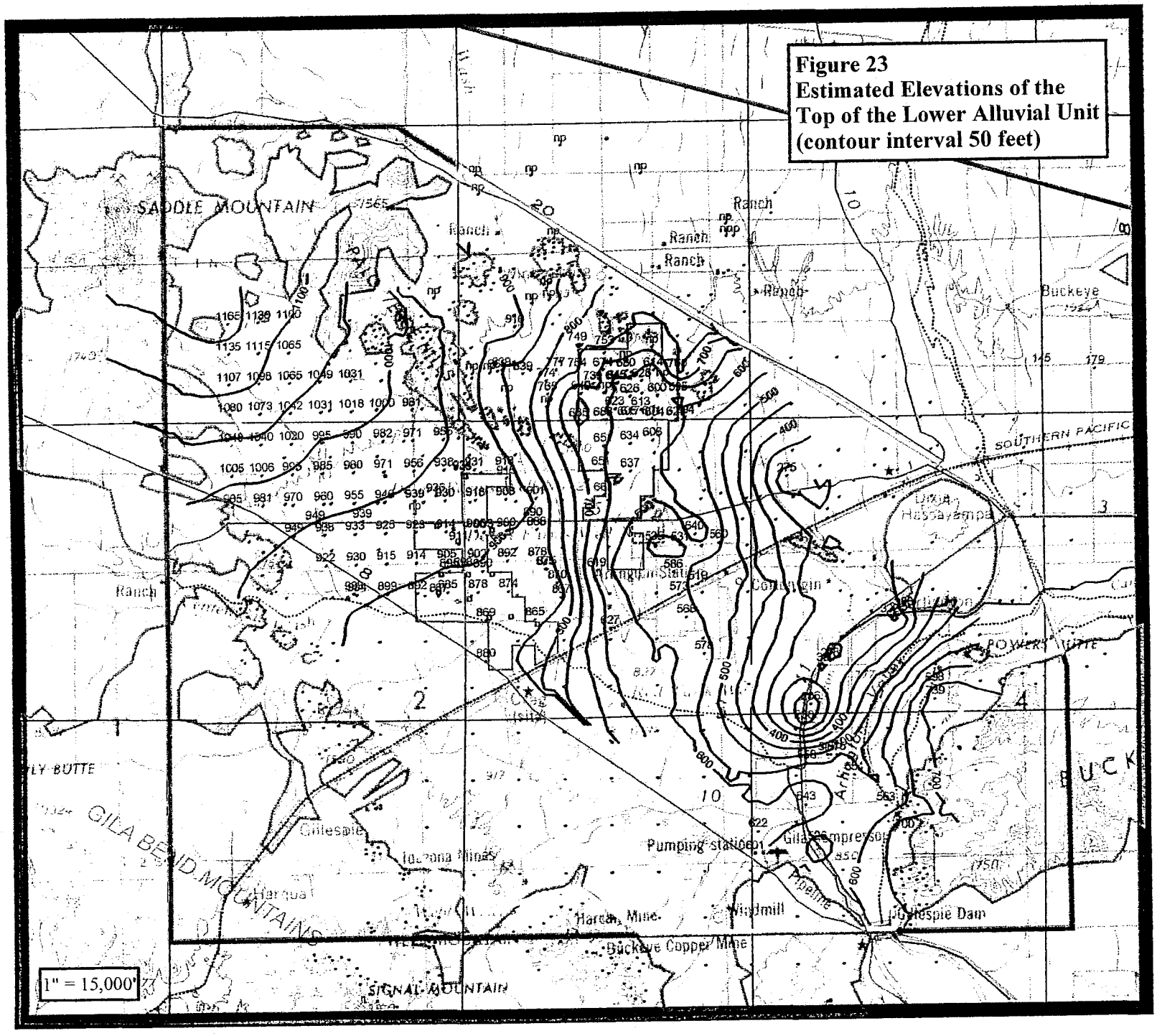


Figure 23
Estimated Elevations of the Top of the Lower Alluvial Unit (contour interval 50 feet)

T_LAU.srf

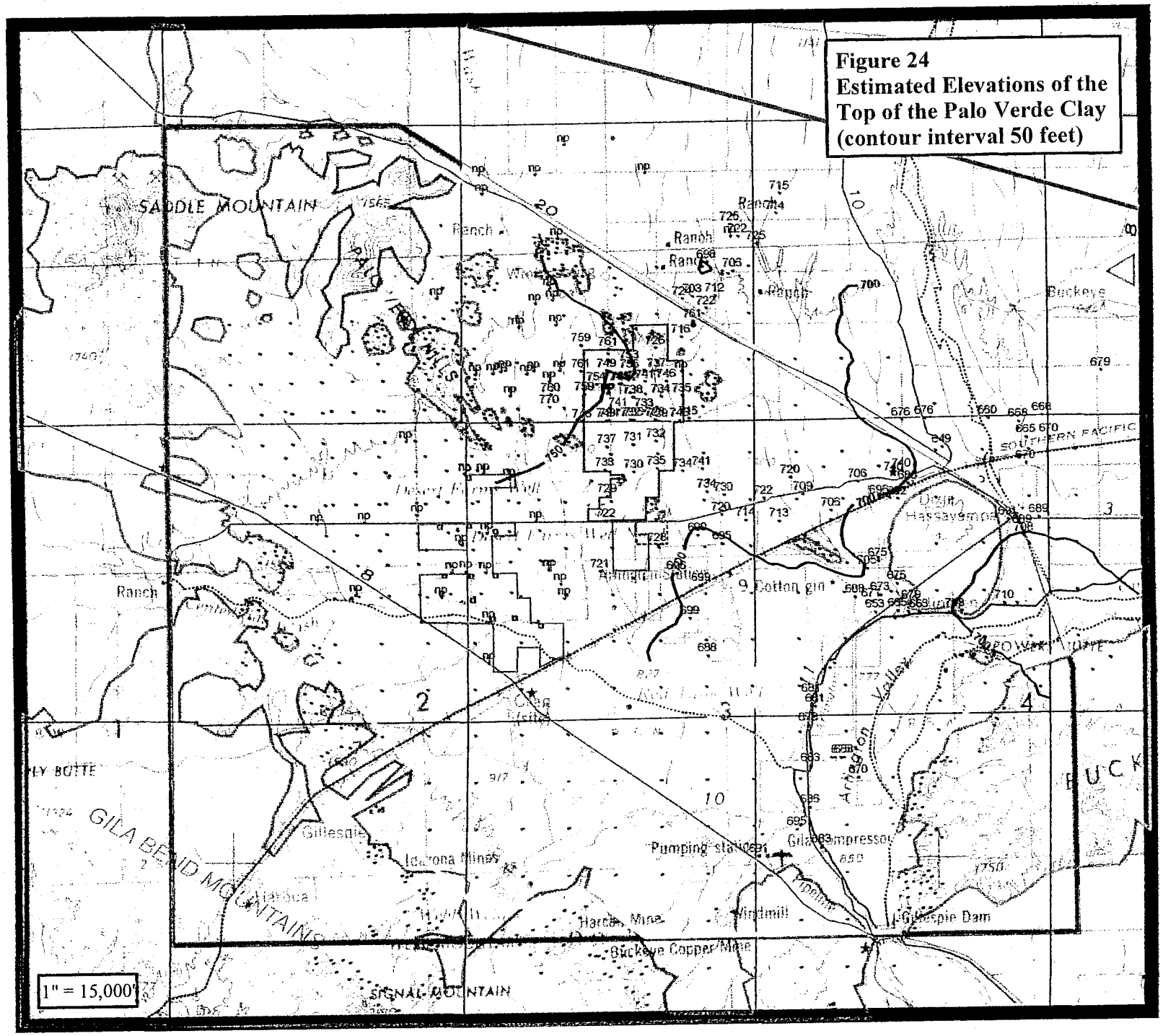


Figure 24
Estimated Elevations of the Top of the Palo Verde Clay (contour interval 50 feet)

T_PVClay.srf

Duke Energy

ARLINGTON VALLEY ENERGY FACILITY II

Presentation in Support of Application for a Certificate of Environmental Compatibility

L-00000P-01-0117

01030135

The Project

Duke Energy

- Expansion of AVEF
- 600 MW in June 2003
- Equipment
- Financing

Environmental Impacts

Duke Energy

- Water
- Air
- Cultural
- Biological
- Noise
- Visual
- Land Use

01030135

Need

Duke Energy

- Market indicators
- WSCC reserve margins
- Growth
- Replacement of aging / less environmentally friendly plants

Arizona Benefits

Duke Energy

- Proximity increases reliability / availability and decreases price
- Reduced air emissions
- Economic impact
- Duke's community involvement
- Improved Arizona transmission system
- Gas transportation reliability and capacity study

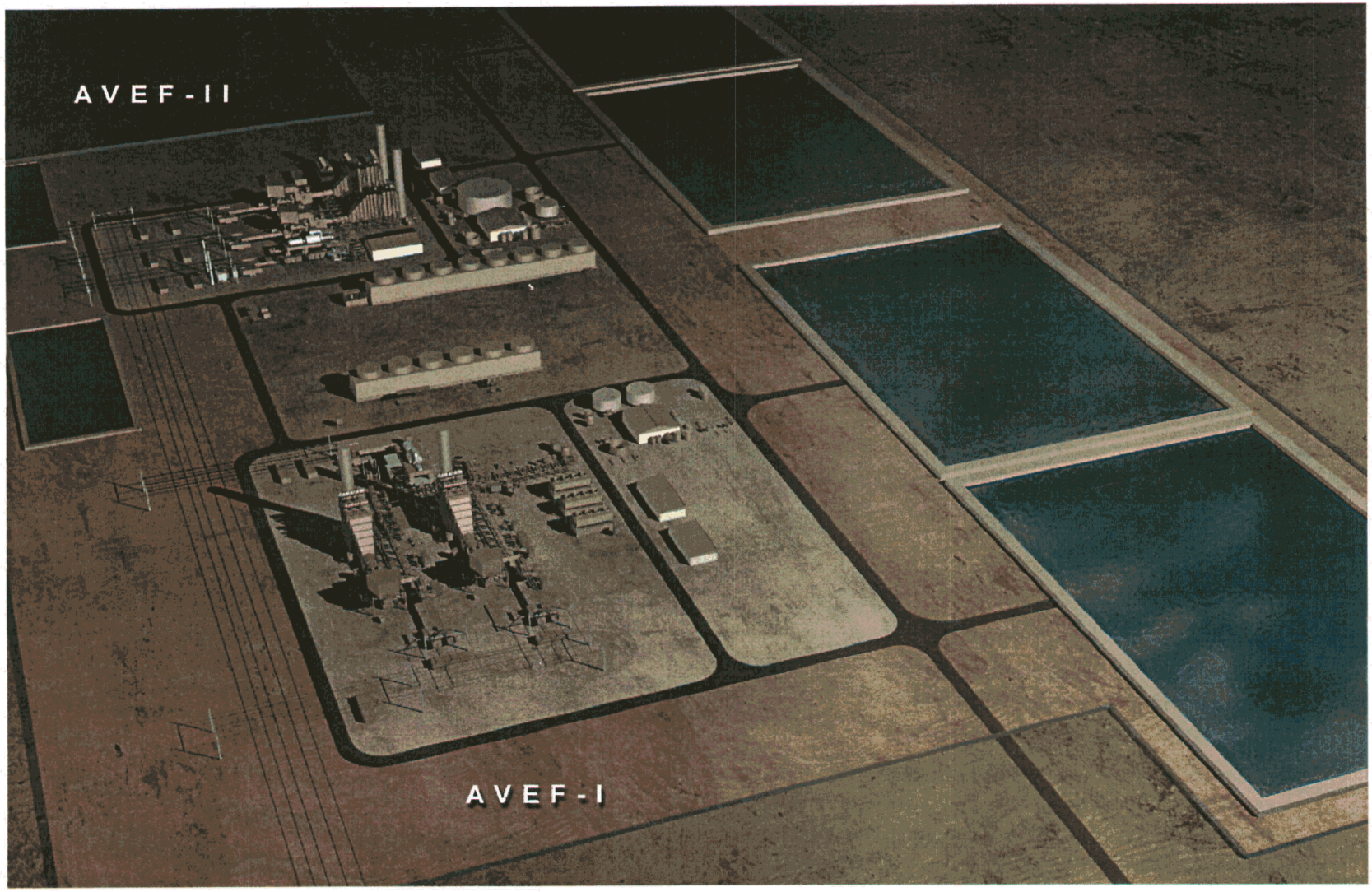
Witnesses

Duke Energy

- Max Shilstone - Overview of Project
  - Community Outreach
- Scott Krantz - Need for Expansion
- Pat Fleischauer - Environmental Impact
- Ken Johnson - Air
- Peter Mock - Water
- Peter Wybierala - Transmission

Photosimulation of AVEF II Layout (with AVEF I in Foreground)

Duke Energy



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Photosimulation of Proposed AVEF II (with AVEF I) 1.5 Miles Down Elliot Rd.

Duke Energy

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AVEF I - Current Construction

Duke Energy

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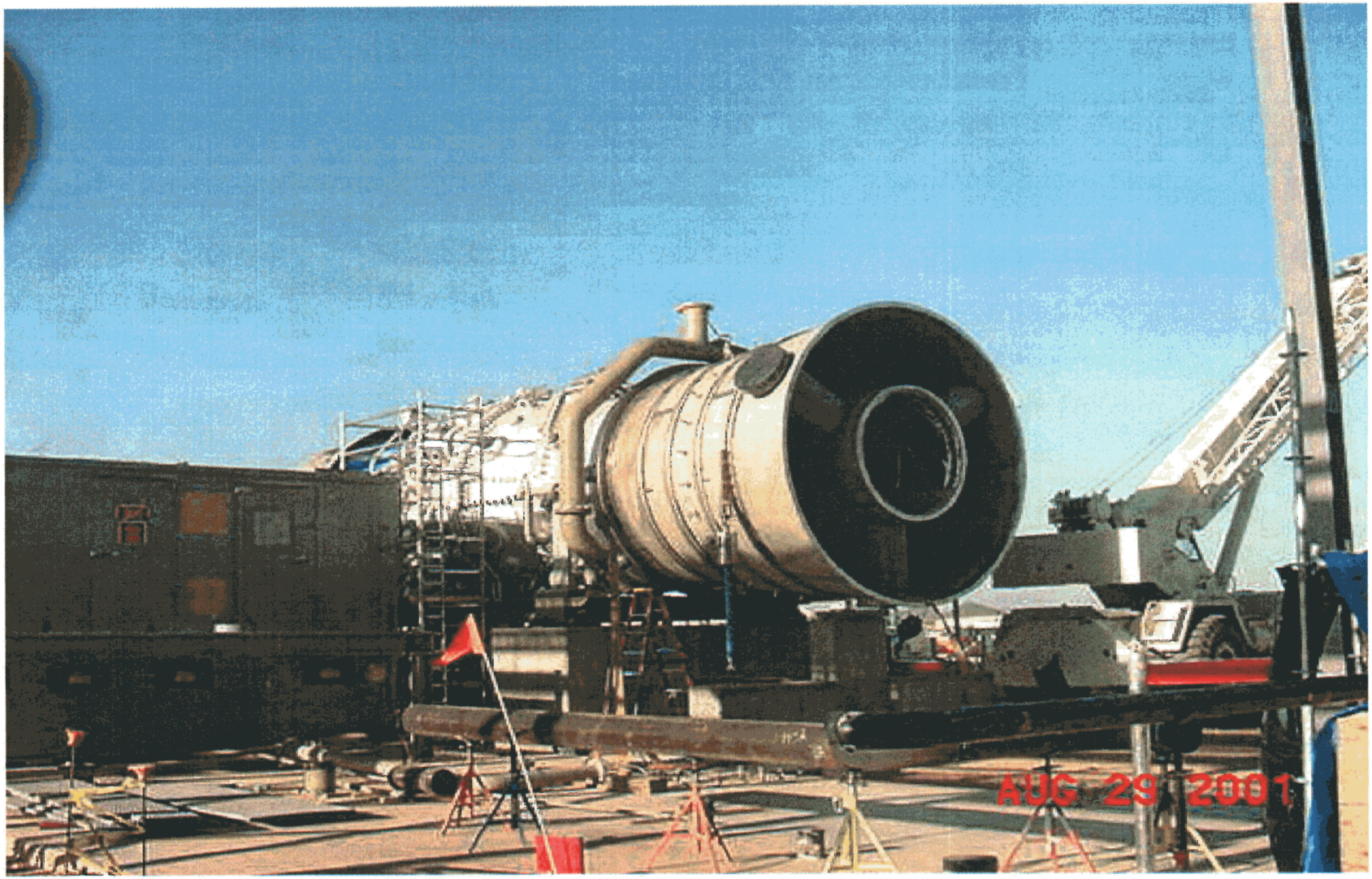
AVEF I - Gas Turbine

Duke Energy



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AVEF I - Gas Turbine and Generator

Duke Energy

01030135

Scott Krantz

Duke Energy

- B.S., Mechanical Engineering, Brigham Young University
- M.B.A., California State University - Hayward
- Professional Engineering Experience
  - Pacific Gas & Electric Co. (1992 - 1996)
    - Commercial and industrial marketing
    - Power market planning under deregulated competitive market
  - Duke Energy Trading & Marketing (1996 - present)
    - Manage the portfolio for all western assets (generation, transportation, storage, transmission) including forward trading of power and gas for generation
    - Structured transactions with utilities and municipalities
    - Valuation of western generation and transportation assets

The Power Market

Duke Energy

- **Forward Market**
  - Sale now of future power for an agreed price, location, and delivery date, e.g., sell X megawatts for Y dollars to Z company to be delivered at Palo Verde in January 2005
- **Spot Market**
  - Sale of power for immediate delivery

The Power Market

Duke Energy

- **Broker Market**
  - Vast majority of forward transactions
  - Neutral party negotiates between buyers and sellers
  - Buyers and sellers are unknown to each other until after the trade
- **Direct Market**
  - Buyer and seller interact directly
  - Often through RFP structure
  - Often non-standard products

The Power Market

Duke Energy

- **Portfolio Management**
  - Duke will sell virtually all of its anticipated production in the forward market
  - Duke sells power from a portfolio of purchases and generation, including AVEF

Need for Generation

Duke Energy

- **Market demand**
  - Wholesale LT markets at Palo Verde
  - LT prices support capital investment
- **SW reserve margins – WSCC report**
  - LT reserve margins insufficient

WSCC - Summary of Actual & Forecast Loads and Resources

Duke Energy

Western Systems Coordinating Council
Summary of Actual and Forecast Loads and Resources
Arizona-New Mexico-So. Nevada Power Area

		August 2003	August 2004	August 2005	August 2006	August 2007	August 2008	August 2009	August 2010
Loads	Peak Demand - Megawatts	24,156	24,934	25,769	26,490	27,238	28,002	28,781	29,549
	Interruptible and Load Mgt.	347	350	353	357	360	361	363	365
Total Loads		**24,503**	**25,284**	**26,122**	**26,847**	**27,598**	**28,363**	**29,144**	**29,914**
Resources	Hydro - Conventional	3,258	3,258	3,258	3,258	3,258	3,258	3,258	3,258
	Hydro - Pump Storage	214	214	214	214	214	214	214	214
	Steam - Coal	8,553	8,553	8,553	8,553	8,553	8,553	8,553	8,553
	Steam - Oil	160	160	160	160	160	160	160	160
	Steam - Gas	2,382	2,382	2,382	2,382	2,382	2,382	2,382	2,382
	Nuclear	2,764	2,764	2,843	2,843	2,843	2,843	2,843	2,843
	Combustion Turbine	2,307	2,307	2,407	2,407	2,407	2,407	2,407	2,407
	Combined Cycle	10,252	11,472	12,247	13,272	13,272	13,772	13,772	13,772
	Geothermal	-	-	-	-	-	-	-	-
	Internal Combustion	4	4	4	4	4	4	4	4
	Other	100	100	100	100	100	100	100	100
Total Resources		**29,994**	**31,214**	**32,168**	**33,193**	**33,193**	**33,693**	**33,693**	**33,693**
Firm/Joint Participant Imports	CAMX	-489	-489	-379	-379	-379	-379	-379	-379
	NWPP	-565	-531	-577	-543	-590	-590	-590	-590
	SWPP	-150	-150	-150	-150	-150	-150	-150	-150
	RMPA	-389	-389	-389	-389	-389	-389	-389	-389
Total Import		(1,593)	(1,559)	(1,495)	(1,461)	(1,508)	(1,508)	(1,508)	(1,508)
Firm/Joint Participants Exports	CAMX	4171	4171	4184	4184	4184	4184	4184	4184
	NWPP	727	727	727	727	727	727	727	727
	RMPA	533	533	533	533	533	533	533	533
Total Exports		5,431	5,431	5,444	5,444	5,444	5,444	5,444	5,444
Net Exports/Imports		**3,838**	**3,872**	**3,949**	**3,983**	**3,936**	**3,936**	**3,936**	**3,936**
Joint Participation Transfers		3,860	3,860	3,873	3,873	3,873	3,873	3,873	3,873
Net Firm Transfers*		**(22)**	**12**	**76**	**110**	**63**	**63**	**63**	**63**
Planned Purchases/Sales		2,364	3,393	4,682	5,071	4,577	3,611	2,832	2,399
Net Resources and Net Transfers		**27,652**	**27,809**	**27,410**	**28,012**	**28,553**	**30,019**	**30,798**	**31,231**
Margin over firm Load - MW		**3,496**	**2,875**	**1,641**	**1,522**	**1,315**	**2,017**	**2,017**	**1,682**
Margin over firm load - Percent		**14.5%**	**11.5%**	**6.4%**	**5.7%**	**4.8%**	**7.2%**	**7.0%**	**5.7%**

*Net Exports/Imports less Joint Participation transfers (Minus sign indicates purchase).
Joint Participation Generation is included by type under "Resources" in each Participant's area

Arizona Benefits

Duke Energy

- **Lower Prices**
  - Lower priced generation
  - Lower transmission costs
- **Increased Reliability**
  - Increased reserve margin
  - Added voltage support
  - Less reliance on imports

Duke Energy Gas Resources Available to Serve Arlington Valley

Duke Energy

- 211,000 MMBtu/d of firm EPNG transportation capacity
- 400,000 MMBtu/d of controlled gas supply in San Juan and Permian basins
- 300,000 MMBtu/d of firm transportation on other regional pipelines
- Numerous expansion opportunities specific to region
- Secondary capacity market
- Direct purchases of delivered gas

Expansion Opportunities in the Region

Duke Energy

Pipeline	Capacity	Region	In-Service
EPNG	230,000	AZ	Q1 2002
SoCal	375,000	Southern CA	Q1 2002
Transwestern	120,000	CA/AZ	Q2 2002
North Baja	555,000	North Baja	Q3 2002
Southern Trails	80,000	Northern California	Q3 2002
PGT/PG&E	200,000	Northern CA	Q4 2002
Kern River	900,000	CA/NV	Q2 2003
TOTAL	2,460,000		

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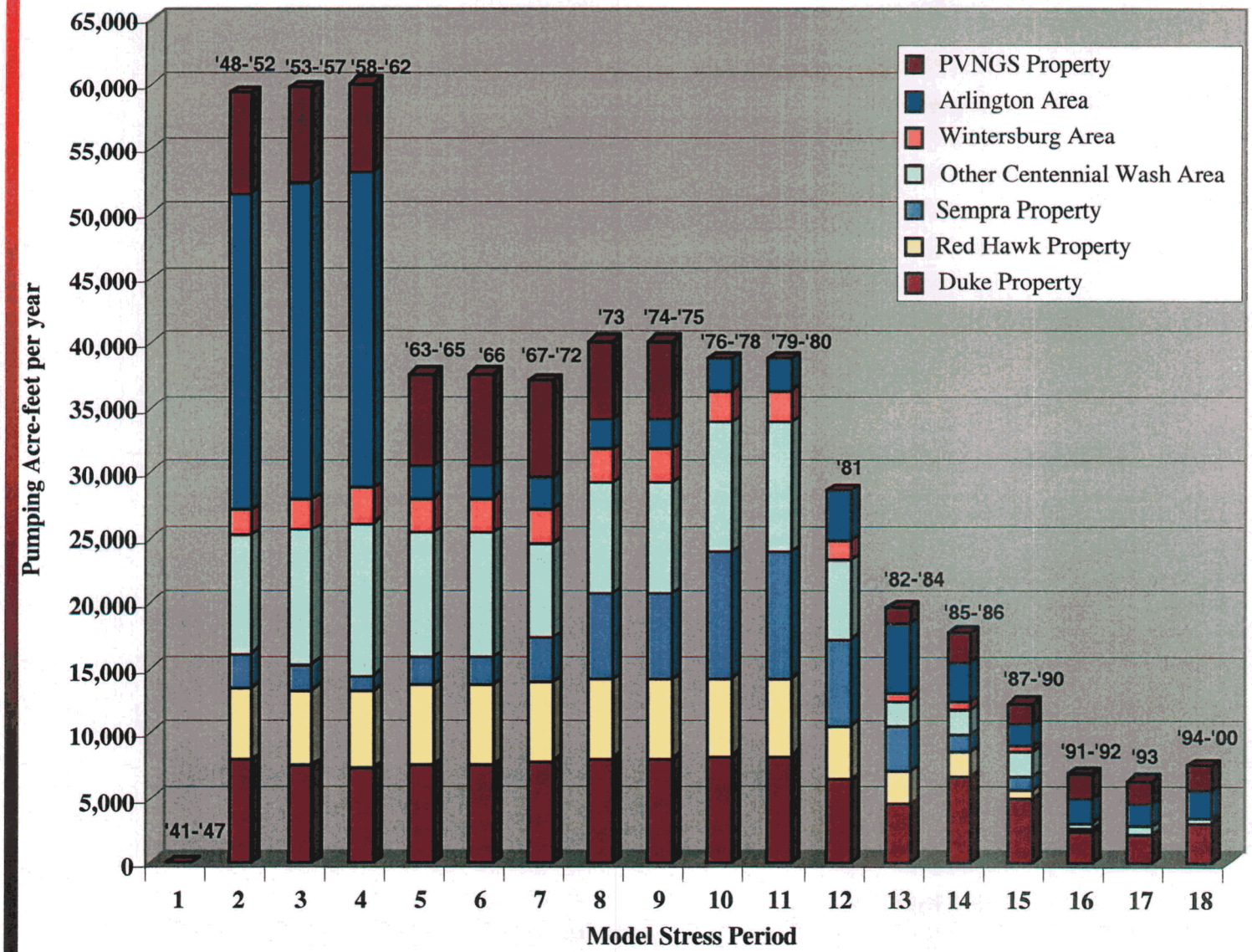
Proposed Expansion in the Region

Duke Energy

Pipeline	Capacity	Region	In-Service
EPNG	320,000	AZ/CA	Q3 2004
Transwestern	540,000	AZ/CA	Q3 2004
EPNG Bi-Directional	500,000	AZ/CA	Q2 2003
Sonoran	750,000	Northern CA	Q3 2003
Ruby	750,000	Northern CA	Q4 2003
TOTAL	2,860,000		

Reconstructed Historical Pumping for the Centennial Wash Area



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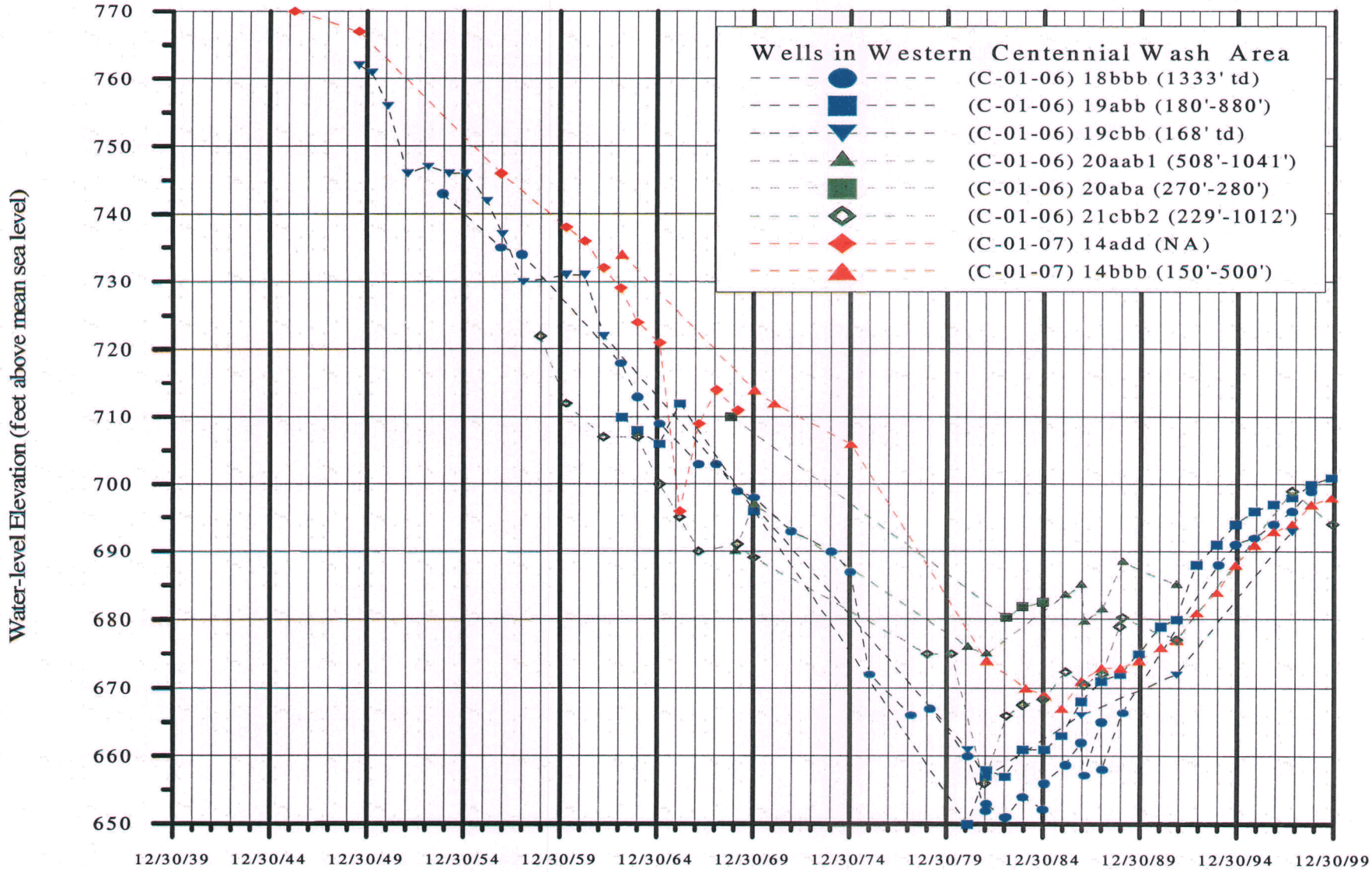
Wells in Western Centennial Wash Area



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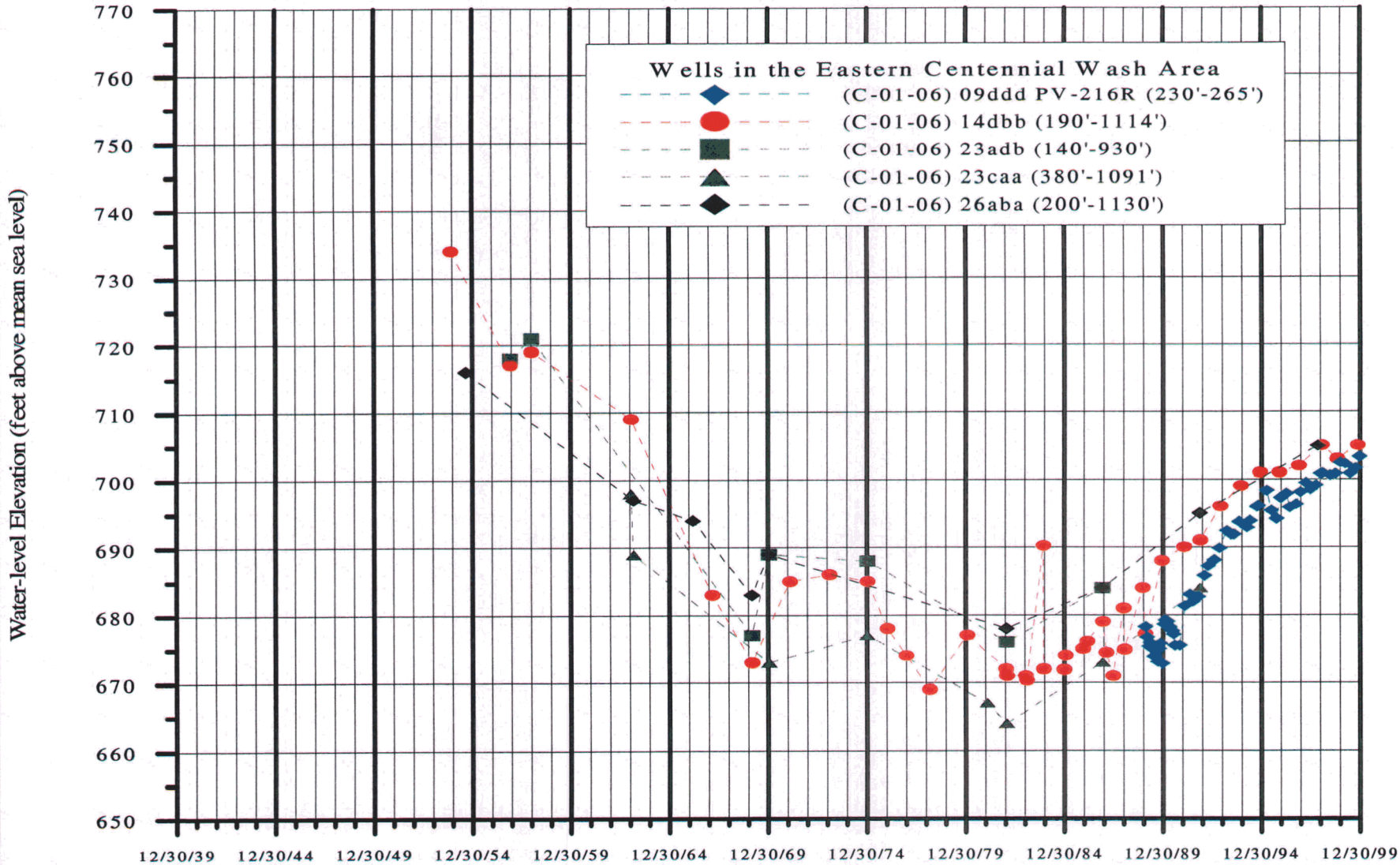
Wells in Eastern Centennial Wash Area



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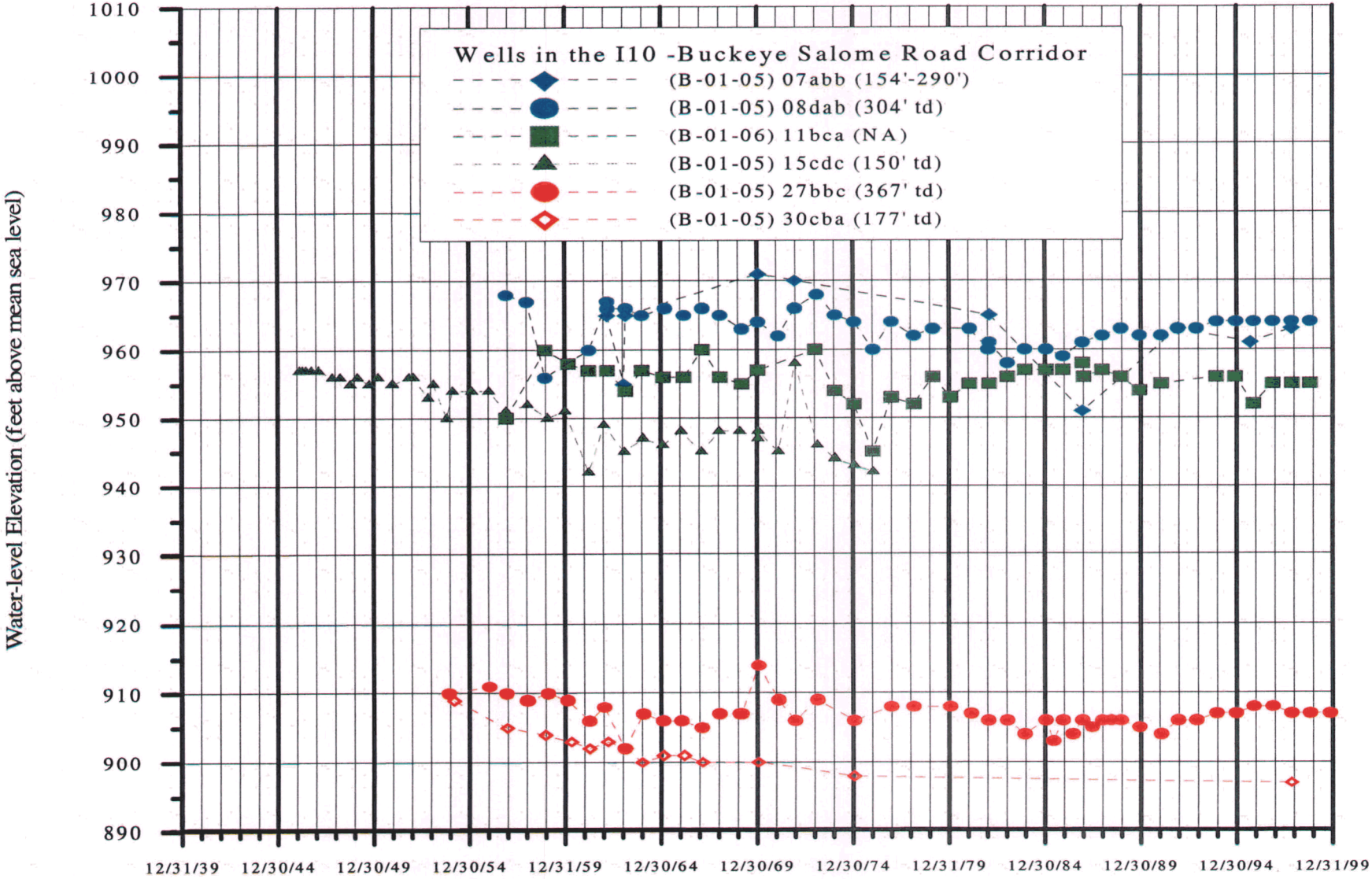
Wells in I10-Buckeye Salome Road Corridor



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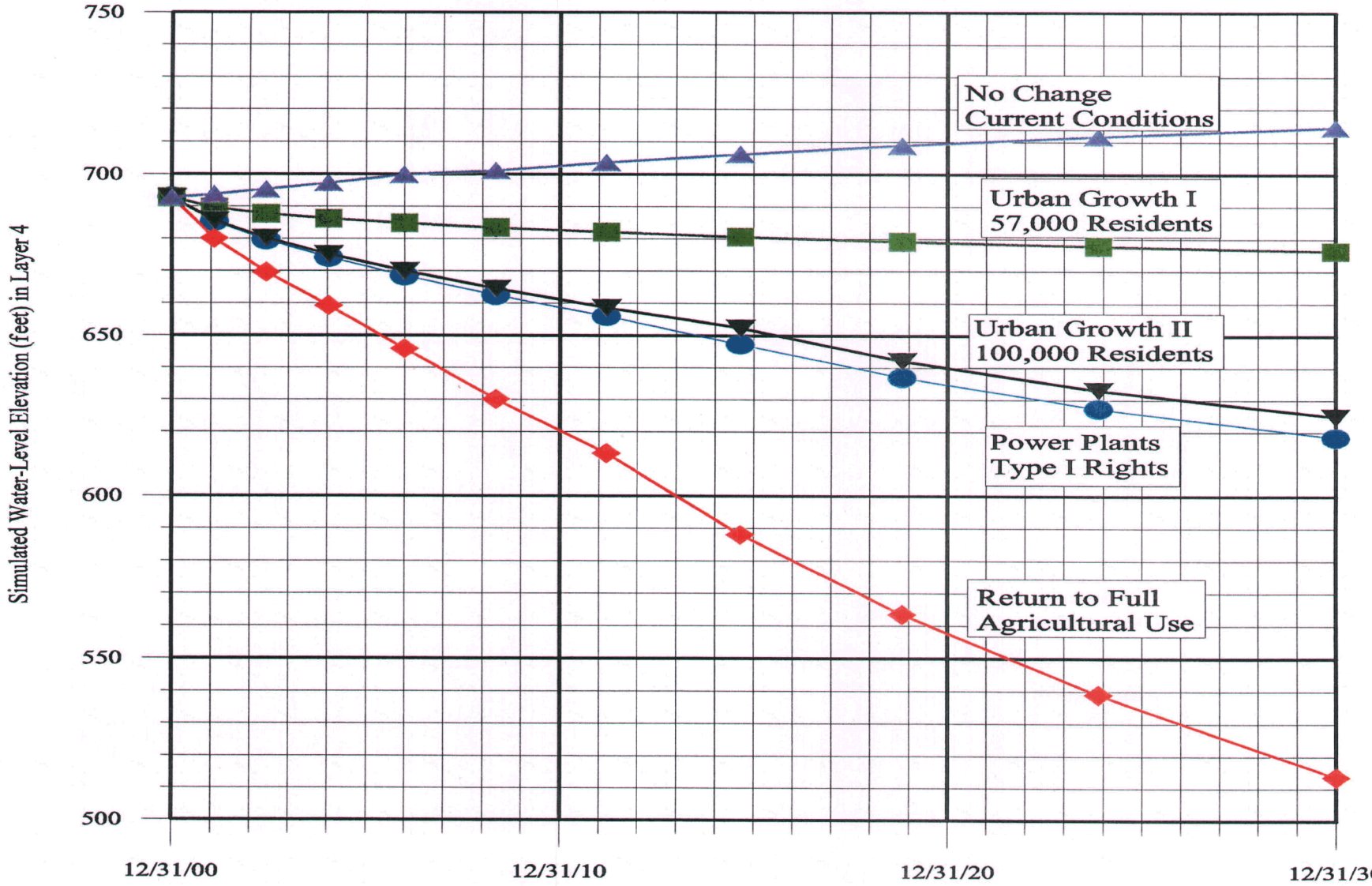
Cumulative Water Study Results



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Arlington Valley Energy

EXHIBIT

A-12

admitted

EXHIBIT
A-13
admitted

Nature of Impact	Level of Impact	How was Impact Determined?	How is Significant Impact Defined?	Responsible Entity
Land Usage	Consistent with Existing	Field Studies	Relation to Plans	Maricopa County
Biological Resources	None	Agency Review	Effect on Protected Resources	US Fish and Wildlife Service, Arizona Game and Fish Department
Recreational Use	None	Field Studies	Relation to Plans	Arizona Corporation Commission
Scenic/Visual Resources	Consistent with Existing	Photo-simulation	Guidelines	Arizona Corporation Commission
Historic/ Archaeological Resources	None	Agency Review	Regulation	State Historic Preservation Office
Water Quality	Environmentally Compatible	Comparison to Standard	Regulation	Arizona Department of Environmental Quality
Noise	Not Discernible	Modeling	EPA Guidelines	Arizona Corporation Commission
Air Quality	Environmentally Compatible	Comparison to Standard	NAAQS	Maricopa County
Water Usage	Environmentally Compatible	Modeling	Obtain Right	Arizona Department of Water Resources

EXHIBIT
Com.-1
admitted

ARIZONA DEPARTMENT OF WATER RESOURCES

HYDROLOGY DIVISION

MEMORANDUM

TO: Gregg Houtz
Power Plant and Transmission Line Siting Committee

THROUGH: Greg Wallace
Chief Hydrologist

FROM: Dale Mason, Supervisor,
Groundwater Modeling Section
Hydrology Division

DATE: October 12, 2001

RE: Preliminary Hydrologic Review of Duke Energy Arlington Valley Facility II Power Plant Application, Docket Number L-00000P-01-0117.

This memo details the Arizona Department of Water Resources (ADWR) preliminary technical review of the potential affect on local groundwater conditions of a proposed second unit to Duke's Arlington Valley Energy Facility. The proposed second unit of the Arlington Valley Energy Facility will be capable of producing 600 megawatts and will use an estimated 1,000 acre-feet of water. This water use is in addition to the 6,800 acre-feet needed for the Arlington Valley Unit I. Total water use for Duke Arlington Valley Energy Facility is now expected to be 7,800 acre-feet per year.

Duke Energy, Sempra Energy Resources, and Pinnacle West have proposed to build and operate three power plants in the area around Centennial Wash, in western Maricopa County. Duke, Sempra, and Pinnacle West funded a joint numerical groundwater modeling study of the Centennial Wash area to determine the cumulative affects of groundwater pumpage on local water levels by the three plants. The groundwater flow model was developed for use as a tool to predict how the groundwater system in the Centennial Wash study area may respond to the cumulative pumpage of the three proposed power plants.

Listed below is a general review of water level and groundwater pumpage for the area around the three proposed plants. In addition, there is a review of new groundwater model simulations recently completed that incorporate the new pumpage totals from the expanded Arlington Valley plant.

Current Water Level Status

The proposed plant site is located in the southern part of the Hassayampa sub basin of the Phoenix AMA in Township 1 South, Range 6 West. Water level records for the entire township were reviewed to determine current depth to water and recent trends in water levels. As part of an ongoing water level data collection program, the ADWR conducts periodic water level sweeps of the Phoenix Active Management Area (AMA). The most recent water level sweeps were done in 1991 and 1997. In addition to the periodic water level sweeps, ADWR measures water levels annually in selected wells throughout the State. The water levels from these wells, called index wells, can be used to identify long-term changes in the water table.

The earliest available depth to water records for the area around the proposed plant site are from the late 1940s and early 1950s. The depth to water ranged from about 115 to 130 feet below land surface at that time. Hydrographs of wells near the proposed plant site indicate a steady regional water-level decline from

the early 1950s to the mid-1980s. A cone of depression centered in the southern part of Township 1 South, Range 6 West, formed during the years of peak groundwater pumpage in the 1960s and 1970s, when groundwater pumpage for agricultural irrigation over-drafted the regional aquifer. Water level declines in the center of the cone totaled as much as 120 feet.

Since the mid-1980s, the regional water level decline has stopped and water levels have steadily recovered. Wells in the area around the proposed plant have measured water level recoveries ranging from 20 to 50 feet since the early 1980s. There are three index wells in the area of the proposed plant site with water level records dating from the early 1950s to the present. These wells show measured water level recoveries of 40 to 50 feet from 1981 to the present. Overall, it appears that since the mid-1980s, water levels in the general vicinity of the proposed plant site have recovered at a rate of 1 to 3 feet per year. The current depth to water in the area ranges from about 160 to 220 feet below land surface. However, despite the recent water level recoveries the current direction of groundwater flow is still generally to the south towards the center of the cone of depression.

Groundwater Pumpage

Most historic pumpage in the area around the proposed plant site was for agricultural irrigation, domestic and stock pumpage is a very minor component of the total groundwater pumpage. Prior to 1984, groundwater pumpage in the Phoenix AMA was not required to be reported to the Department. However, the U. S. Geological Survey (USGS) estimated pumpage for many areas of the state based on power consumption records. Pumpage estimates made by the USGS for the Centennial Wash area from the 1950s, to the 1970s ranged from 30,000 to 45,000 acre-feet per year.

All major groundwater users in the Phoenix AMA have been required to report annual groundwater withdrawals to the Department through the Registry of Groundwater Rights (ROGR) system since 1984. From 1984 to the present groundwater pumpage in the area near the proposed plant site has declined steadily. Since 1991 reported pumpage in Township 1 South, Range 6 West, has averaged only 3,400 acre-feet per year.

Duke Energy has bought or has options to purchase approximately 2,750 acre of land in Township 1 South, Range 6 West. Conversion of these agricultural Irrigation Grandfathered Rights (IGFRs) to Type I industrial rights will give Duke the right to withdraw about 7,800 acre-feet per year, enough to meet the needs of both Arlington Valley Unit I and UnitII. Conversion of the agricultural IGFR to a Type I right will cause a net decrease in the allowable pumpage from the local aquifer.

Groundwater Model

The report, "*Evaluation of Groundwater Responses to Pumping for Proposed Power Plants in the Centennial Wash Area, Maricopa County, Arizona*"(Mock, 2000) detailed the joint groundwater modeling study conducted by Sempra Energy, Duke Energy, and Pinnacle West for the area around Centennial Wash, in western Maricopa County. The groundwater flow model was developed for use as a tool to predict how the groundwater system in the Centennial Wash study area may respond to the cumulative pumpage of the three proposed power plants.

The Department was involved in an ongoing oversight and review capacity during the construction of the model. This early involvement in technical issues during model development has helped to satisfy any concerns that the Department may have had regarding the content and accuracy of the model. The Centennial Wash Area groundwater flow model is able to reasonably simulate both current and historic measured water levels. As a result, any future projections of water level changes based on model result may be inferred to be an accurate approximation of future conditions, given that the future pumpage stresses simulated are an accurate reflection of potential future conditions.

The modeling study presented five future scenarios, each representing a different set of development plans for the area around the proposed power plant. The model scenarios were developed to compare the cumulative effects of the three proposed power plants to other potential uses for the land. One scenario represented a return to full agricultural production with the maximum allowable IGFR pumpage. A second scenario assumed that the three power plants would be built and would utilize their full converted Type I water rights. Two scenarios were developed that had the area undergo urban developed at different population densities. A fifth scenario maintained current conditions with no future development. All the scenarios were run out thirty years into the future to compare water levels at the expected end of the power plants operational life.

In all the pumpage scenarios the existing cone of depression will again begin to deepen as a result of the increased pumpage. Under a return to full agricultural production with pumpage totaling about 35,000 acre-feet per year, the model predicted a maximum water level decline after 30 years of about 180 feet. The urban development scenarios simulated populations of 57,000 and 100,000 people with demands of about 14,000 and 21,200 acre-feet per year, respectively. The lower population density scenario created a predicted maximum drawdown of about 15 feet. The higher population density scenario created a predicted maximum water level decline of 65 feet after 30 years. The power plant scenario assumming a total groundwater pumpage of about 22,600 acre-feet per year predicted a maximum drawdown in the local aquifer of about 75 feet. And if no development were to occur in the area and current water uses are maintained an additional water level recovery of about 25 feet is projected after 30 years

To evaluate the additional pumpage from Duke's Unit II, a new power plant scenario was developed with the additional pumpage for the proposed second unit included in the total groundwater pumpage. In addition, new pumpage locations were set for the wells used to supply the Arlington Valley units. Duke Energy has revised its' well locations based on the decision to drill 4 new wells and one replacement well on the plant property. Increasing Arlington Valley Facility's pumpage by 1,000 acre-feet, and the combined pumpage to a total of 23,600 acre-feet, and concentrating Duke's supply wells on the plant property shifted the center of the cone of depression onto the Duke property. The drawdown in the center of the cone was about 110 feet after 30 years. This is an increase in 10 to 20 feet over the previous predicted drawdowns expected as a result of pumpage by the three power plants. The larger drawdowns are a result of the increasing the Duke pumpage by 1,000 acre-feet per year and concentrating the production wells in close proximity to each other.

Conclusions

The numerical groundwater flow model developed for the Centennial Wash area allows the cumulative affects of pumpage by the three power plants on the local aquifer to be approximated. The proposed pumpage for the three power plants will impact local water levels over the life of the plants. Water levels can be expected to decline by about 110 feet in areas near the withdrawal points. These expected water level declines will negate the recent recoveries, and water levels will return to at or below the levels of the early 1980s after 30 years of combined operation.