AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE	PAGE	OF	PAGES
	1		3

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. *(If applicable)*
0003	26 October 2004		

6. ISSUED BY CODE

US ARMY ENGINEER DISTRICT, FORT WORTH
ATTN: CESWF-CT (RM 2A19)
PO BOX 17300
FORT WORTH, TX 76102-0300

7. ADMINISTERED BY *(If other than Item 6)* CODE

8. NAME AND ADDRESS OF CONTRACTOR *(No., street, county, State and ZIP Code)*

CODE FACILITY CODE

(X)

☒ 9A. AMENDMENT OF SOLICIATION NO.: W9126G-04-R-0042

9B. DATED *(SEE ITEM 11)*: 29 SEPTEMBER 2004

☐ 10A. MODIFICATION OF CONTRACT/ORDER NO.

10B. DATED *(SEE ITEM 11)*

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

☒ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended, ☒ is not extended.

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods:

(a)By completing items 8 and 15, and returning _____ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment your desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA *(If required)*

13. THIS ITEM ONLY APPLIES TO MODIFICATION OF CONTRACTS/ORDERS. IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

CHECK ONE	
	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: *(Specify authority)* THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.
	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES *(such as changes in paying office, appropriation date, etc.)* SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).
	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:
	D. OTHER *(Specify type of modification and authority)*

E. IMPORTANT: Contractor ☐ is not, ☐ is required to sign this document and return _____ copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (*Organized by UCF section headings, including solicitation/contract subject matter where feasible.)*

The Request for Proposals for DESIGN-BUILD WHOLE NEIGHBORHOOD REPLACEMENT, 05, PN57070, WHITE SANDS MISSILE RANGE, NEW MEXICO, is amended as follows:

See Continuation Sheet.

NOTE: Due date and time for Receipt of Proposals remains 5 November 2004, at 4:00 p.m., as previously announced.

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER *(Type or print)*		16A. NAME AND TITLE OF CONTRACTING OFFICER *(Type or print)*	
15B. CONTRACTOR/OFFEROR	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA	16C. DATE SIGNED
(Signature of person authorized to sign)		*(Signature of Contracting Officer)*	

Item 14. Continued.

CHANGES TO PRICE PROPOSAL SCHEDULE

1. Replace the Price Proposal Schedule, pages 00010-3 through 00010-6, with the accompanying new Price Proposal Schedule, bearing the notation "ACCOMPANYING AMENDMENT NO. 0003 TO SOLICITATION NO. W9126G-04-R-0042."

CHANGES TO PROPOSAL SUBMISSION REQUIREMENTS

2. Replacement Section – Replace the following sections with the accompanying new section of the same number and title, bearing the notation "ACCOMPANYING AMENDMENT NO. 0003 TO SOLICITATION NO. W9126G-04-R-0042:"

SECTION 00100 INSTRUCTIONS TO OFFERORS

Note: Change occurs on page 00100-2.

CHANGES TO THE SPECIFICATIONS

3. Replacement Chapters – Replace the following chapters with the accompanying new chapters of the same number and title, bearing the notation "ACCOMPANYING AMENDMENT NO. 0003 TO SOLICITATION NO. W9126G-04-R-0042:"

Section 01001, Chapter 1. DESIGN OBJECTIVES
Section 01001, Chapter 2. CRITERIA REFERENCES
Section 01001, Chapter 3. SITE PLANNING AND DESIGN
Section 01001, Chapter 4. SITE ENGINEERING
Section 01001, Chapter 5. UNIT DESIGN - ARCHITECTURE
Section 01001, Chapter 9. UNIT DESIGN - ELECTRICAL
Section 01001, Chapter 10. UNIT DESIGN - HEATING, VENTILATING, AND AIR CONDITIONING.

4. Replacement Attachments – Replace the following attachment with the accompanying new attachment of the same title, bearing the notation "ACCOMPANYING AMENDMENT NO. 0003 TO SOLICITATION NO. W9126G-04-R-0042:"

Attachment 3 – FORMAT FOR REQUIRED AREA CALCULATIONS

5. New Attachments – Add the following new attachment to specifications and revise Table of Contents from “8 Not Used” to “Attachment 8 – A Water Conservation Guide for Commercial, Institutional and Industrial Users”:

Attachment 8 – A Water Conservation Guide for Commercial, Institutional and Industrial Users

CHANGES TO THE DRAWINGS

6. Replacement drawings.- Replace the following drawings with the accompanying new drawings, bearing the notation “AMENDMENT #3”:

DEMOLITION PLAN
NEW CONSTRUCTION SITE LAYOUT

7. New drawing - Add the following new drawing:

EXISTING WATERLINES

END OF AMENDMENT

PRICE PROPOSAL SCHEDULE
(To be attached to SF 1442)

Design/Build, Whole Neighborhood Replacement FY05, PN 57070
White Sands Missile Range, New Mexico

Item No.	Description	Estimated Quantity	Unit	Unit Price	Estimated Amount
(AM #0003) 0001	**FGO 4 Bedroom Units** Total cost for complete design and construction of Whole Neighborhood Replace Family Housing, including all site improvements within the Building 5 feet lines, Except for separately price bid items	**5**	**EA**	$_____	$ _____
(AM #0003) 0002	**JNCO 3 Bedroom Units** Total cost for complete design and construction of Whole Neighborhood Replace Family Housing, including all site improvements within the Building 5 feet lines, Except for separately price bid items	**106**	**EA**	$_____	$ _____
(AM #0003) 0003	**JNCO 4 Bedroom Units** Total cost for complete design and construction of Whole Neighborhood Replace Family Housing, including all site improvements within the Building 5 feet lines, Except for separately price bid items	**34**	**EA**	$_____	$ _____
(AM #0003) 0004	**JNCO 5 Bedroom Units** Total cost for complete design and construction of Whole Neighborhood Replace Family Housing, including all site improvements within the Building 5 feet lines, Except for separately price bid items	**11**	**EA**	$_____	$ _____

PRICE PROPOSAL SCHEDULE

Item No.	Description	Estimated Quantity	Unit	Unit Price	Estimated Amount
0005	Total cost for Construction of site improvements (outside the Building 5 feet line) for Whole Neighborhood Replace Family Housing, including grading, paving, utilities, storm drainage system, curbs and gutters, sidewalks, landscaping, irrigation, exterior lighting, fencing, all other work not separately listed.	1	LS	***	$ _____
(AM #0003) 0006	Total Cost for Hazardous Material Abatement of ~~170~~ **143** housing Units~~ and 1 Concrete Water Storage Tank~~.	1	LS	***	$ _____
(AM #0003) 0007	Total cost for Demolition ~~170~~ **143** Housing Units~~ and 1 Concrete Water Storage Tank~~, including site demolition paving, utilities, storm drainage system, curbs, and gutters, sidewalks, **garages, storage sheds,** landscaping~~ (except the Arizona Pine shown on the demolition site map)~~, exterior lighting fencing, grading, and all other work not separately listed and shown on the demolition site plan.	1	LS	***	$ _____

PRICE PROPOSAL SCHEDULE

Item No.	Description	Estimated Quantity	Unit	Unit Price	Estimated Amount
(AM #0003)					
0008	Total cost for Demolition transite pipes.	~~25,970~~**17,300**	LF	$_____	$ _____
(AM #0003)					
0009	Operation and Maintenance Manuals	1	LS	***	$ ~~30,000.00~~**60,000.00**
0010	Record Drawings	1	LS	***	$ 50,000.00

TOTAL BID $_____

PROJECT COMPLETION TIME

0011 Completion Time for all work (NOT to exceed the maximum time stated in Section 01000 DESIGN AND CONSTRUCTION SCHEDULE)

PROJECT COMPLETION TIME _____ Calendar days from NTP

PRICE PROPOSAL SCHEDULE

NOTES:

1. ARITHMETIC DISCREPANCIES (EFARS 14.407-2)

(a) For the purpose of initial evaluation of price proposals, the following will be utilized in resolving arithmetic discrepancies found on the face of the price schedule as submitted by offerors:

(1) Obviously misplaced decimal points will be corrected;

(2) In case of discrepancy between unit price and extended price, the unit price will govern;

(3) Apparent errors in extension of unit prices will be corrected; and

(4) Apparent errors in addition of lump-sum and extended prices will be corrected.

(b) For the purpose of price evaluation, the Government will proceed on the assumption that the offeror intends his price to be evaluated on the basis of the unit prices, the totals arrived at by resolution of arithmetic discrepancies as provided above and the price will be so reflected on the abstract of offers.

(c) These correction procedures shall not be used to resolve any ambiguity concerning which offered price is low.

2. If a modification to a price offer based on unit prices is submitted, which provides for a lump sum adjustment to the total estimated cost, the application of the lump sum adjustment to each unit price in the price schedule must be stated. If it is not stated, the offeror agrees that the lump sum adjustment shall be applied on a pro rata basis to every unit price in the price schedule.

3. Offerors must price all items.

4. Failure to insert prices for each item in the Pricing Schedule may cause the proposal to be rejected.

5. Costs attributable to Division 01 - General Requirements are assumed to be prorated among price items listed.

6. Responders are advised that this requirement may be delayed, cancelled or revised at any time during the solicitation, selection, evaluation, negotiation and/or final award process based on decisions related to DOD changes in force structure and disposition of the Armed Forces.

7. The Army will procure this housing through a design and cost competition in accordance with the provisions set forth in this Request for Proposals (RFP). When a contract is awarded, it will be a "Firm Fixed Price Contract."

8. The Congress, in authorizing and funding this contract, has established certain cost limitations for the project. The current authorization for the complete design and construction of this project is **$ 27,800,000.00.** Proposals that exceed this funding limit after exercising any options (if applicable) may be rejected. Submission of desirable alternative features exceeding minimum requirements may be considered as long as award can be made within the established funds.

PRICE PROPOSAL SCHEDULE

NOTES: (cont)

9. Funds are not presently available for this contract. The Government's obligation under this contract is contingent upon the availability of appropriated funds from which payment for contract purposes can be made. See Section 00700, paragraph 52.232-18.

10. ABBREVIATIONS

For the purpose of this solicitation, the units of measure are represented as follows:

a. LS (lump sum)
b. LF (linear feet)
c. EA (each)

END OF PRICE PROPOSAL SCHEDULE

SECTION 00100
Instructions to Offerors

LOCAL INSTRUCTIONS

PROJECT INFORMATION

a. For technical information regarding plans and specifications contact Fort Worth District Office, Corps of Engineers, Fort Worth, Texas, telephone, 817/886-1755, Jim Rawlings, email Jimmy.E. Rawlings@swf02-usace.army.mil.

b. For information regarding bidding procedures or bonds, contact Barbara Zimmer via telephone 817/886-1052; via email Barbara.J.Zimmer@swf02.usace.army.mil; or visit Room 2A19, 819 Taylor Street, Fort Worth, Texas. Collect calls not accepted.

c. Offers will NOT be publicly opened. Information concerning the status of the evaluation and/or award will NOT be available after receipt of proposals.

GENERAL NOTICES

a. In the technical specifications wherever the term "stabilized aggregate base course" is used, or wherever a reference is made to a section entitled "Stabilized Aggregate Base Course," it shall be deemed to mean "Aggregate Base Course."

b. Offerors must provide full, accurate, and complete information as required by this solicitation and its attachments. The penalty for making false statements in Offers is prescribed in 18 USC 1001. (FAR 52.214-4)

c. The Affirmative Action Requirement of the Equal Opportunity Clause may apply to any contract resulting from this RFP.

FACSIMILE OFFERS

For the purposes of this solicitation, *Facsimile Offers for Original submission of proposals are NOT authorized. If during the course of the evaluation phase it is determined by the Contracting Officer to allow submission of facsimile documents, these specific documents will be identified at that time.*

In the event that facsimile documents will be allowed, a fax number will be provided.
This facsimile number will be available for use by all bidders and offerors on a "first come, first served" basis and is, therefore, subject to heavy use for long periods of time. Accordingly, bidders/offerors are cautioned that "last minute" bids/offers may be received late due to heavy message traffic. The government assumes no responsibility for such late bids/offers.

BID GUARANTEE

Reference the provision 52.228-1, Bid Guarantee. **Facsimile Bonds are not acceptable**.

OFFEROR'S QUALIFICATIONS

Pursuant to FAR 9.1, as an evaluation criteria, the offeror will be requested by the Government to submit a statement regarding his previous experience in performing comparable work, his business and technical organization, financial resources, and plant available to be used in performing the work.

NOTICE REGARDING POTENTIAL EMPLOYMENT ON MILITARY INSTALLATION

If the work called for by this request for proposal is located on a military installation, offerors should check with post/base security to determine if potential employees will be allowed on the base/post to seek employment.

SMALL BUSINESS SUBCONTRACTING PLAN

a. This notice applies to Large Businesses only.

b. Reference FAR 52.219-9, SMALL BUSINESS SUBCONTRACTING PLAN. The bidder/offeror shall take into consideration only those subcontracts that he/she will award when preparing the subcontracting plan required by the FAR.

c. The Contracting Officer will NOT make award under this solicitation without an APPROVED subcontracting plan.

d. To be approved, the plan must contain at a minimum, the eleven elements set forth in FAR 52.219-9, paragraph (d). Pursuant to AFARS 19.705-4(d), your plan will be reviewed and scored in accordance with AFARS Appendix DD to ensure it clearly represents your firm's ability to carry out the terms and conditions set forth in the contract clauses.

Am #0003

e. Subcontracting Plan Floors. These are the minimum percentages of subcontracted dollars that will be approved. The current floors for Fiscal Year **2005** are as follows:

Small Business	**50%**	~~73.5%~~
Small Disadvantages Business	**8.%**	~~16.7%~~
Women-Owned Small Business	**7.2%**	~~11.0%~~
Service-Disabled Veteran	**0.5%**	~~3.0%~~
HUBZone Small Business	**2.9%**	~~3.2%~~
Veteran Owned Small Businesses	**1.0%**	

f. Current copies of Standard Form 294 and 295 can be found at http://contacts.gsa.gov/webforms.nsf/

g.

g. Contractors may post subcontracting opportunities at the Small Business Administration's SubNet: http://web.sba.gov/subnet/index.cfm.

AMENDMENTS TO THIS REQUEST FOR PROPOSALS (RFP)

All amendments to this RFP will be made through the use of the Internet. No additional media (CD ROMS, Floppy Disks, Faxes, or paper) will be provided unless the Government determines that it is necessary. Contractors may view/download this solicitation and all amendments from the Internet after solicitation issuance at the following

Internet address:http://ebs.swf.usace.army.mil All offerors are required to check the Ft. Worth District Contracting Division website daily to be notified of any changes to this solicitation.

ESTIMATED CONSTRUCTION COST

The estimated cost of the proposed construction is between $25,000,000 and $50,000 000 (FAR 36.204 Disclosure of the Magnitude of Construction Projects).

SPECIAL NOTICE CONCERNING INDIVIDUAL SURETIES

The Security interest, including pledged assets as set forth in the FAR 52.228-11, PLEDGES OF ASSETS, and executed Standard Form 28 entitled "AFFIDAVIT OF INDIVIDUAL SURETY" shall be furnished with the bond. Failure to provide with the bid bond a pledge of assets (security interest) in accordance with FAR 28.203-1 will result in rejection of a bid that is bonded by individual sureties.

PARTNERING

In order to accomplish this contract, the government is encouraging the formation of a cohesive partnership with the contractor and its subcontractors. This partnership would strive to draw on the strengths of each organization in an effort to achieve a quality project done right the first time, within budget, and on schedule. This partnership would be bilateral in make-up and participation would be totally voluntary. Any cost associated with effectuating this partnership will be agreed to by both parties and will be shared equally with no change in contract price.

PRINCIPAL CONTRACTING OFFICER

The Contracting Officer who signs this contract will be the Principal Contracting Officer for this contract. However, any Contracting Officer assigned to the Fort Worth District, contracting within his or her authority, may take formal action on this contract when a contract action needs to be taken and the Principal Contracting Officer is unavailable.

FAR PROVISIONS

52.204-6 DATA UNIVERSAL NUMBERING SYSTEM (DUNS) NUMBER (JUN 99)

(a) Contractor identification is essential for complying with statutory contract reporting requirements. Therefore, the offeror is requested to enter, in the block with its name and address on the Standard Form 33 or similar document, the annotation "DUNS" followed by the DUNS number which identifies the offeror's name and address exactly as stated in the offer.

(b) If the offeror does not have a DUNS number, it should contact Dun and Bradstreet directly to obtain one. A DUNS number will be provided immediately by telephone at no charge to the offeror. For information on obtaining a DUNS number, the offeror, if located within the United States, should call Dun and Bradstreet at 1-800-333-0505. The offeror should be prepared to provide the following information:

(1) Company name.

(2) Company address.

(3) Company telephone number.

(4) Line of business.

(5) Chief executive officer/key manager.

(6) Date the company was started.

(7) Number of people employed by the company.

(8) Company affiliation.

(c) Offerors located outside the United States may obtain the location and phone number of the local Dun and Bradstreet Information Services office from the Internet Home Page at http://www.customerservice@dnb.com/. If an offeror is unable to locate a local service center, it may send an e-mail to Dun and Bradstreet at globalinfo@dnb.com.
(End of provision)

252.204-7001 Commercial and Government Entity (CAGE) Code Reporting. (AUG 1999)

(a) The offeror is requested to enter its CAGE code on its offer in the block with its name and address. The CAGE code entered must be for that name and address. Enter "CAGE" before the number.

(b) If the offeror does not have a CAGE code, it may ask the Contracting Officer to request one from the Defense Logistics Information Service (DLIS). The Contracting Officer will—

(1) Ask the Contractor to complete section B of a DD Form 2051, Request for Assignment of a Commercial and Government Entity (CAGE) Code;

(2) Complete section A and forward the form to DLIS; and

(3) Notify the Contractor of its assigned CAGE code.

(c) Do not delay submission of the offer pending receipt of a CAGE code.

(End of provision)

52.211-6 Brand Name or Equal (Aug 1999)

(a) If an item in this solicitation is identified as "brand name or equal," the purchase description reflects the characteristics and level of quality that will satisfy the Government's needs. The salient physical, functional, or performance characteristics that "equal" products must meet are specified in the solicitation.
(b) To be considered for award, offers of "equal" products, including "equal" products of the brand name manufacturer, must-
(1) Meet the salient physical, functional, or performance characteristic specified in this solicitation;
(2) Clearly identify the item by-
(i) Brand name, if any; and
(ii) Make or model number;
(3) Include descriptive literature such as illustrations, drawings, or a clear reference to previously furnished descriptive data or information available to the Contracting Officer; and
(4) Clearly describe any modifications the offeror plans to make in a product to make it conform to the solicitation requirements. Mark any descriptive material to clearly show the modifications.
(c) The Contracting Officer will evaluate "equal" products on the basis of information furnished by the offeror or identified in the offer and reasonably available to the Contracting Officer. The Contracting Officer is not responsible for locating or obtaining any information not identified in the offer.
(d) Unless the offeror clearly indicates in its offer that the product being offered is an "equal" product, the offeror shall provide the brand name product referenced in the solicitation.

(End of provision)

52.211-14 Notice of Priority Rating for National Defense Use. (Sept 1990)

Any contract awarded as a result of this solicitation will be **DO** rated order certified for national defense use under the Defense Priorities and Allocations System (DPAS) (15 CFR 700), and the Contractor will be required to follow all of the requirements of this regulation.

(End of provision)

52.0211-0002 AVAILABILITY OF SPECIFICATIONS LISTED IN THE DOD INDEX OF SPECIFICATIONS AND STANDARDS (DODISS) AND DESCRIPTIONS LISTED IN THE ACQUISITION MANAGEMENT SYSTEMS AND DATA REQUIREMENTS CONTROL LIST, DOD 5010.12-L (DEC 1999)

Copies of specifications, standards, and data item descriptions cited in this solicitation may be obtained--

(a) From the ASSIST database via the Internet at http://assist.daps.mil; or

(b) By submitting a request to the--Department of Defense Single Stock Point (DoDSSP), Building 4, Section D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Telephone (215) 697-2667/2179, Facsimile (215) 697-1462.

(End of provision)

52.214-34 SUBMISSION OF OFFERS IN THE ENGLISH LANGUAGE (APR 1991)

Offers submitted in response to this solicitation shall be in the English language. Offers received in other than English shall be rejected.

(End of provision)

52.214-35 SUBMISSION OF OFFERS IN U.S. CURRENCY (APR 1991)

Offers submitted in response to this solicitation shall be in terms of U.S. dollars. Offers received in other than U.S. dollars shall be rejected.

(End of provision)

52.215-1 INSTRUCTIONS TO OFFERORS--COMPETITIVE ACQUISITION (MAY 2001)

(a) Definitions. As used in this provision--

“Discussions” are negotiations that occur after establishment of the competitive range that may, at the Contracting Officer's discretion, result in the offeror being allowed to revise its proposal.

In writing, writing, or written means any worded or numbered expression that can be read, reproduced, and later communicated, and includes electronically transmitted and stored information.

“Proposal modification” is a change made to a proposal before the solicitation's closing date and time, or made in response to an amendment, or made to correct a mistake at any time before award.

“Proposal revision” is a change to a proposal made after the solicitation closing date, at the request of or as allowed by a Contracting Officer as the result of negotiations.

“Time”, if stated as a number of days, is calculated using calendar days, unless otherwise specified, and will include Saturdays, Sundays, and legal holidays. However, if the last day falls on a Saturday, Sunday, or legal holiday, then the period shall include the next working day.

(b) Amendments to solicitations. If this solicitation is amended, all terms and conditions that are not amended remain unchanged. Offerors shall acknowledge receipt of any amendment to this solicitation by the date and time specified in the amendment(s).

(c) Submission, modification, revision, and withdrawal of proposals. (1) Unless other methods (e.g., electronic commerce or facsimile) are permitted in the solicitation, proposals and modifications to proposals shall be submitted in paper media in sealed envelopes or packages (i) addressed to the office specified in the solicitation, and (ii) showing the time and date specified for receipt, the solicitation number, and the name and address of the offeror. Offerors using commercial carriers should ensure that the proposal is marked on the outermost wrapper with the information in paragraphs (c)(1)(i) and (c)(1)(ii) of this provision.

(2) The first page of the proposal must show--

(i) The solicitation number;

(ii) The name, address, and telephone and facsimile numbers of the offeror (and electronic address if available);

(iii) A statement specifying the extent of agreement with all terms, conditions, and provisions included in the solicitation and agreement to furnish any or all items upon which prices are offered at the price set opposite each item;

(iv) Names, titles, and telephone and facsimile numbers (and electronic addresses if available) of persons authorized to negotiate on the offeror's behalf with the Government in connection with this solicitation; and

(v) Name, title, and signature of person authorized to sign the proposal. Proposals signed by an agent shall be accompanied by evidence of that agent's authority, unless that evidence has been previously furnished to the issuing office.

(3) Submission, modification, or revision, of proposals.

(i) Offerors are responsible for submitting proposals, and any modifications, or revisions, so as to reach the Government office designated in the solicitation by the time specified in the solicitation. If no time is specified in the solicitation, the time for receipt is 4:30 p.m., local time, for the designated Government office on the date that proposal or revision is due.

(ii)(A) Any proposal, modification, or revision received at the Government office designated in the solicitation after the exact time specified for receipt of offers is “late” and will not be considered unless it is received before award is made, the Contracting Officer determines that accepting the late offer would not unduly delay the acquisition; and--

(1) If it was transmitted through an electronic commerce method authorized by the solicitation, it was received at the initial point of entry to the Government infrastructure not later than 5:00 p.m. one working day prior to the date specified for receipt of proposals; or

(2) There is acceptable evidence to establish that it was received at the Government installation designated for receipt of offers and was under the Government's control prior to the time set for receipt of offers; or

(3) It is the only proposal received.

(B) However, a late modification of an otherwise successful proposal that makes its terms more favorable to the Government, will be considered at any time it is received and may be accepted.

(iii) Acceptable evidence to establish the time of receipt at the Government installation includes the time/date stamp of that installation on the proposal wrapper, other documentary evidence of receipt maintained by the installation, or oral testimony or statements of Government personnel.

(iv) If an emergency or unanticipated event interrupts normal Government processes so that proposals cannot be received at the office designated for receipt of proposals by the exact time specified in the solicitation, and urgent Government requirements preclude amendment of the solicitation, the time specified for receipt of proposals will be deemed to be extended to the same time of day specified in the solicitation on the first work day on which normal Government processes resume.

(v) Proposals may be withdrawn by written notice received at any time before award. Oral proposals in response to oral solicitations may be withdrawn orally. If the solicitation authorizes facsimile proposals, proposals may be withdrawn via facsimile received at any time before award, subject to the conditions specified in the provision at 52.215-5, Facsimile Proposals. Proposals may be withdrawn in person by an offeror or an authorized representative, if the identity of the person requesting withdrawal is established and the person signs a receipt for the proposal before award.

(4) Unless otherwise specified in the solicitation, the offeror may propose to provide any item or combination of items.

(5) Offerors shall submit proposals in response to this solicitation in English, unless otherwise permitted by the solicitation, and in U.S. dollars, unless the provision at FAR 52.225-17, Evaluation of Foreign Currency Offers, is included in the solicitation.

(6) Offerors may submit modifications to their proposals at any time before the solicitation closing date and time, and may submit modifications in response to an amendment, or to correct a mistake at any time before award.

(7) Offerors may submit revised proposals only if requested or allowed by the Contracting Officer.

(8) Proposals may be withdrawn at any time before award. Withdrawals are effective upon receipt of notice by the Contracting Officer.

(d) Offer expiration date. Proposals in response to this solicitation will be valid for the number of days specified on the solicitation cover sheet (unless a different period is proposed by the offeror).

(e) Restriction on disclosure and use of data. Offerors that include in their proposals data that they do not want disclosed to the public for any purpose, or used by the Government except for evaluation purposes, shall--

(1) Mark the title page with the following legend: This proposal includes data that shall not be disclosed outside the Government and shall not be duplicated, used, or disclosed--in whole or in part--for any purpose other than to evaluate this proposal. If, however, a contract is awarded to this offeror as a result of--or in connection with-- the submission of this data, the Government shall have the right to duplicate, use, or disclose the data to the extent provided in the resulting contract. This restriction does not limit the Government's right to use information contained in this data if it is obtained from another source without restriction. The data subject to this restriction are contained in sheets [insert numbers or other identification of sheets]; and

(2) Mark each sheet of data it wishes to restrict with the following legend: Use or disclosure of data contained on this sheet is subject to the restriction on the title page of this proposal.

(f) Contract award. (1) The Government intends to award a contract or contracts resulting from this solicitation to the responsible offeror(s) whose proposal(s) represents the best value after evaluation in accordance with the factors and subfactors in the solicitation.

(2) The Government may reject any or all proposals if such action is in the Government's interest.

(3) The Government may waive informalities and minor irregularities in proposals received.

(4) The Government intends to evaluate proposals and award a contract without discussions with offerors (except clarifications as described in FAR 15.306(a)). Therefore, the offeror's initial proposal should contain the offeror's best terms from a cost or price and technical standpoint. The Government reserves the right to conduct discussions if the Contracting Officer later determines them to be necessary. If the Contracting Officer determines that the number of proposals that would otherwise be in the competitive range exceeds the number at which an efficient competition can be conducted, the Contracting Officer may limit the number of proposals in the competitive range to the greatest number that will permit an efficient competition among the most highly rated proposals.

(5) The Government reserves the right to make an award on any item for a quantity less than the quantity offered, at the unit cost or prices offered, unless the offeror specifies otherwise in the proposal.

(6) The Government reserves the right to make multiple awards if, after considering the additional administrative costs, it is in the Government's best interest to do so.

(7) Exchanges with offerors after receipt of a proposal do not constitute a rejection or counteroffer by the Government.

(8) The Government may determine that a proposal is unacceptable if the prices proposed are materially unbalanced between line items or subline items. Unbalanced pricing exists when, despite an acceptable total evaluated price, the price of one or more contract line items is significantly overstated or understated as indicated by the application of cost or price analysis techniques. A proposal may be rejected if the Contracting Officer determines that the lack of balance poses an unacceptable risk to the Government.

(9) If a cost realism analysis is performed, cost realism may be considered by the source selection authority in evaluating performance or schedule risk.

(10) A written award or acceptance of proposal mailed or otherwise furnished to the successful offeror within the time specified in the proposal shall result in a binding contract without further action by either party.

(11) The Government may disclose the following information in postaward debriefings to other offerors:

(i) The overall evaluated cost or price and technical rating of the successful offeror;

(ii) The overall ranking of all offerors, when any ranking was developed by the agency during source selection;

(iii) A summary of the rationale for award; and
(iv) For acquisitions of commercial items, the make and model of the item to be delivered by the successful offeror.
(End of provision)

52.215-20 Requirements for Cost or Pricing Data or Information Other Than Cost or Pricing Data.
(Oct 1997)

(a) *Exceptions from cost or pricing data*.
(1) In lieu of submitting cost or pricing data, offerors may submit a written request for exception by submitting the information described in the following paragraphs. The Contracting Officer may require additional supporting

information, but only to the extent necessary to determine whether an exception should be granted, and whether the price is fair and reasonable.
(i) *Identification of the law or regulation establishing the price offered*. If the price is controlled under law by periodic rulings, reviews, or similar actions of a governmental body, attach a copy of the controlling document, unless it was previously submitted to the contracting office.
(ii) *Commercial item exception*. For a commercial item exception, the offeror shall submit, at a minimum, information on prices at which the same item or similar items have previously been sold in the commercial market that is adequate for evaluating the reasonableness of the price for this acquisition. Such information may include-
(A) For catalog items, a copy of or identification of the catalog and its date, or the appropriate pages for the offered items, or a statement that the catalog is on file in the buying office to which the proposal is being submitted. Provide a copy or describe current discount policies and price lists (published or unpublished), *e.g.*, wholesale, original equipment manufacturer, or reseller. Also explain the basis of each offered price and its relationship to the established catalog price, including how the proposed price relates to the price of recent sales in quantities similar to the proposed quantities;
(B) For market-priced items, the source and date or period of the market quotation or other basis for market price, the base amount, and applicable discounts. In addition, describe the nature of the market;
(C) For items included on an active Federal Supply Service Multiple Award Schedule contract, proof that an exception has been granted for the schedule item.
(2) The offeror grants the Contracting Officer or an authorized representative the right to examine, at any time before award, books, records, documents, or other directly pertinent records to verify any request for an exception under this provision, and the reasonableness of price. For items priced using catalog or market prices, or law or regulation, access does not extend to cost or profit information or other data relevant solely to the offeror's determination of the prices to be offered in the catalog or marketplace.
(b) *Requirements for cost or pricing data*. If the offeror is not granted an exception from the requirement to submit cost or pricing data, the following applies:
(1) The offeror shall prepare and submit cost or pricing data and supporting attachments in accordance with Table 15-2 of FAR 15.408.
(2) As soon as practicable after agreement on price, but before contract award (except for unpriced actions such as letter contracts), the offeror shall submit a Certificate of Current Cost or Pricing Data, as prescribed by FAR 15.406-2.

(End of provision)

52.216-1 TYPE OF CONTRACT (APR 1984)

The Government contemplates award of a **firm-fixed priced Design/Construction contract** resulting from this solicitation.

(End of clause)

52.217-5 EVALUATION OF OPTIONS (JUL 1990)

(a) Except when it is determined in accordance with FAR 17.206(b) not to be in the Government's best interests, the Government will evaluate offers for award purposes by adding the total price for all options to the total price for the basic requirement. Evaluation of options will not obligate the Government to exercise the option(s).

(b) The Government may reject an offer as nonresponsive if it is materially unbalanced as to prices for the basic requirement and the option quantities. An offer is unbalanced when it is based on prices significantly less than cost for some work and prices that are significantly overstated for other work.

(End of provision)

52.225-12 Notice of Buy American Act/Balance of Payments Program Requirement-Construction Materials under Trade Agreements. (Feb 2000)

(a) *Definitions.* "Construction material," "designated country construction material," "domestic construction material," "foreign construction material," and "NAFTA country construction material," as used in this provision, are defined in the clause of this solicitation entitled "Buy American Act-Balance of Payments Program-Construction Materials under Trade Agreements" (Federal Acquisition Regulation (FAR) clause 52.225-11).
(b) *Requests for determination of inapplicability*. An offeror requesting a determination regarding the inapplicability of the Buy American Act or Balance of Payments Program should submit the request to the Contracting Officer in time to allow a determination before submission of offers. The offeror shall include the information and applicable supporting data required by paragraphs (c) and (d) of FAR clause 52.225-11 in the request. If an offeror has not requested a determination regarding the inapplicability of the Buy American Act or Balance of Payments Program before submitting its offer, or has not received a response to a previous request, the offeror shall include the information and supporting data in the offer.
(c) *Evaluation of offers*.
(1) The Government will evaluate an offer requesting exception to the requirements of the Buy American Act or Balance of Payments Program, based on claimed unreasonable cost of domestic construction materials, by adding to the offered price the appropriate percentage of the cost of such foreign construction material, as specified in paragraph (b)(4)(i) of FAR clause 52.225-11.
(2) If evaluation results in a tie between an offeror that requested the substitution of foreign construction material based on unreasonable cost and an offeror that did not request an exception, the Contracting Officer will award to the offeror that did not request an exception based on unreasonable cost.
(d) *Alternate offers*.
(1) When an offer includes foreign construction material, other than designated country or NAFTA country construction material, that is not listed by the Government in this solicitation in paragraph (b)(3) of FAR clause 52.225-11, the offeror also may submit an alternate offer based on use of equivalent domestic, designated country, or NAFTA country construction material.
(2) If an alternate offer is submitted, the offeror shall submit a separate Standard Form 1442 for the alternate offer, and a separate price comparison table prepared in accordance with paragraphs (c) and (d) of FAR clause 52.225-11 for the offer that is based on the use of any foreign construction material for which the Government has not yet determined an exception applies.

(3) If the Government determines that a particular exception requested in accordance with paragraph (c) of FAR clause 52.225-11 does not apply, the Government will evaluate only those offers based on use of the equivalent domestic, designated country, or NAFTA country construction material, and the offeror shall be required to furnish such domestic, designated country, or NAFTA country construction material. An offer based on use of the foreign construction material for which an exception was requested-
(i) Will be rejected as nonresponsive if this acquisition is conducted by sealed bidding; or
(ii) May be accepted if revised during negotiations.

(End of provision)

52.233-2 SERVICE OF PROTEST (AUG 1996)

(a) Protests, as defined in section 33.101 of the Federal Acquisition Regulation, that are filed directly with an agency, and copies of any protests that are filed with the General Accounting Office (GAO), shall be served on the Contracting Officer (addressed as follows) by obtaining written and dated acknowledgment of receipt from

US Army Engineer District, Fort Worth
ATTN: CESWF-CT-C, Room 2A19
819 Taylor Street,/PO Box 17300
Fort Worth, TX 76102-0300

(b) The copy of any protest shall be received in the office designated above within one day of filing a protest with the GAO.
(End of provision)

52.236-27 SITE VISIT (CONSTRUCTION) (FEB 1995)

(a) The clauses at 52.236-2, Differing Site Conditions, and 52.236-3, Site Investigations and Conditions Affecting the Work, will be included in any contract awarded as a result of this solicitation. Accordingly, offerors are urged and expected to inspect the site where the work will be performed.

(b) A site visit will be conducted in conjunction with the pre-proposal conference. See Section 00102, PRE-PROPOSAL CONFERENCE/SITE VISITATION, for additional information.

(End of Provision)

52.236-28 PREPARATION OF PROPOSALS--CONSTRUCTION (OCT 1997)

(a) Proposals must be (1) submitted on the forms furnished by the Government or on copies of those forms, and (2) manually signed. The person signing a proposal must initial each erasure or change appearing on any proposal form.

(b) The proposal form may require offerors to submit proposed prices for one or more items on various bases, including--

(1) Lump sum price;

(2) Alternate prices;

(3) Units of construction; or

(4) Any combination of paragraphs (b)(1) through (b)(3) of this provision.

(c) If the solicitation requires submission of a proposal on all items, failure to do so may result in the proposal being rejected without further consideration. If a proposal on all items is not required, offerors should insert the words “no proposal” in the space provided for any item on which no price is submitted.

(d) Alternate proposals will not be considered unless this solicitation authorizes their submission.

(End of provision)

52.252-5 AUTHORIZED DEVIATIONS IN PROVISIONS (APR 1984)

(a) The use in this solicitation of any Federal Acquisition Regulation (48 CFR Chapter 1) provision with an authorized deviation is indicated by the addition of"(DEVIATION)" after the date of the provision.

The use in this solicitation of any Defense Federal Acquisition Regulation Supplement (DFARS) (48 CFR Chapter 2) provision with an authorized deviation is indicated by the addition of "(DEVIATION)" after the name of the regulation.

(End of Section 00100)

SECTION 01001
STATEMENT OF WORK

AM # 3

1. DESIGN OBJECTIVES.

1-1 The design and construction shall comply with the specifications and requirements contained in this Request for Proposals (RFP). The design and technical criteria contained and cited in this RFP establish minimum standards for design and construction quality. All housing units constructed in accordance with these standards are "Energy Star Homes".

1-2 Work Scope. The objective of this solicitation is to obtain housing complete and adequate for assignment as quarters for military personnel and their families. This contract shall consist of the design and construction of a total of 156 housing units, parking, roads, and site amenities on Government-owned land at White Sands MR, New Mexico, which comply with this RFP. Work shall consist of the following:

1-2.1 Housing Units. Housing units with patio, garages interior storage, individual central heating systems, energy conservation systems and central air conditioning, and including the following Contractor-furnished/Contractor-installed (CF/CI) equipment and appliances: range, refrigerator, garbage disposal, dishwasher, water heater, [carbon monoxide alarms], and smoke detectors. Housing units shall be a mix of three-, four-, and/or five-bedroom housing units as shown in Table 1-1:

TABLE 1-1 - HOUSING UNITS

Pay Grade	Number of Bedrooms	Number of Units
(FGO)	4	5
(JNCO)	5	11
	4	34
	3	106

1-2.2 Accessible units. Construction will consist of single-family one-story buildings. No less than five (5) percent of each unit type at each site shall be single-story ground floor housing units. New and replacement general officer units shall be built accessible. These housing units shall be designed and built in such a way that they may be easily and readily modified to accommodate physically challenged occupants at time of occupancy. AM # 3Eight of the **JNCO** houses will be accessible and easily modifiable to accommodate the requirements of the handicapped. See paragraph 5.a.(2)(a). Design of accessible housing units shall conform to the Uniform Federal Accessibility Standards (UFAS) and American Disabilities Act Accessibility Guidelines (ADAAG). Accessible housing units shall be well dispersed throughout the development and shall not be grouped or clustered so as to create segregated pockets within the housing community. The requirement to have an additional two (2) percent of housing units equipped with warning devices for the hearing and visually impaired will be met at the time the unit is assigned to an occupant needing this equipment.

1-2.3 Site area and density.

1-2.3.1 Site area. The site is described on the RFP drawings included as part of this solicitation and includes approximately 51.3 acres. Site work includes all design and construction of the site design to include grading, storm drainage, storm management, erosion control, pedestrian and vehicular circulation, utility systems, outdoor lighting, neighborhood parks, and physical security.

1-2.3.2 Site density. This project consists of 156 housing units on 51.3 acres of land. The project site is approved for LOW DENSITY siting. Site development shall comply with the minimum requirements for LOW DENSITY siting. AM # 3.~~The new housing area will be constructed ***"TBD - site is not finalized yet – TBD"***~~

1-2.4 Special utilities and supplementary construction. All new utilities shall be underground in the street limits or front yards and properly marked. Existing abandoned utilities that are encountered within three feet of the ground surface will be removed from this project area.

1-2.5 Demolition considerations and requirements. Demolition will consist of any housing units utilities and/or subsurface structures (i.e. foundations, piers) that have been abandoned in place and which fall within the boundaries of this project as shown on Sheet C-001. Any roads within this project's boundaries shall be demolished also. Housing units, utility systems, and streets must be demolished in such a manner as to maintain active service and vehicular circulation to the existing housing area. Houses once existed on this site in the vacant areas, therefore, these areas shall be thoroughly investigated to determine the extent and/or presence of subsurface structures that may have been abandoned in place and will require removal before construction. Existing service utility lines within three feet of the ground surface that are encountered shall be completely removed to the existing main and plugged. The approximate location of the trees has been identified on the topographic maps so the trees can be removed during demolition, except as noted on drawings. See paragraph 14- ENVIRONMENTAL for environmental demolition concerns that may be encountered.

1-3 Energy Star Homes Program Requirements: The Contractor, at the direction of the USACE Contracting Officer's Representative, shall be required to submit to the EPA the necessary information and certifications to register the units constructed in this project as Energy Star Homes. The contractor constructing housing units in accordance with this Statement of Work should be a registered Energy Star Contractor. The required information can be submitted to EPA in several methods:

1-3.1 Through the Internet by clicking on the *certificate automation system* icon at the World Wide Website http://yosemite.epa.gov/appd/eshomes/eshomes.nsf and following the instructions

1-3.2 By emailing to certificates@epa.gov

1-3.3 By mailing to the EPA Customer Service Manager (address & tel. no. below):

The following information needs to be submitted for each home [note: homes can be submitted *individually* (each home individually tested/rated) or in a "*batch*" (for batches of homes, particular unit types). The following data should be provided for each home (note: this can be in the form of a spreadsheet, database, word processing file or email; if the format changes in the future EPA will inform the contractor of the changes):

Contractor company name (ex. Jones Construction Co.)
Contractor telephone number (ex. 703-123-4567)
Name of company/organization performing testing/rating (ex. Jones Construction Co.)
Telephone number of company/organization performing testing/rating (ex. 703-123-4567)
Street address of home being submitted, including city, state & zip code (ex. 123 Smith St., City, State 12345)
Type of verification:

"**FEP**" --- if this particular home underwent infiltration testing (and possibly duct leakage testing). Please list the tested infiltration value in ACH/nat (natural air changes per hour) and if tested, the duct leakage into unconditioned spaces in cfm and % of air handler flow at a pressure of 25 pascals.

SEP" --- if this particular home did *not* undergo infiltration and/or duct leakage testing, but was a member of a batch out of which at least 15% DID; if so, then the address of a home that was a tested member of this batch should also be identified as the tested member of the batch.

1-3.4 The following statement: "This home qualifies as an EPA Energy Star Home by conforming to the residential energy efficiency specifications and quality control confirmation of U.S. Army Corps of Engineers TI 801-02, Family Housing, 01-10-01 which has been determined by the EPA and USACE to be an ***Equivalent Program*** to the EPA Energy Star Homes Program." In addition, the "checklist" of home specifications that the USACE Contracting Officer's Representative uses to ascertain if the TI 801-02 specifications and testing results were met should be submitted. The statement and checklist should have the USACE Contracting Officer's Representative's signature affixed.

The year the house was built (ex. 2001)
The year the house was submitted for Energy Star certification (ex. 2001)
The name and title/rank, mailing address, email address, telephone number and fax number of the USACE Contracting Officer's Representative overseeing the contractor's adherence to construction specifications, quality control of construction and testing/rating activities.

1-3.5 The Contractor will make arrangements with the EPA for receipt of the "Energy Star Homes" certificates and unit plaques and shall provide the certificates to the USACE Contracting Officer's Representative and included in the project the installation of the plaques on each of the housing units. Coordination point with the EPA regarding Energy Star certification and plaques shall be as follows:

United States Environmental Protection Agency
Climate Protection Division
US EPA 6202J
Washington DC 20460
ENERGY STAR Homes Customer Service Manager
ATTN: Mr. Brian Ng, Ng.Brian@epa.gov, 202-564-9162, fax: 202-565-2079
http://www.energystar.gov/homes

Technical questions on the Energy Star Homes Program in general can be addressed to:

ENERGY STAR Homes Technical Coordinator
ATTN: Mr Glenn T. Chinery,
Chinery.Glenn@epa.gov, 202-564-9784, fax: 202-565-2079

1-4 Design Freedom. Requirements stated in this RFP are minimums. Innovative, creative, or cost-saving proposals which meet or exceed these requirements are encouraged and will receive quality points accordingly. Deviations from space and adjacency requirements are discouraged unless the changes result in improvement to the facilities.

1-5 Not used

1-6 Site-built housing.

1-6.1 A residential building or housing unit wholly or substantially constructed at the site.

1-6.1.1 Where multiple prototype units are being constructed, one or two prototype units shall be left in the "rough in" stage (no interior finishes) so that the utility systems and framing construction is exposed. Exteriors of these prototypes shall be completely finished. When the last new units are constructed, these "rough in" stage prototype units shall be completed and turned over to the Government with the last turnover group.

1-6.2 Detached house. A single-family housing unit which is not attached to another housing unit.

1-7 Design Quality. The objectives are to obtain housing structures and complimentary site development within funds available and to optimize livability. Design quality is achieved through the optimization of interior planning, integration of housing structures to the site, and balancing

architectural attractiveness, variety, function, and design for low-cost maintenance and operation. Offerors should consider sustainable design applications in developing proposals, see para 13.

1-8 AM # 3 Not Used. ~~Installation Real Property Master Plan. The installation real property master plan provides comprehensive documentation of the existing conditions of natural, man-made, and human resources. It also guides the future land-use development. The real property master plan should be consulted as it is the mechanism for ensuring that individual projects are sited to meet overall installation goals and objectives for land use development~~

1-9 AM # 3. Not Used. ~~Installation Design Guide. Design of this project shall incorporate the design guidance and criteria contained in the Installation Design Guide, excerpts of which are contained as an attachment.~~

1-10 Energy and Resources Conserving Features. Public Law 102-486, Executive Order 13123, and Federal Regulations 10 CFR 435, require Federal buildings to be designed and constructed to reduce energy consumption in a life-cycle, cost-effective manner using renewable energy sources when economical. Products designed to conserve energy and resources by controlling the amounts of consumed energy or by operating at increased efficiencies should be considered. Minimum requirements for this project are high-efficiency central air conditioning and/or heating units, setback thermostats, and water flow-limiting plumbing fixtures. Offerors are required to provide Energy and Resource conserving improvements that at least insure compliance with the Energy Star Homes Program parameters.

1-11 Prototype Housing Units. The purpose of the prototype housing unit is to verify the details of the approved design and material selections, and to establish the quality level against which the remaining work will be judged. At the plant, or at the site, construction connection details shall be exposed for study by authorized Government inspectors for a period of time agreed to by the Contractor and the Contracting Officer. The housing unit or units at the plant and/or the prototype at the site are subject to Contracting Officer's approval. At the site, the complete prototype shall be constructed for each housing unit type. Each stage of work shall be completed and accepted on the prototype prior to starting work on the same stage for similar housing units in the project.

1-11.1 "Site-Built." A prototype housing unit shall be required for each housing unit type.

1-11.1.1 Where multiple prototype units are being constructed, one or two prototype units shall be left in the “rough in” stage (no interior finishes) so that the utility systems and framing construction is exposed. Exteriors of these prototypes shall be completely finished. When the last new units are constructed, these “rough in” stage prototype units shall be completed and turned over to the Government with the last turn-over group.

1-12 Force Protection & Anti-Terrorism Considerations. Project design and construction shall comply with the applicable DoD standards.

End of 01001-1

2. CRITERIA REFERENCES. AM # 3

2-1 Criteria to be used for design and construction shall be taken from the most current references at the date of issue of the RFP. Administrative, contractual, and procedural features of the contract shall be as described in other sections of the RFP. Referenced codes and standards herein and those listed below are minimum acceptable criteria.

2-2 Local and State Codes or Standards. The following specifications, standards, bulletins, and handbooks form a part of this document to the extent specified herein.

2-2.1 Local. AM # 3 ~~White Sands Missile Range Installation Design Guide.~~ ETL 1110-3-491 SUSTAINABLE DESIGN FOR MILITARY FACILITIES.

2-2.2 State.

2-3 Federal Laws. The Federal laws and regulations listed in Table 2-1 form a part of this document. They are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20401-9325 (202) 512 - 1800

TABLE 2-1 – FEDERAL LAWS & REGULATIONS

CFR/USC No.	Description
P.L. 102-486	Energy Policy Act of 1992
10 CFR 430	National Appliance Energy Conservation Act (NAECA)
10 CFR 435	Voluntary Performance Standards for New Commercial and Multi-Family High Rise Residential Buildings; Mandatory for Federal Buildings.
10 CFR 436	Methodology and Procedures for Life Cycle Cost Analyses
16 CFR 1630	Standard for Surface Flammability of Carpet and Rugs
40 CFR 247.12	Comprehensive Procurement Guideline for Products Containing Recovered Materials, Construction Products
40 CFR 280	Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks
49 CFR 192	Transportation of Natural Gas and Other Gas by Pipeline: Minimum Federal Safety Standards
49 CFR 195	Transportation of Hazardous Liquids by Pipeline
24 USC 5301	Public Law 93-383, Community Development
42 USC 4321-4361	National Environmental Policy Act (NEPA)
42 USC 4901-4918 & 49 USC 1431	Noise Control Act of 1972

TABLE 2-1 – FEDERAL LAWS & REGULATIONS	
CFR/USC No.	Description
Army Regulation 200-1	Environmental Protection and Enhancement, May 1990
E.O. 13123	Energy Efficiency and Water Conservation in Federal Facilities

2-4 Federal Specifications and Standards. The specifications listed form a part of this document to the extent specified herein. Federal Standard 795, Uniform Federal Accessibility Standards, and federal specifications are available from the Commanding Officer, Naval Publications and Forms Center, ATTENTION: NPODS, 5801 Tabor Avenue, Philadelphia, PA 19120-5099.

2-5 Other Government Documents and Publications. The following Government documents and publications form a part of this document to the extent specified herein:

2-5.1 Americans With Disabilities Act Accessibility Guidelines, are available from U.S. Architectural and Transportation Barriers Compliance Board, 1331 F Street, N.W., Washington, D.C. 20004-1111

2-5.2 Federal Emergency Management Agency, Mitigation Directorate; 500 C Street, SW; Washington DC 20472: National Performance Criteria for Tornado Shelters and FEMA 320, Taking Shelter from the Storm: Building a Safe Room Inside Your Home. http://www.fema.gov/

2-5.3 NBS Handbook 135, Life-Cycle Costing Manual for the Federal Energy Management Program. This handbook is available from the National Institute of Science and Technology, formerly National Bureau of Standards (NBS).

2-5.4 Standard for the Surface Flammability of Carpets and Rugs; and (Unnumbered) Handbook for Public Playground Safety, CFR 16-1630. Available from the Consumer Product Safety Commission, Directorate for Compliance and Administrative Litigation, Department of Regulatory Development, Washington, DC 20207, (301) 492-0626 or 492-0400.

2-5.5 United States Environmental Protection Agency criteria are available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161, (703) 487-4650: EPA/600/8-88/087, Radon-Resistant Residential New Construction; EPA/625/5-88/024, Application of Radon Reduction Methods; and EPA/625/5-87/019, Radon Reduction Techniques for Detached Houses.

2-6 Non-Government Publications. The following publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are Department of Defense (DoD) adopted are those listed in the Department of Defense Index of Specifications and Standards (DODISS).

2-6.1 Air Conditioning Contractors of America, Inc. (ACCA). 1712 New Hampshire Ave. NW. Washington DC 20009; (202) 483-9370; FAX (202) 588-1217; http://www.acca.org/.

2-6.2 Air-Conditioning and Refrigeration Institute (ARI). Information listed below is available from ARI, 4301 Fairfax Dr., Suite 425, ATTN: Pubs Dept.,Arlington, VA 22203, Ph: 703-524-8800, Fax: 703-528-3816, Internet E-Mail: ari@dgsys.com, Directory of Certified Unitary Air Conditioners, Unitary Heat Pumps and Sound Rated Outdoor Unitary Equipment; ARI 210/240, Unitary Air Conditioning and Air-Source Heat Pump Equipment: http://www.ari.org/

2-6.3 AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA), AMCA 210, Laboratory Methods of Testing Fans For Rating, is available from AMCA, 30 West University Drive, Arlington Heights, IL 60004, (312) 394-0150: http://www.amca.org/

2-6.4 American Architectural Manufacturers Association (AAMA). AAMA specifications shown in Table 2-2 are available from AAMA, 1540 East Dundee Rd., Suite 310, Palatine, IL 60067-8321,Ph: 708-202-1350,Fax: 708-202-1480 2700 River Road, Suite 118, Des Plaines, IL 60018, (312) 699-7310.

TABLE 2-2 - AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION SPECIFICATIONS

No.	Description
AAMA 101	Voluntary Specification for Aluminum Prime Windows and Sliding Glass Doors
AAMA 101V	Voluntary Specification for Poly (Vinyl Chloride) (PVC) Prime Windows and Sliding Glass Doors
AAMA 1002.10	Voluntary Specifications for Aluminum Insulating Storm Products for Windows and Sliding Glass Doors
AAMA 1402	Standard Specifications for Aluminum Siding, Soffit, and Fascia

2-6.5 American Gas Association (AGA). Standards and specifications are available from AGA, 1515 Wilson Blvd., Arlington, VA 22209, Ph: 703-841-8556,Fax: 703-841-8406: http://www.aga.org/

2-6.6 American National Standards Institute, Inc. (ANSI). Copies of the standards listed in Table 2-3 are available from ANSI, 11 West 42nd St., New York, NY 10036, Ph: 212-642-4900, Fax: 212-302-1286: http://www.ansi.org/

TABLE 2-3 - AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI) STANDARDS

Std. No.	Std. Description
A112.19.2	Vitreous China Plumbing Fixtures (DoD Adopted)
A112.19.3	Stainless Steel Plumbing Fixtures (Designed for Residential Use)
A112.19.4	Porcelain Enameled Formed Steel Plumbing Fixtures (DoD Adopted)
A112.19.5	Trim for Water-Closet Bowls, Tanks, and Urinals (Dimensional Standards) (DoD Adopted)
A161.1	Recommended Construction and Performance Standards for Kitchen and Vanity Cabinets
B16.5	Steel Pipe Flanges and Flanged Fittings (DoD Adopted)

TABLE 2-3 - AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI) STANDARDS

Std. No.	Std. Description
B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings (DoD Adopted)
B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes (DoD Adopted)
B31.8	Gas Transmission and Distribution Piping Systems
C2	National Electrical Safety Code
ANSI C105 AWWA A21.5	Polyethylene Encasement for Ductile-Iron Pipe Systems
Z21.10.1	Water Heaters, Gas, Volume I, Storage Type, 75,000 BTUH Input or Less
Z21.45	Flexible Connectors of Other Than All-Metal Construction for Gas Appliances
Z60.1	American Standard for Nursery Stock

2-6.7 American Plywood Association. APA B840-K-88, 303 Siding Manufacturing Specifications, are available from the American Plywood Association, P.O. Box 11700, Takoma, WA 98411, (206) 565-6600.

2-6.8 American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) documents, listed in Table 2-4, are available from ASHRAE,1791 Tullie Cir., NE, Atlanta, GA 30329-2305, Ph: 404-636-8400 Fax: 404-321-5478 1791 Tullie Circle, N.E., Atlanta, GA 30329, (404) 636-8400: http://www.ashrae.org/

TABLE 2-4 – AMERICAN SOCIETY OF HEATING, REFRIGERATION, AND AIR-CONDITIONING ENGINEERS (ASHRAE)

No.	Description
ASHRAE -	Handbook of Fundamentals
ASHRAE -	Residential Cooling Load Calculations
ASHRAE 62	Ventilation for Acceptable Indoor Air Quality
ASHRAE 52	Method of Testing Air Cleaning Devices used in General Ventilation for Removing Particulate Matter
ASHRAE 111	Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air Conditioning, and Refrigeration Systems

2-6.9 American Society of Mechanical Engineers (ASME). ASME B16.11, Forged Fittings, Socket-Welding and Threaded, and ASME B31.8, Gas Transmission and Distribution Systems, are available from ASME, 22 Law Dr., Box 2300, Fairfield, NJ 07007-2900, Ph: 800-843-2763, Fax: 201-882-1717:
http://www.asme.org/

2-6.10 American Society of Sanitary Engineers (ASSE). ASSE 1006, Residential Use (Household) Dishwashers, and ASSE 1008, Food Waste Disposal Units, Household, are available from ASSE, AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE), P.O. Box 40362, Bay Village, OH 44140, Ph: 216-835-3040, Fax: 216-835-3488:

2-6.11 American Society for Testing and Materials (ASTM). ASTM specifications listed in Table 2-5 are available from ASTM, AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) 1916 Race St., Philadelphia, PA 19103, Ph: 215-299-5585, Fax: 215-977-9679: http://www.astm.org/

TABLE 2-5 - AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) SPECIFICATIONS

Spec. No.	Spec. Description
A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
A526	Specification for Steel Sheet Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality (DoD Adopted)
B117	Method of Salt Spray (Fog) Testing (DoD Adopted)
C90	Specification for Hollow Load-Bearing Concrete Masonry Units (DoD Adopted)
C216	Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale) (DoD Adopted)
D3676	Rubber Cellular Cushion Used for Carpet or Rug Underlay
D1557	Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft 2700kN-m/m)
D1785	Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120 (DoD Adopted)
D2513	Standard Specification for Thermoplastic Gas Pressure Piping (DoD Adopted)
D2683	Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing (DoD Adopted)
D2846	Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot and Cold-Water Distribution Systems (DoD Adopted)
D3018	Specification for Class A Asphalt Shingles Surfaced with Mineral Granules (DoD Adopted)
D3679	Specification for Rigid Poly (Vinyl Chloride) (PVC) Siding

TABLE 2-5 - AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) SPECIFICATIONS

Spec. No.	Spec. Description
E84	Standard Test Method for Surface Burning Characteristics of Building Materials (DoD Adopted)
E90	Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions (DoD Adopted))
E108	Standard Methods of Fire Tests of Roof Coverings
E119	Standard Methods of Fire Tests of Building Construction and Materials
E162	Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source (DoD Adopted)
E283	Standard Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors
E330	Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference
E336	Standard Test Method for Measurement of Airborne Sound Insulation in Buildings
E547	Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Cyclic Static Air Pressure Differential
E648	Critical Radiant Flux of Floor-Covering Systems Using a Radiant Energy Source
E779	Measuring Air Leakage by the Pressurization Method
E1007	Standard Test Method for Field Measurement of Tapping Machine Impact Sound Transmission Through Floor-Ceiling Assemblies and Associated Support Structures
E1465	Standard Guide for Radon Control Options for the Design and Construction of New Low-Rise Residential Buildings
F1292	Specification for Impact Attenuation of Surface Systems Under and Around Playground Equipment
E1423	Standard Practice for Determining the Steady State Thermal Transmittance of Fenestration Systems
E 1554	Determining External Air Leakage of Air Distribution Systems by Fan Pressurization.
F 1066	Standard Specification for Sheet Vinyl Composition Floor Covering
F1487-98	Standard Consumer Safety Performance Specification for Playground Equipment for Public Use

TABLE 2-5 - AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) SPECIFICATIONS

Spec. No.	Spec. Description
G90	Standard Practice for Performing Accelerated Outdoor Weathering of Nonmetallic Materials Using Concentrated Natural Sunlight

2-6.12 American Water Works Association, Inc. (AWWA). Specifications listed below are available from AWWA, 6666 West Quincy, Denver, CO 80235, Ph: 800-926-7337, Fax: 303-795-1989, AWWA C500, Gate Valves for Water and Sewerage Systems (DoD adopted); AWWA C502, Dry-Barrel Fire Hydrants; and AWWA C503, Wet-Barrel Fire Hydrants: http://www.awwa.org/

2-6.13 Associated Air Balance Council (AABC). AABC MN-1, National Standards for Total System Balance, is available from AABC, 1518 K St., NW, Washington, DC 20005, Ph: 202-737-0202, Fax: 202-638-4833: http://www.aabchq.com/

2-6.14 American Association of Textile Chemists and Colorists (AATCC). AATCC 134, Electrostatic Propensity of Carpets, is available from AATCC, P.O. Box 12215, Research Triangle Park, NC 27709, (919) 549-8141.: http://www.aatcc.org/

2-6.15 Builders Hardware Manufacturers Association, Inc. (BHMA). Specifications shown in Table 2-6 are available from the Builders Hardware Manufacturers Association, Inc. (BHMA), 355 Lexington Ave., New York, NY 10017, Ph: 212-661-4261, FAX: 212-370-9047.

TABLE 2-6 - BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA) SPECIFICATIONS

No.	Description (Specs. are DoD Adopted)
BHMA 156.1	Butts and Hinges
BHMA 156.4	Door Controls, Closers
BHMA 156.4	Auxiliary Locks and Associated Products
BHMA 156.2	Bored and Preassembled Locks and Latches
BHMA 156.12	Interconnected Locks and Latches

2-6.16 AM # 3. Not Used.~~Building Officials & Code Administrators International, Inc. (BOCA). The BOCA National Building Code is available from Building Officials & Code Administrators International, Inc., (BOCA), 4051 W. Flossmoor Rd., Country Club Hills, IL 60478-5795, Ph: 708-799-2300, Fax: 708-799-4981: http://www.boca.org/~~

2-6.17 Carpet and Rug Institute (CRI). CRI Standard for Installation of Commercial Textile Floor Covering Materials, CRI 104, is available from the Carpet and Rug Institute, 310 Holiday Ave. P.O. Box 2048, Dalton, GA 30722-2048, Ph: 706-278-0232: http://www.carpet-rug.com/

2-6.18 AM # 3. Not Used.~~Council of American Building Officials (CABO). The CABO One (1) and Two (2) Family Dwelling Code and Model Energy Code, are available from the COUNCIL OF~~

~~AMERICAN BUILDING OFFICIALS (CABO) 5203 Leesburg Pike, Suite 708, Falls Church, VA 22041, Fax: 703-379-1546: http://www.intlcode.org/~~

2-6.19 Electronic Industries Association Telecommunications Industry Association (EIA/TIA). EIA/TIA Standard EIA/TIA-570, is available from Electronic Industries Association, Engineering Department, Order From: Global Engineering Documents, 7730 Carondelet Ave., Suite 407 Clayton, MO 63105, Ph: 800-854-7179, or 714-979-8135, Fax: 314-726-6418

2-6.20 Illuminating Engineering Society of North America (IESNA). The IESNA Lighting Handbook, is available from Illuminating Engineering Society of North America, (IESNA), 120 Wall St., 17th Floor, New York, NY 10005-4001, Ph: 212-248-5000, Fax: 212-248-5017: http://www.iesna.org/

2-6.21 International Conference of Building Officials (ICBO). The International Residential Code (IRC) 2003 is available from the, INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO), 5360 S. Workman Mill Rd., Whittier, CA 90601-2258, Ph: 310-699-0541, Fax: 310-692-3853: http://www.icbo.org/

2-6.22 National Association of Architectural Metal Manufacturers Association (NAAMA). NAAMA Metal Finishes Manual, is available from the NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM), 11 So. LaSalle St., Suite 1400, Chicago, IL 60603, Ph: 312-201-0101, FAX: 312-201-0214:

2-6.23 National Association of Corrosion Engineers (NACE). NACE RP-0286, The Electrical Isolation of Cathodically Protected Pipelines, is available from NACE, P.O. Box 218340, Houston, TX 77218: http://www.nace.org/

2-6.24 International Code Council (ICC). The International Plumbing Code, 5203 Leesburg Pike, Suite 708, Falls Church, VA 22041-3401, 703-931-4533.

2-6.25 National Electrical Manufacturers Association (NEMA). NEMA standards listed below are available from the National Electrical Manufacturers Association (NEMA), NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA),2101 L St., NW, Suite 300,Washington, DC 20037-1526
Ph: 202-457-8474 Fax: 202-457-8473 NEMA DC 3, Wall-Mounted Room Thermostats; and NEMA WD 1, General Requirements for Wiring Devices: http://www.nema.org/

2-6.26 NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB), NEBB-01, Procedural Standards for Testing-Adjusting-Balancing of Environmental Systems, is available from NEBB, 875 Grove Mount circle, Gaithersburg, MD 20877-4121, Ph: 301-977-3698, Fax: 301-977-9589: http://www.nebb.org/

2-6.27 National Fenestration Rating Council (NFRC). NFRC 100-91, Procedure for Determining Fenestration Product Thermal Properties, is available from NFRC, 1300 Spring Street, Suite 500, Silver Spring, MD. Telephone: (301) 589-NFRC, http://www.nrfc.org

2-6.28 National Fire Protection Association, Inc. (NFPA). NFPA codes listed in Table 2-7 are available from the National Fire Protection Association, Inc. (NFPA), 1Battery March Park, P.O. Box 9101, Quincy, MA 02269. Telephone: (617) 770-3000, Fax: (617) 770-0700: http://www.nfpa.org/

TABLE 2-7 - NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) CODES

Code No.	Code Description
NFPA 13	Installation of Sprinkler Systems
NFPA 24	Private Fire Service Mains
NFPA 30	Flammable Liquids Code
NFPA 54	National Fuel Gas Code
NFPA 58	LP-Gas Storage
NFPA 70	National Electrical Code (DoD Adopted)
NFPA 72	National Fire Alarm Code
NFPA 101	Life Safety Code
NFPA 101M	Alternative Approaches to Life Safety
NFPA 255	Method of Test of Surface Burning Characteristics of Building Materials
NFPA 501D	Recreational Vehicle Parks and Campgrounds
NFPA 701	Standard Methods of Fire Tests for Flame Resistant Textiles and Films

2-6.29 National Sanitation Foundation, 3475 Plymouth Road, Ann Arbor, MI 48105. Telephone: (313) 769-8010, Fax: (313) 769-8010: http://www.nsf.org/.

2-6.30 National Wood Window and Door Association (NWWDA) standard, NWWDA I.S.2, Standard for Wood Window Units is available from the National Wood Window and Door Association (NWWDA), 1400 East Touhy Ave., Suite 470, Des Plaines, IL 60018, (847) 299-5200, Fax: (847) 299-1286: http://www.nwwda.org/.

2-6.31 Sheet Metal and Air Conditioning Contractors National Association (SMACNA). SMACNA Installation Standards for Residential Heating and Air Conditioning Systems and SMACNA-07, HVAC Systems, Testing, Adjusting, and Balancing, are available from SMACNA, 4201 Lafayette Center Drive, Chantilly, VA 22180, (703) 803-2980, Fax: (703) 803-3732: http://www.smacna.org/

2-6.32 Underwriters Laboratories, Inc. (UL) specifications listed in Table 2-8 are available from the Underwriters Laboratories, Inc. (UL), 333 Pfingston Road, Northbrook, IL 62096. Telephone: (847) 272-8800. Fax: (847) 509-6220: http://www.ul.com/.

TABLE 2-8 – UNDERWRITERS LABORATORIES SPECIFICATIONS

No.	Description (Specs. Are DoD Adopted)
UL 58	Steel Underground Tanks for Flammable and Combustible Liquids
UL 174	Water Heaters, Household Gas Storage Tank Type
UL 430	Waste Disposers
UL 507	Electric Fans
UL 555	Fire Dampers
UL 567	Pipe Connectors for Flammable and Combustible Liquids and LP Gas
UL 746C	Polymeric Materials - Use in Electrical Equipment Evaluations
UL 749	Household Dishwashers
UL 858	Household Electric/Gas Ranges
UL 923	Microwave Cooking Appliances
UL 900	Test Performance of Air Filter Units
UL 1746	Standard for Safety External Corrosion Protection Systems for Steel Underground Storage Tanks

End of 01001-2.

3. SITE PLANNING AND DESIGN.

3-1 Scope. This project consists of 156 housing units with site amenities on 51.3 acres of land area. Of the 156 units, 151 for junior Non-Commissioned Officers (JNCO), and 5 for Field Grade Officers (FGO). Site amenities include, but are not limited to, the construction of new residential streets, as directed in the RFP, sidewalks, barrier-type curb and gutters, utilities, drainage, play structures, planters, sitting benches, skate board structures, concrete walking paths, parking lots, cooking grills, bollards, vehicle gates, landscaping, and fencing. The site boundaries, project composition, and gross density are fixed. Based on the graphic and narrative description of site opportunities and constraints provided, the offeror shall verify that the site meets the program requirements. The playgrounds will not be started until the streets are complete.

3-2 REFERENCES.

The design of this facility shall comply with the requirements of the applicable parts of the following references:

CESWD Architectural and Engineering Instruction Manual (CESWD-AEIM)

Uniform Federal Accessibility Standards, Federal Register (UFAS)

Americans with Disabilities Act Guidelines (ADA)

TM 5-803-5, Installation Design

TM 5-803-14, Site Planning and Design

TM 5-813-5, Water Supply, Water Distribution Systems

TM 5-814-1, Sanitary and Industrial Wastewater Collection- Gravity Sewers and Appurtenances

TM 5-814-2, Sanitary and Industrial Wastewater Collection- Pumping Stations and Force Mains

TM 5-820-4, Drainage for Areas Other Than Airfields

TM 5-822-2, General Provisions and Geometric Design for Roads, Streets, Walks, and Open Storage Areas

TM 5-822-5, Pavement Design for Roads, Streets, Walks, and Open Storage Areas

TM 5-822-7, Standard Practice for Concrete Pavements

TM 5-848-1, Gas Distribution

DG 1110-3-204, Design Guide for Army and Air Force Airfields, Pavements, Railroads, Storm Drainage, and Earthwork

MIL-HDBK-1008C, Fire Protection for Facilities

MIL-HDBK-1190, Facility Planning and Design Guide

HQUSACE Architectural and Engineering Instructions-Design Criteria (USACE AEI)

3-3 Area Development Plan. Provide a housing area development plan that shows the spatial and functional arrangement of all housing requirements. The plan should ensure an economical, compatible and functional residential land use development that utilizes the advantages of the site, fosters visual order, and provides a sense of community. The area development plan shows consideration for the site opportunities and constraints, housing program requirements, and specific site design criteria and guidance provided. AM # 3. ~~The recommendations of the Installation Real Property Master Plan and Installation Design Guide should be addressed.~~

3-3.1 Density. The project site is approved for LOW DENSITY siting. Land area for density calculations excludes slopes greater than 10 percent, major highways, flood plains and flood areas, lakes and watercourses.

3-3.2 Land use. The plan for the area should reflect an optimum balance of housing unit floor area, open space, and pedestrian and vehicular circulation. The plan should show an efficient, organized and economical land use arrangement that is compatible and functional. This plan should show the relationship of the area to adjacent land uses.

3-3.3 Noise. Not Used.

3-3.4 Buffer area. Provide appropriate buffer areas to separate and visually isolate the community from undesirable external influences. Stone fences shall be placed between houses for buffers.

3-3.5 Housing unit grouping. Variety in groupings, arrangements, and siting configurations of housing units is encouraged to fit varying terrain conditions and to provide compatible and functional residential layouts and streetscapes. Building arrangements should be informal and imaginative with setbacks and orientation to provide for the best view, privacy, and variety. The proper grouping of housing units will provide backyard screening, separation of pedestrian and vehicular traffic. The layout should reflect simplicity of design and provide a visual sense of community.

3-3.6 Housing unit variation. Housing unit variation shall afford distinctly different exterior appearances within each housing unit type. Provide stylistic compatibility that will give the neighborhood a sense of order. Housing units shall vary in two or more of the following: Floor plans, massing, elevation, garage location, and exterior materials. One floor plan for each housing unit type is acceptable if sufficient variety is achieved by means of other variations mentioned above. In addition, housing units shall vary in color and siting. A reverse floor plan (mirror-image), although an acceptable means of creating variety, shall not constitute a housing unit change. Offerors shall comply with land-use restraints set forth in this document. AM#3 ~~Five percent~~**Eight** of the units shall be **easily modified to be** handicapped accessible and shall meet the requirements of the Uniform Federal Accessibility Standards (UFAS) and the Americans with Disabilities Act (ADA). This would result in ~~seven (7)~~ **Eight (8)** JNCO units and zero (0) FGO units being handicapped accessible. The design should reflect low cost life cycle maintenance and energy efficiency.

3-3.7 Housing unit orientation. Housing units shall be oriented, to the maximum extent possible within the constraints of the site available, so that a major section of the roof faces within 20 degrees of South. The purpose of proper orientation is to expose a minimum surface area to direct solar gain while allowing the units the potential for passive solar applications. Additional consideration will be given during the quality evaluations with respect to unit orientations and passive solar applications considered and included. For additional passive solar information and considerations, see paragraph 11- ENERGY CONSERVATION, of this Statement of Work.

3-3.8 Grading. The grading should maintain existing topography while recognizing standard gradients for the housing units and various functions. If feasible, there should strive to be a balance of the quantity of cut and fill, which would create a smooth transition of graded areas into

the existing natural site. Grading should manage site runoff for a 25-year flood event. The principles of positive drainage should be applied to control the conditions that remove rainfall away from facilities and functions.

3-3.8.1 Turfed Areas. In any turfed area, the minimum slope shall be 2%. In housing unit backyards,AM#3*3% maximum slopes are encouraged. 6% slopes will be allowed where necessary but are discouraged.* ~~the maximum slope shall be 3%~~. In other areas the finished grade should slope away from the buildings at 5% for at least 10 feet. In areas outside of housing unit yards, turfed slopes may vary between 2% minimum and a maximum of 3%, however the maximum slope should be avoided, if possible. Should slopes in excess of 3% be required, slope protection such as slope paving, should be employed or retaining walls shall be used to effect grade changes.

3-3.8.2 Roads, Streets, Access Drives and Parking Areas. A change in the longitudinal grade changes in excess of 1% shall be accomplished by vertical curves. Profiles are mandatory for vertical control of centerline gradients.

3-3.8.3 Parking Areas. Pavement grades shall provide positive drainage with a 1% minimum slope in the direction of drainage. The maximum slope in the direction of parking shall be 1.5%. The slope perpendicular to the direction of parking shall be 5% maximum for bituminous or concrete surfaces and 3% for other all-weather surfaces.

3-3.8.4 Sidewalks. Sidewalks with a slope gradient equal to or less than 3% are preferred. Sidewalk transverse cross-slope shall be a 1% minimum with a maximum no greater than 3%. Any walkway with a slope greater than 4.2% shall be designated as a ramp. Any sustained walkways with grades greater than 3.3% shall have a level landing of at least 6ft x 6ft at 60ft intervals for rest and safety. Walks and ramps serving facilities that are accessible to and usable by the physically handicapped shall meet the requirements of UFAS and ADA. Sidewalks shall have a broom finish.

3-4 Site Design Criteria. The following specific criteria, based on site density, are to be used as guidance in site design, and proposals will be evaluated accordingly.

3-4.1 Housing units per acre by site density are shown in Table 3-1.

TABLE 3-1 – HOUSING UNITS DENSITY

Pay Grade	Low Density	
		units/ac
FGO		4
E-1 - E-6 (JNCO)		4

3-4.2 Privacy Fence. Stone walls will serve as privacy fence and be constructed in the following manner:

Back yard and side yards

Height: 5 feet above grade and will transition into existing wall at the same height for pleasing appearance
Thickness: 18 inches
Depth below grade: 18 inches
Length: As shown on the site layout drawing

Top Cap: Rounded concrete, 2 inches at crest

Note: Install footings if required by Geotech report, in order to meet the maximum allowable pounds per square foot.

3-4.3 Backyard Gates. Backyard gates shall be constructed of 1-inch square iron. Gates shall be a minimum of 54-inches in height and 48 inches wide. A gate shall be provided for each of the backyard for each unit.

3-4.4 Parking requirements by site density.

3-4.4.1 Low density: Two off-street stalls and one guest on-street stall per unit.

3-4.5 Children's outdoors play areas.

3-4.5.1 Neighborhood parks shall be ADA compliant. The impact areas shall be of a rubberized material suitable and generally accepted for this use in the industry. The impact material shall be wheel chair friendly. The play areas should incorporate multiuse play structures. They should include areas for independent, team, skill, and climbers at a minimum. Cool touch handling surfaces and adequate shade surfaces shall be used due to the extreme heat in this area. Painted finishes shall be powder coat paint and have a quality to assure limited fading for the life of the system. The play structure shall be of a design to limit the need for ongoing maintenance. All potential pinch points shall be designed to be child safe.

Neighborhood parks shall have shaded sitting areas for the parents. They shall also have parking for bicycles litter receptacles.

3-4.5.2 Neighborhood parks: Two neighborhood parks will be within the scope of this project. The neighborhood parks shall be designed to accommodate two age groups; 2 to 5 years age group and 6 to 12 years age group. The neighborhood parks shall be constructed as shown on the site development map.

3-4.6 Site amenities. Additional site amenities to be included in the design include walks. New walks shall be located on both sides of the street and shall be designed to connect the new housing area to both new and existing amenities. Sidewalks shall not be separated from the back of the curb. The amenities should be sited so as to provide easy access to the units that will be located at the site boundaries. Direct sidewalks shall be provided from the front entry of the house to the driveway.

3-5 Building Setbacks and Spacing. Clearances between and adjacent to buildings must consider requirements for fire protection, safety, privacy, and emergency access in addition to the following minimum criteria. Setback or yard dimensions shall be from the building wall to a rock wall around each building measured perpendicular to the building. Wall lengths with horizontal offsets of 1 ft or more may be measured separately when determining yard depth. Distance between buildings shall be not less than the sum of setbacks or yards, as required.

3-5.1 Minimum setbacks and spacing for low-density sites is shown in Table 3-4.

TABLE 3-4 - MINIMUM SETBACKS AND SPACING, LOW DENSITY SITES

Description		Feet
From front of house to curb of residential street.		25

TABLE 3-4 - MINIMUM SETBACKS AND SPACING, LOW DENSITY SITES

Description		Feet
From house to major/arterial highway. (Edge of pavement)		150
From driveway to collector street. (Edge of pavement)		60
Side of garage to curb.		20
Side of house to curb[1].		20
Between outside walls of houses[1].		30
Between rear walls of houses.		80
Between side and rear walls of houses.		55
Between street face of garage and curb or sidewalk.		25
Between street face of garage and curb or sidewalk when second off-street parking space is between garage and street.		28

Note[1]: When patios are located within a yard, separation shall not be less than 40 ft between patios.

3-5.2 Not Used.

3-5.3 Setback Notes.

3-5.3.1 Not Used.

3-5.3.2 Courts, outer and inner, shall have dimensions not less than the sum of the required yard distances. An inner court shall have a minimum area of 100 ft² for a one-story building.

3-6 Circulation, Parking, and Bus Stops. The vehicular and pedestrian circulation system shall promote safe, efficient movement of vehicles and pedestrians within the housing area. It should maintain the maximum separation of vehicles and pedestrians. Safe circulation systems have a clear hierarchy of movement, lead to a clear destination, and do not interrupt other functions. The following criteria shall be considered for designing streets and drives for vehicles and pedestrians:

3-6.1 Vehicular circulation. Vehicular circulation layout is determined by applying the design vehicle templates to the site design. The passenger car class includes passenger cars and light delivery trucks, such as vans and pick-ups. The passenger car template is equivalent to the non-organizational - privately owned vehicle (POV). The truck class template includes single-unit trucks, recreation vehicles, buses, truck tractor-semitrailer combinations, and trucks or truck tractors with semi-trailers in combination with full trailers. The American Association of State Highway and Transportation Officials (AASHTO) provide templates showing the turning movements for design vehicles. Design site entrances, exits, service drives, and special

circulation areas to accommodate the largest vehicle that uses the area. In the case of family housing the largest vehicle to use the area on a weekly basis will be the 40 ft garbage truck. Provide the vehicle clearances that are required to meet traffic safety for emergency vehicles, service vehicles, and moving vans. Streets shall include required traffic control and street identification signage, maximum spacing between drives, right-angle turns, and limit points of conflicts for the traffic flow.

3-6.1.1 Definitions.

3-6.1.1.1 Nonresidential Streets

3-6.1.1.1.1 Arterial. Major roads and street systems external to the residential area.

3-6.1.1.1.2 Collector. Feeder streets connect external street system with residential streets in the subdivision and adjoining areas subject to future development. No houses shall face collector streets, and no driveway or access shall be gained from collector streets to the housing units.

3-6.1.1.2 Residential Streets and Utility Easement Access Roads. The residential streets and utility easement access roads will be designed to carry the same vehicular loads except that the utility easement roads will be 32 feet wide. Curb and gutters will be provided for these streets and roads. Provide utility easement with 6” traffic bollards and a utility vehicle access gate at intersections.

3-6.1.1.2.1 Loop. Both ends are open to traffic.

3-6.1.1.2.2 Cul-de-sac. Only one end of the street is open to an access street.

3-6.1.2 Cul-de-sac Design. The circulation system may be based on cul-de-sacs a maximum 600 ft long, measured from the center of the cul-de-sac to the centerline of the access street.

3-6.1.3 Intersection Design. Provide "T" intersection offsets of at least 125 ft. The preferred angle of intersections for driveways and streets is a right angle (90 degrees).

3-6.1.4 Street design. The selected design vehicle templates determine street dimensions. Separation, corner clearances, and sight distance are established when the design vehicle templates and speed limits are selected. Streets shall be designed for vehicles with not less than 6,000 lb wheel load. Pavement shall be asphaltic concrete as described in the furnished GEOTECHNICAL REPORT. White Sands Missile Range Installation desires that Picatinny Avenue be utilized as primary access for this family housing group. Ravena Avenue has a major water supply line within its limits of its ROW, but other existing streets can be demolished and relocated as necessary for an efficient design. Streets shall be provided with barrier-type reinforced concrete curbs and gutters. Reinforcement shall be # 3 bars. Turning radii on streets and service roads shall be designed to accommodate a fire department ladder truck and large moving vans. Curbs shall be depressed at entrances to driveways. All gradients shall provide positive drainage from the housing units with no ponding. Longitudinal street grades shall vary between 0.3% minimum and 3% maximum. Vertical curves shall be provided where longitudinal grade changes equal 1% or more.

3-6.2 Privately owned vehicle (POV) parking. Two POV stalls without vehicle overhang into the street shall be a maximum 9 ft x 18 ft for each housing unit. The design vehicle template that is used to design this space shall be described. Design on-street parking stalls to be of sufficient length and width to allow safe movement into and out of the stall and to adequately separate the parked vehicle from the traffic flow. On-street parking will not be allowed on service roads.

Signage shall provide this requirement. Provide compact passenger car dimensions only when recommended by a Site Traffic Impact Study for WSMR.

3-6.2.1 Housing unit POV parking. POV parking areas consisting of more than 4 vehicles backing into the street are unacceptable.

3-6.2.2 Not Used.

3-6.3 Bus stops. Bus stops shall be provided as shown on site map. Bus stops shall be AM # 3. ~~in compliance with the Installation Design Guide and~~ located with a turnout from the collector street. The design vehicle that is used to design this space shall be described.

3-6.4 Pedestrian circulation. Pedestrian circulation should be safe, separated from vehicle circulation, and relate to the housing units, parking, and community facilities. Pedestrian circulation should be based on pedestrian desired lines of walking between facilities. Desired lines should be weighted to predict the most traveled routes. These routes would require paving. Topography and vegetation can be used to reinforce a sense of movement. Design pedestrian concentration areas with adequate paved area.

3-6.4.1 Sidewalk design. Sidewalks shall be provided on both sides of the street. Walks shall be a minimum of 4 ft wide (except for those in the vicinity of the handicapped accessible units and accessible site amenities) exclusive of curb width, and made of wire mesh concrete with a minimum thickness of 4 inches. Walks in the vicinity of the handicapped accessible units and accessible site amenities shall be designed as specified in UFAS and ADA. Where walks are adjacent to the curb, the curb width is not to be included as sidewalk. Ramps for handicapped individuals shall be provided at intersections by depressing street curbs and adjacent sidewalk and shall meet the requirements specified in UFAS and ADA. Concrete construction shall also apply to porches, patios, stoops and walks unit entrances.

3-6.5 Signs. Locate all proposed signs on a site plan in accordance with distance and placement guidelines. The signing system shall provide consistency and continuity to the overall visual image of the installation. The signs shall be coordinated with the design of other site furnishings to minimize the number of streetscape elements and reduce clutter.

3-6.5.1 Traffic signs. Traffic signs shall be in accordance with the latest edition of the Manual on Uniform Traffic Control Devices for Streets and Highways, U.S. Department of Transportation, Federal Highways Administration.

3-7 Children's Outdoor Play Areas. The design of the children's outdoor play areas shall comply with the safety requirements of ASTM F 1487, ASTM F 1292, the Public Playground Safety Handbook, and the Consumer Product Safety Commission’s Handbook (CPSC) 325. The children's outdoor play areas are unsupervised play areas and do not have a supervised play program for child development. These areas are not part of trained recreation, youth center or child development staff support. Supervised outdoor play areas occur at youth centers and child development centers.

3-7.1 Child Safety and Accessibility.

3-7.1.1 Accessibility to children and adults with disabilities. Play areas shall be accessible to children and adults with disabilities. In addition to wheelchair users, the needs of children and adults who walk with canes, walkers, or crutches; who have limited use of the upper body; who have visual or hearing disabilities, or who have developmental disabilities shall be considered. Design criteria based on child dimensions should be used for the proper functioning of the play area. Every part of a play area may not be accessible to all its users, but the social experience provided should be accessible to everyone. When more than one play activity of the same type is provided, one shall be accessible. When one activity is provided, it shall be accessible. A

diverse play area has the greatest potential for meeting the needs of all users. Separate play areas for the physically challenged are not acceptable. Integrating all children in the same play setting will be emphasized. Guidelines available from this design district for accessible routes, ramps for wheelchair access, transfer points, wheelchair accessible platforms, and accessible stepped platforms should be followed.

3-7.1.2 Age appropriate scale. Age appropriate scale is a term used to describe equipment which will allow safe and successful use by children of a specific chronological age, mental age, and physical ability. Play equipment height and complexity will not exceed the user's ability. The children's outdoor play areas will meet age appropriate scale for the age groups that the areas are designed to accommodate.

3-7.1.3 Use zones. In accordance with ASTM F 1487, a use zone is a clear, unobstructed area under and around play equipment where a child would be expected to land when jumping or falling from a piece of play equipment. These zones require a playground safety rubberized surface in accordance with ASTM F 1292 and CPSC 325. Requirements for use zones vary for the age group and for different pieces of equipment. All use zones for play equipment should be shown on the site plan to ensure there is no conflict between play activities on the ground and swinging or jumping from the equipment. Use zones will not overlap.

3-7.1.4 Playground safety surface. A playground safety rubberized surface is constructed of a material that meets the shock absorbency criteria recommended in ASTM F 1292. Playground safety surfaces shall be provided throughout all use zones and under all play equipment as required.

3-7.1.5 Inappropriate play events. The following play events are not appropriate for use in unsupervised play areas; Chain walks, chain or tire climbers, fulcrum seesaws, log roles, May poles, merry-go-rounds, rotating equipment, spring rocking equipment intended for standing, swinging exercise bars, trapeze bars, and whirls.

3-7.2 Playgrounds. Provide playgrounds that are located within the site lines of the housing units to be supported. Provide shade. Each play ground shall be provided with the following age appropriate play events and equipment for the two age groups to be accommodated:

3-7.2.1 Pathway. The pathway should be constructed as shown on the site plan.

3-7.2.2 Gathering place. This setting provides an open space for groups of different sizes and people of all ages. Shade structures shall be provided as shown on the site plan.

3-7.2.3 Sand will only be allowed is impact areas under the swings.

3-7.2.4 Manufactured play equipment setting. This setting includes an age appropriate composite structure consisting of multiple play events for each of the following age groups; 2 to 5 years of age and 6 to 12 years of age. The swing should be located as a free standing play event.

3-7.3 Neighborhood parks. Provide neighborhood parks that are to be located as shown on the site plan. Connect neighborhood parks to the housing units by a walkway system. Provide shade shelters as shown on the site map. Each neighborhood park shall be provided with the following age appropriate play events and equipment for the two age groups to be accommodated: 2 to 5 years of age and 6 to 12 years of age.

3-7.3.1 Pathway. The pathway should be constructed as shown on the site plan.

3-7.3.2 Gathering place. This setting provides an open space for groups of different sizes and people of all ages. Shade structures shall be provided as shown on the site plan.

3-7.3.3 Manufactured play equipment setting. This setting includes an age appropriate composite structure consisting of multiple play events for children 2 to 5 years of age and 6 to 12 years of age. Other play events include free standing equipment such as spring rocking equipment, swing, track ride, and balance beam. The swing should be located as a free standing play event on the perimeter.

3-7.3.4 Sports and games setting. This setting includes a turf area as the central element of the park. The turf area should accommodate various sports activities. Locate a 4' wide broom finish surface area as shown on the site plan. Other design elements include surfacing, drinking fountains, lighting, seating, grills, planters, bollards, vehicle gates, and trash receptacles.

3-7.4 Plant materials. Plants and ground cover should be installed as shown on the site plan. Plants define space and provide shade. Poisonous plants and plants with thorns are not allowed and should be removed from the play areas. Plants should be provided from the approved plant list.

3-8 General Landscaping and Irrigation Requirements. The front and sides of these units shall be "xeroscaped" to agree with the natural environment of White Sands Missile Range. Plants will be provided that are safe and nonpoisonous. The back yards of the units shall be landscaped and turfed to provide a pleasant experience to the occupants. The back yard shall be provided with an automatic irrigation system that will provide sufficient water for the turf planted during the growing season. The turfed area as shown the site plan shall be provided with an irrigation system that will provide sufficient water for the turf area without ponding water.

3-9 Landscape Planting Plan. The offeror shall obtain and use the services of a qualified *AM#3Texas Registered Landscape Architect*, experienced in site planning and planting design for this area. A complete and integrated landscape-planting plan shall be designed by incorporating the provided plant and tree list for the overall housing project. The design shall reflect appropriate groupings, and street tree plantings to define the open spaces to ensure a complete landscaped project. Undesirable views shall be screened from the housing units. The screening may be accomplished through the use of landscaping, berms or a combination of the two. The screening shall be at least 50% effective when installed and shall offer a minimum of 85% coverage after 3 growing seasons. Using the existing stone fence with appropriate landscaping as screening is desirable. Foundation plantings for each house will not be required although a series of typical planting plans may be provided to guide the new residences in installing the foundation plantings themselves. Selected plant materials shall be easily maintained and tolerant of the specific site conditions. Planting or seeding shall occur only during periods when beneficial results can be obtained.

AM#3***WhiteSands Plant LIst***

COMMON NAME	*SCIENTIFIC NAME*
GROUND COVER	
Mexican Gold Poppy	*Eschscholzia Californica*
Andorra Juniper	*Juniperus horizontalis 'plumosa Compacta'*
Wild Foxglove	*Ceratotheca triloba*
Pink Plans Penstemon	*Penstemon ambiguus*
Sun Drops	*Caylophus serrulatus*
Blanket Flower	*Gaillardia 'Burgunder'*
Blue Flax	*Linum perenne*

SHRUBS	
Apache Plume	*Fallugia Paradoxa*
Texas Sage	*Leucophyllum frutescens*
Purple Fountain Grass	*Pennisetum alopecuroides*
Pink Fairy Duster	*Callandra eriophylla*
Chihuahuan Sage	*Leucophyllum laevigatum*
French Lavender	*Lavandula dentata*
TREES	
Fan-Tex Ash	*Fraxinus velutina*
Chinese Pistache	*Pistacia chinesis*
Afgan Pine	*Pinus eldarica*
Turf	
Santa Ana Bermuda Grass	
Erosion Control	
Buffalo Grass	*Buchloe dactyloides*

AM#3

3-9.1 Trees, shrubs, and ground cover. Plant varieties shall be nursery grown or plantation grown stock conforming to ANSI/ANLA Z60.1. The varieties chosen shall be chosen from the approved list accompanying the existing design guide. They shall be grown under climatic conditions similar to those in the locality of the project.

3-9.1.1 Quality. Well-shaped, well-grown, vigorous, healthy plants having healthy and well-branched root systems shall be provided. Plants shall be free from disease, harmful insects and insect eggs, sunscald injury, disfigurement, and abrasion. Plants shall be provided that are typical of the species or variety, and conforming to standards as set forth in ANSI/ANLA Z60.1.

3-9.1.2 Shade and flowering trees. A height relationship to caliper shall be provided as recommended by ANSI/ANLA Z60.1. Height of branching should bear a relationship to the size and variety of tree specified, and with the crown in good balance with the trunk. Trees shall not be "poled" or the leader removed.

3-9.1.2.1 Single stem. Trunk shall be reasonably straight and symmetrical with crown and have a persistent main leader.

3-9.1.2.2 Multi-stem. All countable stems, in aggregate, shall average the size specified. To be considered a stem, there should be no division of the trunk that branch more than 6 in from the ground level.

3-9.1.2.3 Specimen. A plant shall be provided that is well branched and pruned naturally according to the species. The form of growth desired, which may not be in accordance with natural growth habit, shall be as indicated.

3-9.1.3 Deciduous shrub. Plants shall be provided that have the height and number of primary stems as recommended by ANSI/ANLA Z60.1. An acceptable plant shall be well shaped with sufficient well-spaced side branches recognized by the trade as typical for the variety grown in the region.

3-9.1.4 Coniferous evergreen. Trees shall be provided that have the height-to-spread ratio as recommended by ANSI/ANLA Z60.1. Trees shall not be "poled" or the leader removed. An

acceptable plant shall be exceptionally heavy, well shaped and trimmed to form a symmetrical and tightly knit plant. The form of growth desired shall be as indicated.

3-9.1.5 Broadleaf evergreen. Plants shall be provided that have a ratio of height-to-spread as recommended by ANSI/ANLA Z60.1. An acceptable plant shall be well shaped and recognized by the trade as typical for the variety grown in the region.

3-9.1.6 Ground cover. Plants shall be provided with the minimum number of runners and length of runner as recommended by ANSI/ANLA Z60.1. Plants shall be furnished that have heavy, well developed, and balanced top with vigorous well developed root system, and shall be furnished in containers.

3-9.1.7 Measurement. Plant measurements shall be in accordance with ANSI/ANLA Z60.1.

3-9.1.8 Percolation test. Test for percolation shall be done to determine positive drainage of plant pits and beds. All soil and drainage conditions detrimental to the growth of plant material shall be identified and a proposal correcting the conditions shall be submitted.

3-9.2 Soil test. A soil test shall be performed for pH, chemical analysis, and mechanical analysis to establish the quantities and type of soil amendments required to meet local growing conditions for the type and variety of plant material specified.

3-9.3 Installation. Verify the location of underground utilities. When obstructions below ground or poor drainage affect the planting operation, proposed adjustments to plant location, type of plant, and planting method or drainage correction shall be submitted. The plant material shall be installed during appropriate planting times and conditions recommended by the trade for the type and variety of plant material specified. Plant pits shall be excavated and backfilled as recommended by the trade and ANSI/ANLA Z60.1. The planting operation shall be performed only during periods when beneficial results can be obtained. When special conditions warrant a variance to the planting operations, proposed revised planting seasons will be submitted.

3-9.4 Pruning. The total amount of foliage shall be pruned by one-fourth to one-third on installed trees and shrubs to compensate for loss of roots and transplanting shock. The typical growth habit of individual plants shall be retained. Trees shall not be poled or the leader removed, nor shall the leader be pruned or "topped off".

3-9.5 Maintenance during planting operation. Installed plants shall be maintained in a healthy growing condition. Maintenance operations shall begin immediately after each plant is installed and shall continue until the plant establishment period commences.

3-9.6 Plant establishment period. On completion of the last day of the planting operation, the plant establishment period for maintaining installed plants in a healthy growing condition shall commence and shall be in effect for the remaining contract time period not to exceed 12 months. When the planting operation extends over more than one season or there is a variance to the planting times, the plant establishment periods shall be established for the work completed.

3-9.7 Maintenance during establishment period. The maintenance of plants shall include straightening plants, tightening stakes and guying material, repairing tree wrap, protecting plant areas from erosion, maintaining erosion material, supplementing mulch, accomplishing wound dressing, removing dead or broken tip growth by pruning, maintaining edging of beds, checking for girdling of plants and maintaining plant labels, watering, weeding, removing and replacing unhealthy plants.

3-9.8 Unhealthy plant. A plant shall be considered unhealthy or dead when the main leader has died back, or 25 percent of the crown is dead. Determine the cause for an unhealthy plant.

Unhealthy or dead plants shall be removed immediately and shall be replaced as soon as seasonal conditions permit in accordance with the following warranty paragraph.

3-9.9 Warranty. Furnished plant material shall be guaranteed to be in a vigorous growing condition for a period of 12 months regardless of the contract time period. A plant shall be replaced one time under this guarantee.

3-9.10 Turf. Turf consists of seeding and sod. There may be several different types of turf mixtures applied; one for lawn areas around housing units and one for field areas. The boundaries of each area shall be clearly defined on the planting plan.

3-9.10.1 Seed quality. State approved seed of the latest season's crop shall be provided in the original sealed packages bearing the producer's guaranteed analysis for percentages of mixture, purity, germination, hard seed, weed seed content, and inert material. Labels shall be in conformance with applicable State seed laws. Seed mixtures shall be proportioned by weight. Weed seed shall not exceed one percent by weight of the total mixture.

3-9.10.2 Sod. State approved sod shall be provided as classified by applicable State laws. Each individual sod section shall be of a size to permit rolling and lifting without breaking.

3-9.10.2.1 Quality. The sod shall be relatively free of thatch, diseases, nematodes, soil-borne insects, weeds or undesirable plants, stones larger than 2 inches in any dimension, woody plant roots, and other material detrimental to a healthy stand of turf. Sod that has become dry, moldy, or yellow from heating, or has irregular shaped pieces of sod and torn or uneven ends shall be rejected.

3-9.10.2.2 Thickness. Sod shall be machine cut to a uniform thickness of 1-1/4in within a tolerance of 1/4 inch excluding top growth and thatch. Measurement for thickness shall exclude top growth and thatch.

3-9.10.2.3 Time limitation. The limitation of time between harvesting and placing sod shall be 36 hours.

3-9.10.3 Not Used.

3-9.10.3.1 Soil test. A soil test shall be performed for pH, chemical analysis, and mechanical analysis to establish the quantities and type of soil amendments required to meet local growing conditions for the type and variety of turf specified.

3-9.11 Temporary turf cover. When there are contract delays in the turfing operation or a quick cover is required to prevent erosion, the areas designated for turf shall be covered with a temporary erosion control blanket.

3-9.12 Installation. The turf shall be installed during appropriate planting times and conditions recommended by the trade for the type and variety of turf specified. The turf operations shall be performed only during periods when beneficial results can be obtained. Drainage patterns shall be maintained. The turf shall be installed by using the methods as recommended by the trade for the type and variety of turf specified.

3-9.13 Protection. Immediately after turfing, the area shall be protected against traffic or other use by erecting barricades and providing signage as required.

3-9.14 Turf establishment period. The turf establishment period for establishing a healthy stand of turf shall begin on the first day of work under the turfing contract and shall end three months after the last day of the turfing operation. An unsatisfactory stand of turf shall be repaired as soon as turfing conditions permit.

3-9.15 Satisfactory stand of turf.

3-9.15.1 Not Used.

3-9.15.2 Seeded field area. A satisfactory stand of turf from the seeding operation for a field area is defined as a minimum of 85 grass plants per square yard. The total bare spots shall not exceed two (2) percent of the total seeded area.

3-9.15.3 Sodded area. A satisfactory stand of turf from the sodding operation is defined as living sod uniform in color and texture. Bare spots shall be no larger than 2 inches square.

3-9.15.4 Not Used.

3-9.16 Maintenance during establishment period. The maintenance of the turfed areas shall include eradicating weeds, eradicating insects and diseases, protecting embankments and ditches from erosion, maintaining erosion control materials and mulch, protecting turf areas from traffic, mowing, watering, post-fertilization, and replacing unsatisfactory turf areas.

End of 01001-3

4. SITE ENGINEERING.

4-1 Soils.

4-1.1 Soil and Foundation Report (Geotechnical Report). A preliminary Soil and Foundation Report is provided as part of this RFP. A drawing indicating Subsurface Explorations and Geologic Profiles for the proposed site is also provided. The report provides an overview of soils and geologic conditions, and is furnished for informational purposes only. The offeror to whom this contract is awarded shall, with his or her consulting professional geotechnical engineer experienced in geotechnical engineering, be responsible for determining site specific geotechnical conditions.

4-1.1.1 The Contractor provided site specific geotechnical conditions report shall include, but not be limited to:

4-1.1.1.1 Classification of soil and rock.

4-1.1.1.2 Depth to bedrock.

4-1.1.1.3 Extent of boulders.

4-1.1.1.4 Bearing capacity of soil and rock.

4-1.1.1.5 Settlement potential.

4-1.1.1.6 Compaction requirements.

4-1.1.1.7 Groundwater characteristics.

4-1.1.1.8 Infiltration and permeability.

4-1.1.1.9 Erosion and siltation.

4-1.1.1.10 Surface and subsurface drainage.

4-1.1.1.11 Soil resistivity.

4-1.1.1.12 Other

4-1.1.2 The offeror and his or her professional geotechnical engineer consultant shall certify in writing that the design of the project has been developed consistent with the site specific geotechnical conditions. The certification shall be stamped by the consulting professional geotechnical engineer and shall be submitted with the 60 percent design submission. If revisions are made to the 60 percent design submission, a new certification shall be provided with the final design submission.

4-1.2 Soil compaction.

4-1.2.1 Soil compaction shall be achieved by equipment approved by a professional geotechnical engineer. Material shall be moistened or aerated as necessary to provide the moisture content that will readily facilitate obtaining the compaction specified with the equipment used. Compact each layer to not less than the percentage of maximum density specified in Table 4-1, determined in accordance with ASTM D 1557 Method D.

TABLE 4-1 – SOIL COMPACTION

Subgrade Preparation, Fills, Embankments, and Backfills	Compaction Requirements (Percentage of Maximum Density)
Structures & Building Slabs	95
Streets, Paved Areas, Bike Paths	95
Sidewalks	85
Grassed Areas	80

4-1.2.2 The requirements shall be verified or modifications recommended by the consulting professional geotechnical engineer in the report wherever engineering, soils, or climatic factors indicate the necessity. Any modification to the stated compaction requirements shall require the approval of the Contracting Officer.

4-1.3 Not Used

4-1.4 Soil treatment. Soil treatment for termites shall be by the chemical method. Methods and extent of protection required are as follows: shall comply with local or state industrial standards, whichever is more stringent.

4-1.5 Not Used

4-1.6 Not used.

4-2 Water Distribution System. See new housing site map for layout and size of main and lateral water lines.

4-2.1 Water Mains and Building Service Connections. Mains shall be considered as that part of the distribution system supplying fire hydrants, or fire hydrant laterals. Service connections supply water from the main to the building. Separate automated readers for meters will be provided at each unit. Mains shall be looped with no dead ends and be sized as shown on the site map. Minimum main size is 10 in. Sufficient sectional control valves shall be provided so that no more than two fire hydrants will be out of service in the event of a single break in a water main. A copper tracer wire shall be placed directly above all non-metallic mains when plastic marking tape does not provide means of determining alignment of pipe by metal detecting equipment. The pipe, valves, and all other materials shall meet the American Water Works Association (AWWA) standards for a 150 psi working pressure system. See electrical for cathodic protection. Provide sacrificial anodes for all valves and metal pipe. Building connections shall be designed and constructed in accordance with the International Plumbing Code and the New Mexico Plumbing Code, whichever is stricter. A certified State of New Mexico Professional Engineer shall stamp the water system. All material that comes into contact with potable water shall meet NSF 61.

4-2.2 Flow requirements. Water must be supplied by mains of appropriate capacity to provide 500 gpm at one-story units and 500 gpm for a flow duration of 1-1/2 hours. This mandatory flow is over and above domestic requirements. Domestic requirements shall be based on 300 gal/day per housing unit for single family housing. Mains shall be sized to carry this flow with a 2.5 peak hourly factor. Pressure shall be a minimum of 20 psi at the required flows indicated above for each fire hydrant, and a maximum of 70 psi at each outlet after allowing for friction, elevation, and other pressure losses. Pressure at each housing unit shall not exceed 55 psi.

4-2.3 Trenches. Water and gas mains shall not be installed in the same trench. (Coordinate with the local gas utility supplier to determine system acceptability). Water mains shall have a minimum of 3 ft of earth cover. Minimum cover above water lines shall be 2 ft 6 in in grassed areas and 3 ft in paved areas. Adequate cover must be provided for freeze protection. Where frost penetrates to a depth greater than the minimum above, greater cover will be required. Sufficient cover must also be provided to protect the pipe against structural damage due to superimposed surface loads. Lines laid lower than the minimums stated shall be concrete encased with a minimum concrete thickness of 6 in.

4-2.4 Fire hydrants. Hydrants shall conform to AWWA C502, Dry-Barrel Fire Hydrants. Valves shall conform to AWWA C500, Gate Valves for Water and Sewerage Systems. Fire hydrants shall be compatible with those presently in use at the installation or local Government Juridicant, with similar pump and hose connections for one 4-1/2" pumper connection and two 2-1/2" hose connections. Fire hydrant spacing shall be no greater that 300 ft apart, by paved road. In addition, a hydrant shall be provided so that all parts of the housing units can be reached by hose lines not over 350 ft long. Hydrant laterals shall be 6 in minimum size, shall not exceed 30 ft in length, and shall have an underground shutoff valve. Valve box, at each lateral, shall be located within 10 ft of the hydrant, and shall not be located where obstructed by parked vehicles, shrubbery, etc. Guard post barriers shall be provided where hydrant locations are subject to vehicle damage. A minimum 5 ft clearance shall be maintained between fire hydrants and poles, trees, shrubs or other permanent obstructions. Hydrants shall be located no closer than 5 ft and no further than 7 ft from the street curb line. Fire hydrants shall be painted, color coded, and properly numbered.

4-2.5 Shutoff valve. Each building shall be provided with a separate service and main shutoff valve, readily accessible to maintenance and emergency personnel. Shutoff valves in walks are prohibited.

4-2.6 Valve Boxes. Valve boxes shall be cast iron of approved manufacture. Boxes shall be extension type with slide type adjustment and with flared base. The word "WATER" shall be cast in the cover. The valve boxes shall have a concrete ring with pipe type, size, and direction of flow on the cover (See White Sands personnel for detail). The boxes shall be of such length as will be adapted, without full extension, to the depth of cover required over the pipe at the valve location. Valve boxes shall be constructed for design traffic. Cast iron valve boxes shall be bonded with the ferrous valve and cathodically protected. Cast iron valve boxes shall have a protective coating applied using a coal tar epoxy.

4-2.7 Materials for Water Lines. Acceptable materials for water lines are as follows:

4-2.7.1 Service Lines less than 3" in diameter: polyvinyl chloride (PVC) plastic, Oriented PVC plastic polyethylene or copper tubing.

4-2.7.2 Service Lines greater than or equal to 3" in diameter: PVC, filament-wound or centrifugally cast reinforced thermosetting resin, or reinforced plastic mortar pressure pipe.

4-2.7.3 Distribution Lines greater than or equal to 3" in diameter: PVC through 36" nominal diameter plastic, Oriented PVC plastic filament-wound or centrifugally cast reinforced thermosetting resin, reinforced plastic mortar pressure pipe or reinforced concrete.

4-3 Sanitary Sewerage System. Connection to the existing sewage collection system shall be made at the closest sewer line(s) capable of servicing the housing units at locations shown on the RFP drawings. Sewage collection systems shall be designed and constructed in accordance with the International Plumbing Code criteria in this paragraph, and WSMR's installation requirements. Pipe sizes and slopes shall be calculated using the Manning Formula. Manholes are required at all changes of direction and spaced not more than 300 ft apart. A fixed side rail ladder shall be provided for manholes greater than 12 ft in depth. The word "SEWER" shall be

cast in manhole covers. Curved sewers are prohibited. Pipes shall be designed to flow full and maintain a minimum velocity of 2 ft per second. If siphons are used, two lines of equivalent capacity shall be used with cleanouts. Where pumping is required, force mains shall be sized to minimize pumping head, with a 3 ft to 5 ft per second velocity.

4-3.1 Sewer mains. Design shall be based on an average daily per capita flow of sanitary sewage of 100 GAL per day with a 4.0 peak hourly factor. Mains shall be a minimum of 8 in in diameter.

4-3.2 Sewer Building Laterals. Each building lateral shall be connected directly to a sewer main. Manholes shall be provided where lateral lines exceed 100 ft in length from the housing unit to the service main line. Combining multiple building laterals is prohibited. Two-way cleanouts shall be provided to allow cleaning of all lines to grade. Cleanouts, in yard areas, shall be set in a box with a hinged cover. Laterals from one building shall not cross under another building. Lines shall be sized in accordance with the National Standard Plumbing Code. Sewer laterals serving one or two housing units shall be a minimum of six (6) inches diameter.

4-3.3 Trenches. Sewer and water lines, mains or laterals, shall be placed in separate trenches. The separate trenches shall maintain a minimum lateral separation of 10 ft.

4-3.4 Cover. Sewer lines shall be located at a depth greater than the frost penetration. Minimum cover above the top of pipes shall be 2 ft in areas not subject to vehicular loads and 3 ft in all other areas. If the minimum cover can not be met, the length of pipe shall be concrete encased with a minimum 6 in thickness of concrete

4-3.5 Acceptable Materials for Sanitary Sewer Lines. Plastic (PVC or ABS), reinforced plastic mortar pipe, or reinforced thermosetting resin pipe. Cement used for concrete pipe fittings, manholes and other sanitary sewer structures shall be Type V.

4-3.6 Design Criteria. Gravity lines shall be sized based upon peak flow and designed to provide a minimum velocity of 2 feet per second (fps) at the average daily flow rate and a minimum velocity of 2.5 fps to 3.5 fps at 1/2 the peak flow rate. The maximum flow velocity shall not exceed 10 fps, based on peak flow. For gravity lines, Manning's formula shall be used. Manning's "n" values less than 0.013 shall not be permitted despite manufacturer's reports of "n" values between 0.009 and 0.011. When the required 2 fps flow velocity at the average flow rate cannot be met in gravity sewer lines (lateral or main) due to inadequate flow, a minimum slope of 0.6% shall be provided for 6" lines and 0.4% for 8" lines.

4-4 Storm Drainage System. The storm drainage system shall be properly coordinated with surrounding properties to ensure that runoff does not cause damage to other properties. All drainage lines, if required, shall remain in conduit to stable grade. The minimum pipe size shall be 12" inside diameter. The minimum velocity of flow in conduits during a design storm shall be 2.5 ft/sec. Storm water collection, disposal (and retardation) system shall be designed for a minimum of a 25-year return frequency. Rainfall intensities for project locations shall be in accordance with local community/locality/State Transportation (Highway) agency design parameters.

4-4.1 Storm Runoff. The Rational Method as described in SWD AEIM, Chapter II, shall be used to calculate storm water runoff.

4-4.1.1 Storm Drainage Design. Runoff from other properties presently directed towards the new project site shall be incorporated into the new storm drainage system design to ensure that this runoff does not cause damage to surrounding properties and the new housing area. Storm drains shall be designed in accordance with criteria in SWD AEIM. Storm drain systems shall be designed so that the hydraulic grade line for the computed design discharge is as near optimum depth as practicable, and velocities are not less than 2.5 fps when the drains are one-third or

more full. Energy dissipaters shall be provided at storm drain outlets where outlet velocities exceed 5 fps. Storm drain inlets shall be located so that no collection swales flow across a street or sidewalk to reach a storm drain, other than where cross gutters are used. Use curb inlets. Side opening catch basins are preferable. Where a grating must be used, it shall be of "bicycle proof" design. Sidewalk culverts are not permitted.

4-4.2 Manholes. Manholes shall be located at intersections and changes in alignment or grade. Intermediate manhole maximum spacing shall be 250 ft for pipes 3 ft or less in diameter or box drains with the smallest dimension less than 3 ft. Maximum spacing for intermediate manholes on larger pipes and drain boxes shall be 500 ft. Manholes shall be precast concrete and shall conform to ASTM C 478 or AASHTO M 199. Steel ladders shall be installed where the depth of the manhole exceeds 3 ft. The ladder shall be galvanized after fabrication in accordance with ASTM A 123. The wall along the ladder shall be vertical. The manhole shall have a 2 ft minimum opening as measured from the face of the steel ladder.

4-4.3 Drainage of roads and pavements. Provide a positive crown or sheet drainage to all streets and roads. Pavement collectors for storm water shall be by curb inlets and gutters. Field inlets and an underground collection system shall drain open areas. No roadside ditches shall be permitted. Overland flow shall be held to a minimum, where feasible. The maximum flow in all gutters shall be restricted to the quantity that will cause flooding of 1/2 the adjacent traffic lane at the design storm flow. When this flow is reached, it shall be intercepted and removed to an underground system. Inlets in the sag of vertical curves on streets that act as sumps shall be oversized 100%. Design shall be based on the Rational Formula and other criteria contained in SWD AEIM.

4-4.4 Pipe for culverts and storm drains may be of concrete, PVC, or PE. Cement used in concrete pipe, fittings, manholes and other storm drainage structures shall be designed in accordance with the attached Geotechnical Report.

4-5 Gas Distribution System. Gas lines are owned by the Government. The Contractor (AE) shall design and construct the new gas distribution system, including main and service lines, up to and including the meter. A gas regulator and automated meter reader to monitor fuel use shall be provided for each housing unit. The automated meter reader and regulator will be provided and installed by the Contractor. All new construction shall be coordinated with the White Sands Missile Range Gas Department. The Contractor is responsible for design and construction of service lines within in the units and the laterals connecting to the Contractor installed automated meter readers. Service laterals shall be designed in accordance with local codes and WSMR's requirements. Gas lines shall comply with the requirements of ASME B31.8. Shutoff valves shall be provided on the exterior of each building. Contact WSMR Gas Department for determination of all costs associated with connection to the gas distribution system and existing meters. Existing gas lines that are to be abandoned shall be removed. Abandoning existing gas piping shall be done in accordance with ANSI B31.8, Gas Transmission and Distribution Piping Systems. Installation of gas piping will be in accordance with ANSI B31.8 and 49 CFR 192.

4-5.1 Materials. Materials and appurtenances shall be free of defects and suitable to accomplish the stated objectives of gas distribution systems. Pipe shall be polyethylene or steel as described below.

4-5.1.1 Polyethylene pipe shall conform to ASTM D2513, Standard Specification for Thermoplastic Gas Pressure Piping Systems, with fittings complying with either ASTM D2513 or ASTM D2683, Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing. Connections to metal pipe shall comply with ANSI B16.5, Pipe Flanges and Flanged Fittings, or manufacturer's recommended standards.
4-5.1.2 Steel pipe shall conform to ASTM A 53, Grade A or B, Type E or S, Schedule 40; or seamless or electric resistance welded, Schedule 40; black, as specified in ASME B31.8. Furnace butt-welded pipe may be used in sizes 1-1/2 inch and smaller. Fittings 1-1/2 inch and

smaller shall conform to ASME B16.11. Pipe flanges and flanged fittings larger than 1-1/2 inch, including bolts, nuts, and bolt patterns shall be in accordance with ASME B16.5, Class 150. Butt weld fittings shall be in accordance with ASME B16.9. Weld neck flanges shall be used.

4-5.2 Testing. Prove that the entire system of gas mains and service lines is gas-tight by an air test, in accordance with ANSI B31.8. The test shall continue for at least 24 hours between initial and final readings of pressure and temperature.

4-5.3 Drips. Unless high pressure natural gas is used, drips shall be installed at the low points, immediately following reduction from high pressure to medium pressure (at supply points) and at occasional low points throughout the system to provide for blowing out the lines.

4-5.4 Valves. Plug valves shall be installed at intersections of mains and other locations so that interruptions to service can be confined to no more than 30 housing units.

4-5.5 Mains and service lines. Lines shall not be placed under any buildings. Lines shall be placed with a minimum of 3 ft of earth cover. Protective casings shall be provided to protect lines from superimposed street or heavy traffic loads.

4-6 Not Used.

4-7 Liquefied Petroleum (LP) Gas Storage and Distribution. Not Used.

4-8 Electrical Distribution. Connection to the existing electrical distribution system shall be made at the location shown on the enclosed RFP drawings. Aerial to underground connection shall be made utilizing hot line stirrups, surge arrestors, fused cutouts, terminators, rigid galvanized steel conduit riser, and all other necessary hardware for a complete installation. New primary electrical distribution and electrical services shall be underground.

4-8.1 System design. The electrical on-site distribution system shall be designed in compliance with the rules and recommendations of ANSI C2, National Electrical Safety Code; NFPA 70, National Electrical Code whichever is more stringent; and ANSI C84.1, Electric Power Systems and Equipment – Voltage Ratings. Provide new electrical distribution system as necessary and connect to existing system. System shall be a load-balanced 3-phase loop-primary. Feeder loads shall be as balanced as possible. Primary feeder cables shall be copper **(AM#3), and shall have 133% insulation** ~~or aluminum~~. Medium voltage conductors shall have protective shielding. Use of concentric neutral type cable is not allowed. Medium voltage cable shall be buried a minimum of 3 ft concrete encased below the finished grade with continuous cable marker tape 1 ft below grade. Cable markers shall be installed along the length of electric cable runs to identify their routes from the surface. Markers will be provided at changes of direction and at intervals not to exceed 300 ft. All utilities shall be located and routed along streets and enter the dwelling units in the front of the dwelling units. All transformers and pedestals shall be located in the front yards of dwelling units. No utilities will be routed, located, or installed in the rear of any dwelling units. Provide landscaping techniques to minimize the unsightliness of these elements.

4-8.2 Underground splices. Underground connection or splices are prohibited, except in manholes.

4-8.3 Service laterals. Service laterals shall be underground. Voltage drop in each service lateral shall not exceed three percent at the calculated maximum demand load. Secondary service power lines to each individual unit shall be buried a minimum of 36 inches from the surface in schedule 40 PVC, and not be concrete encased; unless they run beneath new pavement. The length of secondary distribution service laterals from the transformer secondary to the building service entrances shall be minimized.

4-8.4 Service entrance. Only one service entrance per dwelling unit shall be provided. The

service entrance conductor shall be buried a minimum of 3 ft below finished grade with a minimum separation of 2 ft from telephone or TV cables. System shall be designed such that the fault current available at the service entrance equipment will not exceed 10,000 amps.

4-8.5 Secondary Distribution Panels. Panels shall have main circuit breaker and branch circuit breakers for each dwelling unit service, street lighting circuit, etc. The panels shall be rated for the available fault current from the transformer. Enclosure shall be capable of being locked. Panels shall be located within 10 feet of transformers.

4-8.6 Transformers: Transformers shall be low profile, dead front pad-mounted, have transient voltage surge suppressor (TVSS), and have two non-fused switches for the loop connection. The high voltage compartment of the transformer shall include a load break switch with fused circuit for the transformer. The transformed secondary voltages shall be 120/240 V, single-phase, three-wire, solid neutral service to dwelling units. In selecting a transformer, the name plate rating shall not be less than 90 percent of the kilovolt/amperes (kV/A) demand load calculated for the transformer. The transformers shall have exterior mounted meters, that is read remotely and automatically using telephone line.

4-8.7 Street, sidewalk, and area lighting: Residential roadway lighting, including collector streets (AM#3) and recreation area, shall be provided in accordance with the IES Lighting Handbook. Provide lighting at roadway intersections, and at intervals not exceeding 200 ft between intersections. Area lighting shall be provided at intervals not exceeding 200 ft along sidewalks not otherwise illuminated. Luminaries shall be actuated by photoelectric control, one photocell per circuit, and supplied from multiple circuits originating from secondary distribution panels. All lighting levels shall be provided in accordance with the IES Lighting Handbook. Lighting circuit shall be underground. See attachment drawing for lighting fixture detail. Lighting shall be in accordance with the attachment “Highlights of the Night Sky Protection Act”.

4-8.8 Individual units shall be provided with a dedicated circuit, 120V, for lawn irrigation system.

4-9 Metering. Metering of utilities shall be provided as follows:

4-9.1 Master meters. Master meters for water, electricity, and gas shall be provided for all new dwelling units.

4-9.2 Individual meter and meter drops: Individual utility meter including water, electric, and gas shall be provided for each dwelling unit that can be read remotely (in building 102), automatically, using telephone line. Existing system server/software are in Building 102. Provide exterior electric watt-hour meters with clear weather sealed cover. Provide manual by-pass jumper plates for each watt-hour meter. Locate electric and gas utility meters on exterior face of garage sidewall, so service personnel do not enter backyard. Meters and meter bases shall be sight screened, and located to provide convenient access while so as not to distract from building appearance.

4-9.3 Gas metering: Individual housing unit metering devices, which comply with local requirements, shall be furnished and installed by the Contractor to be read automatically by a remote reader. Meter and regulator location shall be sight screened, and located to provide convenient access while not distracting from the appearance of the units.

4-9.4 Water meter requirements: Water meters are required at each unit. Each water meter shall be sized to provide 20 gpm @ 5 psi loss, shall be the rotating disc type, bronze case, bronze disc, straight reading register (gallons), and shall be read remotely and automatically by the computer server.

4-10 Telephone. The contractor is responsible for all costs associated with installation and design of the exterior telephone system regardless of whether the contractor furnishes and

installs the materials or the local telephone company furnishes and installs the materials. The contractor shall pay the local telephone company directly for all labor and materials provided by said company. The local telephone company will furnish and install distribution cables and pedestals; and will make final connections to the protected telephone terminal ("Demarcation Box") located on the side of each dwelling unit. Contractor shall provide all trenching, conduit, and backfilling as directed by the local telephone company. Contractor is responsible for contacting the local telephone company during proposal and implementing the local telephone company's cable distribution design into the electrical site plan. During construction, contractor shall coordinate with local telephone company and allow local telephone company on the site to install cabling, pedestals, all splicing in manholes, and make final connections to each dwelling unit.

4-10.1 Communication (including telephone and CATV) shall be installed in separate conduit, schedule 40 PVC, direct buried 2 ft below finished grade; unless they run beneath new pavement then concrete encased shall be provided. Provide warning tape 1 ft below the surface. Secondary power and communication services to individual unit are allowed to be in the same trench.

4-11 Television. The contractor is responsible for all costs associated with installation and design of the exterior cable TV system regardless of whether the contractor furnishes and installs the materials or the local cable TV company furnishes and installs the materials. The contractor shall pay the local cable TV company directly for all labor and materials provided by said company. Distribution cables, ducts, pedestals, and final connections to the protected cable TV terminal box of each dwelling unit shall be provided.

4-12 Cathodic Protection (CP):

4-12.1 All ferrous material including cast iron and ductile iron for new underground electric, gas, hydrant, water piping, shall be coated and cathodically protected.

4-12.2 Not used.

4-12.3 CP systems must be designed to provide protective potential to meet the requirements of the National Association of Corrosion Engineers (NACE) Standard RP-0169, Control of External Corrosion on Underground or Submerged Metallic Piping Systems.

4-12.4 Not Use

4-12.5 When plastic pipe is used to extend a steel gas distribution system, an insulated No. 8 AWG copper wire shall be exothermically welded to the existing steel main and run the length of the new plastic main. This wire can be used as a locator tracer wire and to maintain continuity to any future steel gas extension.

4-12.6 CP and protective coatings shall be provided for the following buried ferrous metallic structures regardless of soil or water resistivity:

4-12.6.1 Natural gas and propane piping.

4-12.6.2 Liquid fuel piping.

4-12.6.3 Not Used

4-12.6.4 Fire protection piping.

4-12.6.5 Ductile or cast iron pressurized piping under floor (slab on grade) in soil.

4-12.6.6 Underground heat distribution and chilled water piping in ferrous metallic conduit.

4-12.6.7 Other structures with hazardous products as identified by the installation.

4-12.7 Copper water service lines shall be dielectrically isolated from ferrous pipe. Dielectric isolation shall conform with NACE RP 0286.

4-12.8 Ferrous metallic piping passing through concrete shall not be in contact with the concrete.

End of 01001-4.

5. UNIT DESIGN - ARCHITECTURE. WITH AMENDMENT 3

5-1 Unit Design. The architectural work includes the design and construction of 156 housing units. 151 Junior Enlisted units, and 5 field grade officer family housing quarters are to be constructed. The dwelling units will be single story, three, four bedroom, and five bedroom single family, detached houses

5-2 These dwelling units shall convey a visual image consistent with White Sands Missile Range's design characteristic requirement and its physical organization. Dwellings shall be similar in finish material and style as shown in the Architectural Attachment, even though the size, shape, and configuration may be different.

5-3 Designs shall provide housing units as shown below in the Table 5-1, as provided in the Proposed Department of Defense Family Housing Size Standards by Grade chart and outlined in Public Law 92-214. Title 10 USC, Section 2826,

TABLE 5-1

Pay Grade	Number Of Bedrooms	Programming Benchmark Gross Floor Areas	
		Number of units	ft^2
(FGO)	4	5	2,310
(JNCO)	5	11	2,300
	4	34	1,950
	3	106	1,630

5.3.1 Calculation of square footage is defined in American National Standard for Single-Family Residential Buildings ANSI Z 765, Gross Area Definition.

5.3.2 Net area definition. Net area is defined as the space inside the exterior and party walls. Net area excludes:

5-3.2.1 Exterior walls.

5-3.2.2 Half thickness of interior walls adjacent to excluded areas.

5-3.2.3 Utility and laundry rooms.

5-3.2.4 Interior bulk storage rooms.

5-3.2.5 Not used.

5-3.2.6 Furnace, domestic water heater, and solar equipment spaces.

5-3.2.7 Walls and interior spaces specifically designed for passive solar systems (other than required habitable areas).

5-3.2.8 Weather vestibules (not to exceed 16 ft²) sheltering the main entry.

5-3.2.9 Unfinished attic space.

5-3.2.10 Patios.

5-3.2.11 Garages.

5-3.2.12 Increases required to meet accessibility standards.

5-3.2.13 Open or screened porches without heating, air conditioning, or interior-type finishes. In localities subject to adverse weather conditions, such as wind-driven mist or noxious atmosphere, or both, open porches may be enclosed with appropriate fenestration or screening, or both, and not considered to increase the net area of the housing units, provided that air conditioning or heating, or both, is not added and the basic character of the enclosed area is still that of a porch.

5-3.3 Five percent of the dwelling units are to ADA accessible. Physical limitations may include any of several types of disabilities. The unit should anticipate a variety of conditions. Accessible housing units shall be designed in such a way that they may be easily and readily modified to accommodate physically challenged occupants, if necessary, at time of occupancy. This means required access clearances, room sizes, bathroom layout, kitchen layout, doors and hardware, grab bars, plumbing hookups, light switches and outlets, controls, and warning devices must meet requirements at time of construction. Readily modifiable means that requirements for adjustable height cabinets and work surfaces, plumbing fixtures, and the warning devices for the hearing and visually impaired can be made either at time of construction or at time of occupancy. **Provide space in design for ease in future ADA conversion, but no ADA equipment shall be provided in this contract. However, do provide blocking within walls and at the proper heights per ADA criteria for future accessory attachments/anchorage.**

5.4. Functionality. Rooms shall be sized and arranged for efficient use, good circulation, and furniture placement. The distribution of space for food preparation living and dining, sleeping, bathing, halls, closets, and services should be balanced and should enhance the intended functions. The master bedroom shall be isolated from the other bedrooms. The submitted floor plan shall pursue an open plan between the kitchen, family room and auxiliary dining area.

5-4.1 Habitable rooms shall not be used as halls for entry into a housing unit or for primary circulation within a housing unit.

5-4.2 Provide convenient access between garage and service area, and between kitchen and service area.

5-4.3 Do not use a sliding glass door as a primary housing unit access.

5-5 Indoor and Outdoor Integration. Emphasize factors that enhance indoor and outdoor living. Consider size, layout and location of patios, outside trash screen walls, HVAC screen walls, and yards, and features that encourage family use of outdoor areas.

5-6 Fire Protection and Safety. Housing units will comply with the applicable National Fire Codes, including NFPA 101, Life Safety Code and the UFC 3-600-01, Fire Protection Engineering for facilities. Construction features will be provided in accordance with the International Building Code (IBC).

5-6.1 Fire resistance of walls and roof material. Walls separating living units from exterior bulk storage shall be of U.L. design for 1-hour fire rating partitions and shall have a UL design for 1 hour fire rating celing, as a

single design assembly. Penetrations in the fire rated partitions shall maintain the rated integrity. This requirement shall be in addition to any code requirements. Provide fire stops at floor, and ceiling or roof line. Provide Class A (ASTM E108, Standard Methods of Fire Tests of Roof Coverings) roof covering material throughout.

5-6.2 Not used

5-6.3 Heater rooms. Rooms equipped with fuel-fired equipment such as boiler rooms, furnace rooms, and rooms with fuel-fired water heaters shall be separated by one-hour fire-rated construction. Direct access to these rooms from the exterior is required.

5-6.4 Alarm systems. Smoke detectors which are located within the housing unit and which sound an alarm only within the housing unit are not required to be transmitted to the installation fire department.

5-7 Sound Attenuation.

5-7.1 Testing. Certified proof-of-performance field tests will be conducted to demonstrate that the floor and wall systems as constructed provide the required sound isolation. Tests for air-borne sound shall be made in compliance with ASTM E336. Tests for impact sound shall be made in compliance with ASTM E1007. Testing of 10 percent (minimum) of each type of floor and wall system is required. Location of test sites will be chosen at random by the Government. Tests will be conducted with the contacting officer in attendance.

5-7.1.1 Any wall or floor system found to be inadequate shall have the deficiencies corrected and the additional qualifying tests conducted at the Contractor's expense. Testing at the Contractor's expense of greater than 10 percent of each system may be required if the Contracting Officer determines that the quality of construction requires this additional testing.

5-7.1.2 Walls and ceiling systems shall be designed to meet or exceed the requirements stated below. In cases where the field tested performance of the systems does not meet the designed performance, the maximum acceptable difference between field tests and sound transmission ratings shall be 2 decibels (dB) for airborne sound ratings and 5 dB for impact sound ratings.

5-7.1.3 Walls and ceiling construction shall be designed to provide the minimum airborne sound transmission ratings and impact isolation ratings stated in Table 5-2.

TABLE 5-2 - SOUND TRANSMISSION STANDARDS FOR WALLS, FLOORS AND CEILING CONSTRUCTION

Area	FSTC[1]	FIIC[2]
Primary Habitable Areas (Living, Dining, Family Room, Bedrooms, Circulation)	38	65
Habitable Wet Areas (Kitchen, Bath, Utility, Laundry, Equipment)	38	57

Note[1]: Field Sound Transmission Class. See ASTM E336.
Note[2]: Field Impact Isolation Class. See ASTM E1007.

5.7.2 Floor construction. Floor construction shall be designed to provide the minimum FSTC and FIIC ratings stated in Table 5-2. Materials used to obtain the required sound attenuation for the floor construction shall not be liquid-soluble or softened by moisture. Sound insulation shall have a flame-spread rating of 25 or less and a smoke development rating of 50 or less when tested in accordance with ASTM E84.

5.7.3 Not Used

5.7.4 Plumbing and HVAC equipment. Design of plumbing and Heating, Ventilating, Air-Conditioning (HVAC),

and dehumidifying equipment shall include design provisions such as location, enclosure and acoustical treatment, to minimize transmission of noise generated by equipment within each housing unit and to eliminate transmission of noise to other housing units.

5-8 Dimensions and Areas. Minimum areas and dimensions for interior spaces are shown in Table 5-3. Minimum areas and dimensions for exterior spaces are shown in Table 5-4.

TABLE 5-3 - MINIMUM AREAS AND DIMENSIONS - INTERIOR SPACES

Space	Area	Length	Width/Depth	Height[1]
	ft^2	ft-in	ft-in	ft-in
Living[2]	150	11-8	11-8	9-0
Dining (3 BR)[2]	120	9-6	9-6	9-0
Dining (4/5 BR)[2]	120	10-6	10-6	9-0
Family Room[2]	100	9-6	9-6	9-0
Kitchen[3,6]	72	8-0	8-0	9-0
Eating in Kit.[4]	80	8-6	8-6	9-0
Refrigerator & Freezer	14	3-0	3-0	9-0
Washer/Dryer[5]	20	6-0	3-0	9-0
BR #1	150	11-8	11-8	9-0
BR #2	120	10-0	10-0	9-0
BR #3	120	10-0	10-0	9-0
BR #4/5	120	10-0	10-0	9-0
Equipment Room[8]	-	-	-	9-0
Full Bath[6]	-	-	6-0	9-0
Vestibule	16	4-0	5-0	9-0
Hall	-	-	3-3	9-0

Note[1]: Ceiling heights in habitable rooms shall be a minimum of 9 feet.
Note[2]: Room dimensions are exclusive of circulation. Circulation paths along one side of a room are permitted but add 3 ft-3 inches to the minimum dimension.
Note[3]: A minimum of 4 ft must be maintained in front of and between cabinets.
Note[4]: Minimum area and dimensions are measured from face of cabinets to walls.
Note[5]: Minimum area and dimensions are indicated for a washer and dryer closet. This area shall be provided in a utility room. When so provided, area and dimensions are exclusive of circulation.
Note[6]: Accessible units must conform to UFAS. UFAS requires greater minimum dimensions.
Note[7]: Not Used
Note[8]: The length and width/depth shall accommodate the equipment installed and any required area to access and maintain the equipment.

TABLE 5-4 - MINIMUM AREAS AND DIMENSIONS - EXTERIOR SPACES

Spaces	Area	Length	Width/Depth	Height[1]
	ft^2	ft-in	ft-in	ft-in
Garage (two-car)	420	21-8	20-0	9-0
Covered Patio - 3 BR	144	6-0	10-0	9-0
Covered Patio - 4 BR	180	6-0	10-0	9-0
Covered Patio - 5 BR	180	6-0	12-0	9-0

Note[1]: Ceiling heights apply when patios and balconies are covered.

5-8.1 Minimum area requirements for kitchen cabinets, counters, and pantries are shown in Table 5-5. Flat area is shown for countertops and drawers. Combined shelf area is shown for pantry and base, wall and wall cabinets.

TABLE 5-5 - KITCHEN CABINET, COUNTER, & PANTRY AREA

Type of Housing Unit	Wall	Base	Drawer	Counter	Pantry
	ft_2	ft^2	ft^2	ft^2	ft^2
JNCO/FGO 4/5 BR	40	50	20	20	20
JNCO/FGO 3 BR	30	40	18	16	16

5-8.2 **AMEND 3** Minimum closet width requirements are stated in Table 5-6.

TABLE 5-6 – MINIMUM CLOSET WIDTHS[1]

Type of Unit	FGO/SO	JNCO
	ft	ft
Coat/ Entry Hall	4	**(AM 3) 4**
Master[2] BR #1	8	8
BR #2	6	6
BR #3	6	6
BR #4/5	6	6
Broom	3	3

Type of Unit	FGO/SO	JNCO
	ft	ft
Linen[3]	3	3

Note[1]: Minimum inside clear depth for standard/broom closets shall be 2ft
Note[2]: Walk-in closet is preferred.
Note[3]: Minimum clear inside depth for linen closets shall be 1ft-6inches.

5-8.3 Minimum requirements for interior bulk storage are shown in Table 5-7.

TABLE 5-7 – MINIMUM INTERIOR & GARAGE BULK STORAGE

Type of Unit	Type of Storage	FGO	JNCO
		FT^2	FT^2
3 BR	Int.	-	40
	Garage	-	36
4 BR	Int.	47	45
	Garage	45	40
5 BR	Int.	-	47
	Garage	-	45

5-9 Major Zones. Living and Dining, Kitchen and Auxiliary Dining Area, Family Room, and Bedrooms.

5-9.1 Living and dining. The living room should have direct access to the front entrance foyer and to the dining area without passing through another room. When circulation is required along the perimeter of the space or between areas in open plans, minimum circulation space of 3ft-3inches shall be added to the required minimum room dimension.

5-9.1.1 The dining area may be an extension of, or an "L" off the living room.

5-9.1.2. The dining area shall be directly accessible from the kitchen without passing through another room.

5-9.2 Kitchen and auxiliary dining area.

5-9.2.1 The kitchen shall provide an efficient work triangle. A base cabinet, minimum 15 inches wide, shall be provided on the handle side of the refrigerator. The range shall not be located adjacent to the refrigerator, in a corner, or adjacent to a passageway. The dishwasher shall be installed adjacent to the kitchen sink. Provide a backsplash behind the range, extending to the underside of the range hood, finished to match the countertop or range and the range hood. Space for a tenant-owned upright freezer shall be provided adjacent to the kitchen in the utility room or garage. Space for a tenant-owned microwave oven shall be provided in the kitchen by way of a microwave cabinet.

5-9.2.2 Provide auxiliary dining areas in the form of table space in the kitchen or in a family room adjacent to, or as an extension of, the kitchen. The auxiliary dining area shall not be located in the living or dining rooms.

5-9.2.3 In the kitchen, shoe molding (1/4 round) is required at all base cabinets where they meet the floor surface.

5-9.3 Family room. Provide a separate family room, adjacent to and contiguous with the kitchen, for all three-, four, and five-bedroom units.

5-9.4 Bedrooms. Bedrooms shall be designed to accommodate king-size beds in master bedrooms and full beds in the other bedrooms. Window, door, and closet placement should enhance furnishability. Each bedroom shall be accessible without passing through another bedroom.

5-10 Minor Zones. Bathrooms, Laundry, Closets, and Bulk Storage rooms.

5-10.1 Bathrooms. Emphasis shall be placed on size, furnishings, layout, and privacy. Direct access to a bathroom from the master bedroom is required for three-, four-, and five-bedroom units. Compartmented bath design, for family and guest use. Determine the number of bathrooms based on Table 5-8.

TABLE 5-8 - BATHROOM REQUIREMENTS

Number of Bedrooms per Floor	Number of Bathrooms Per Floor
3 - 5	2

5-10.1.1 A full bath shall contain a water closet, lavatory, a tub with shower assembly. One full bath in each housing unit shall include a tub with shower assembly and shall be directly accessible from the bedroom hall without passing through another room. Tubs with shower assemblies, shall include curtain rods with curtain rings.

5-10.1.2 Provide lavatories mounted in 3-ft wide (minimum) countertops, with vanity bases. Countertops shall be homogeneous, non-porous, solid surface type materials, with minimum 4 inches high back splashes. Maximize vanity storage space.

AM 3 5-10.1.3 Bathroom accessories may be surface mounted or recessed, of non-corrodible metal or ceramic tile, and shall include a toilet paper holder, soap dish (at sink and at tub/shower), toothbrush and tumbler holder, and grab bar at tub or shower stall, bathrobe hook, and towel bars totaling not less than 42 inches for a full bath. **AM3 This does not describe ADA type grab bars.**

5-10.1.4 A mirror glass above the vanity and a recessed medicine cabinet shall be provided in each bathroom. Cabinets shall be corrosion-resistant with plate glass mirrors, sliding or hinged door type.

5-10.1.5 Tubs and showers shall not be placed under windows.

5-10.1.6 Exhaust shall be provided in all baths. They shall be ducted directly to the exterior of the roof, and shall be a part of an engineered ventilation system (See paragraph 10).

5-10.1.7 Each bathroom in each unit shall have one tube-type solar skylight, minimum 10" diameter. Skylight shall be equal to that manufactured by Solatube, 2210 Oakridge Way, Vista, CA 90283-8341, and having the following salient features:
a) high impact polycarbonate dome to block harmful UV rays, and be resistant to debris impacts from high winds
b) interior tube surface to be 95% light reflective
c) flexible tube design to bypass attic obstacles
d) water, bug, and dust leak proof seamless flashings
e) minimal heat gain and loss
f) 10-year warranty against breakage and yellowing.

5-10.2 Laundry. Washer and dryer space shall be provided in a utility room, not in an enclosed recess off the

hall.

5-10.2.1 A minimum of two full-length shelves, 10 inches minimum nominal depth, shall be provided above the washer and dryer.

5-10.2.2 Minimum net clear door width to washer and dryer in utility room shall be 3ft 2inches. Doors shall be either undercut or louvered to provide adequate make-up air for the dryer in accordance with typical household.

5-10.3 Closets. Closets shall provide the minimum widths indicated in Table 5-6. A broom closet shall be provided convenient to the kitchen, and a coat closet shall be located convenient to the housing unit entrance.

5-10.3.1 Closet shelving. Closets (except linen closets) shall be equipped with a 18 inches deep shelf and a clothes hanger rod. Linen closets shall be provided with at least four full-depth shelves. Closet shelving and rods in excess of 4ft shall have center supports. Shelves and supports shall be capable of carrying 35 lbs/ft. Closet shelving shall be minimum 3/4 inch thick solid wood, plywood, or high density particle board. Shelving shall be finished with high-pressure laminated plastic. Factory finished welded wire shelving shall not be used.

5-10.3.2 Closet doors. Closet doors should be located to permit placement of furniture in the corners of the rooms by providing a 18-inch] return adjacent to a furnishable wall. Closets 6 ft or more in width shall have sliding doors, maximum 6 ft-8 inches high. Wall closet width shall not extend beyond either door jamb more than 20 inches. Wardrobe closet doors (sliding and bi-fold) shall be provided with both top and bottom door tracks. Accordion doors are not permitted.

5-10.4 Bulk storage rooms. Provide each housing unit with interior storage rooms meeting the minimum requirements of Table 5-7. Provide interior storage in separate rooms. Provide storage rooms in the garage of the housing unit with access from the interior of the garage.

5-10.4.1 Utility room. The utility room shall contain a utility sink. The utility room should be located adjacent to the rear entrance. A hose bib shall be located near the rear entrance at a hardstand. Hardstand shall be 2’ x 2’ x 4” concrete slab.

5-10.4.2 Bulk storage rooms should be at least 4 ft in depth and a minimum clear height of 6 ft-6 inches.

5-10.4.3 Provide a minimum of three nominally 12 inches deep shelves with a combined length of 24 ft within each bulk storage rooms.

5-10.4.4 Common walls and ceilings between adjacent storage areas shall be finished on both sides.

5-10.4.5 The equipment room shall contain heating and cooling systems equipment. The equipment room shall be accessible from the exterior. Consideration should be given to design accessibility to the equipment room by maintenance personnel, with the yard fence in place. There shall be a lighted dry covered flat surface for maintenance personnel to work. The HVAC filters are to be accessible from within the dwelling.

5-11 Interior Finishes

5-11.1 Provide three interior color/finish schemes.

5-11.2 Walls and ceilings. Provide 5/8 inch gypsum wallboard, taped and textured with orange peel finish. Water-resistant wallboard shall be used in wet areas such as bath, powder, and laundry rooms. Provide Type “X” gypsum board where required for fire-rating and /or acoustical treatments (STC-Sound Transmission Class rating). Cementitious backer board shall be used for ceramic tile applications. An orange peel ceiling and wall texture with semi-gloss enamel finish shall be provided in all rooms. Interior finish shall have a flame-spread rating of 25 or less and a smoke-developed rating of 50 or less when tested in accordance with ASTM E84. Clear acrylic corner guards may be used to protect corners. Wallpaper shall not be used.

5-11.3 Kitchen and eating area walls and ceiling. Combined kitchen and eating rooms shall have the same

type of wall and ceiling finishes.

AMEND 3 5-11.4 Flooring and base. Front entry, kitchen, auxiliary dining area laundry, and utility flooring shall be ceramic tile with wood base. Bathrooms **AM3 and halls** shall be ceramic tile flooring and base. The **AM3** ~~hall,~~ bedrooms, and living room shall be carpeted with wood base. Wood flooring or a factory-made, pre-finished wood plank flooring with wood base in the living-dining area is required. This material identification is not justification to exceed the mandatory price limitation set forth in this solicitation. Vinyl terminations and transitions strips are prohibited.

5-11.4.1 Ceramic tile shall conform to ANSI 137.1, moderate or heavy grade.

5-11.4.2 Carpet shall be installed in the stretch method over carpet pad utilizing tackless strips in accordance with CRI-104. Carpet shall meet the following criteria:

5-11.4.2.1 Properties: Tufted construction, 100 percent branded continuous filament nylon or polyethylene theraphthalate, soil hiding, multi-colored, loop or cut pile, 1/8 gauge, yarn weight 28 ounces per square yard, total weight grams per square meter 60 ounces per square yard, 5000 minimum density, synthetic primary and secondary backing.

5-11.4.2.2 Tuft bind for tufted carpet shall meet a minimum of 10 pounds when tested in accordance with ASTM D1335, 1967; R-1972

5-11.4.2.3 Carpet shall meet requirements of 16 CFR 1630 and have a minimum average critical flux of .45 watts per square centimeter when tested in accordance with ASTM E648.

5-11.4.2.4 Ten-year warranty from the carpet manufacturer against edge ravel, delamination, and tuft bind is required.

5-11.4.2.5 Carpet pad shall be 5/8 inch bonded urethane, minimum 8-pound density. Urethane pad will conform to ASTM.D.3676.

5-11.4.2.6 Carpet edging shall be 1-1/2-inch minimum width floor flange and minimum 5/8-inch wide face.

5-11.4.2.7 Tackless strip for stretch-in installation over carpet pad shall be exterior grade Douglas Fir plywood, with minimum dimensions of 1-1/8-inch wide suitable for the cushion thickness specified. Tackless strips with two or three rows of staggered pins shall be used. For areas over 20 ft long, tackless strip with three rows of pins shall be used. Pins of the proper length shall be provided to penetrate through carpet backing, but shall not be a safety hazard.

5-11.4.2.8 Carpet containing recovered material is designated in 40 CFR 247.12 as an affirmative procurement item. Products containing recovered material will be provided when price, performance, and availability meet project requirements. Various nylon and polyethylene terephthalate carpet offer the opportunity to meet this requirement.

5-11.5 Painting. Primers, paints, and stains shall meet or exceed the requirements of Corps of Engineers Unified Facilities Specification 09900. Finishes shall be lead free and scrub able. Walls and ceilings in kitchen, baths, laundry, utility rooms, and all painted trim shall be painted with semi-gloss enamel. Colors shall be submitted by the Contractor and approved by the Contracting Officer. Blown-on acoustical finish is prohibited. Orange peel finish on gypsum walls and ceilings shall be used.

5-12 . Garages. Provide a double car garage for each housing unit. Bulk storage room is included in the garage, such room is in addition to the required car storage area. Provide the bulk storage room in the garage, in addition to the required car storage room. Refer to Table 5-4 and 5-7 for minimum dimensions. Set the garage slab elevation a minimum of 4 inches below the level of the housing unit floor. Slope slabs to drain out the garage door. Garage doors shall have hardware that can be opened and locked from inside and outside of the garage Provision of a two-car garage with two 9 feet wide doors shall be provided for each housing unit.

Each door shall be provided with a garage door opener. Garage exterior and interior walls shall be insulated to a minimum of R-19. The garage ceiling shall be insulated to R-30. The garage doors and floor shall be insulated to R-5

5-13 Roofing and Drainage. Roofs are to maintain a 5:12 slope.

5-13.1 Roof water. Gutters and downspouts shall be provided for all roof areas. The gutter system should minimize maintenance. The Design should prevent water run-off onto porous materials. Downspouts draining onto a lower roof shall have metal splash deflectors. Concrete splash blocks shall be provided under downspouts if not connected to the storm drainage system.

5-13.2 Roof surface. Emphasis shall be placed on low maintenance and durability of roof material. The number of roof penetrations shall be minimized. Metal roofing shall be an architectural simulated-clay metal tile roof panel system, matching the appearance of Spanish clay roof tile. Roof construction shall conforming to UL 580 class 90 Wind Uplift, Construction Number 533 over 5/8" plywood deck, UL 790, Class A Fire Resistance Rating, and UL 2218, Class 4 Impact Resistance. Roof Panels shall be a minimum standard of 24 Gauge and applied over a plywood substrate with 30 pound felt underlayment. Finish shall meet both KYNAR 500 (PVF2) and HYLAR 5000 Specifications.

5-14 Exterior Finishes. Emphasis shall be placed on low maintenance and durability for exterior finish materials. Materials shall be residential in size, scale, and texture. Finishes shall be earth tone in color. The following siding materials may be used, they are listed in declining order of preference:

5-14.1 Autoclaved Aerated Concrete (AAC). Units shall be steel reinforced, load bearing, pre-cast wall panels as manufactured by Texas Contec, Inc or approved equal. Erected panels shall be coated on the exterior/exposed face with a base and finish coat of stucco finish, per AAC manufacturer's recommendation. Contractor shall follow manufacturer's installation instructions explicitly and shall certify accurate and correct installation of all AAC type materials.

5-14.2 Stucco. Portland cement plaster or synthetic stucco shall have integral color. Stucco total surface area shall be divided into panels with control joints spaced no more than 10 ft apart to form a panel of less than 150 ft^2. Contractor shall follow manufacturer's installation instructions explicitly and shall certify accurate and correct installation of all stucco type materials.

5-14.3 Exterior Insulation and Finish System (EIFS). EIFS may be used if high quality materials and installation checks are used. A drainable-substrate EIFS system shall be used. Provide a complete secondary weather barrier with a water-shedding drainage plane and flashings. Provide sealed isolation joints around all penetrations. Provide pan flashing at windows. Use wet-mix base coats. Use 6-ounce or heavier mesh. Use high-impact mesh at the ground level and in traffic areas. Use silicone sealants for joints. Contractor shall follow manufacturer's installation instructions explicitly and shall certify accurate and correct installation of all EIFS type materials.

5-14.4 and 5-14.5 Not Used.

5-14.6 Trim elements. Aluminum or vinyl clad wood trim is preferred. Painted exterior surfaces shall be minimized. When exterior exposed wood trim is used, the following requirements apply:

5-14.6.1 Exposed wood, such as window trim, door sills, window sills, railings and balusters, wood fencing, solar shading devices including louvers, arbors, and trellis shall be treated for rot resistance in accordance with NWWDA Industry Standards I.S.4, Water Repellant Preservative Treatment for Millwork.

5-14.6.2 Exterior surfaces requiring painting shall receive a minimum of one prime coat and two finish coats of paint. Wood trim frames, etc., shall be back primed. Exterior semi-transparent stains, two coats, are acceptable, where appropriate for wood, plywood, etc.

5-14.6.3 Flag mounting brackets shall be installed to accommodate a ¾" to 1" flag pole. The mounting bracket

will be installed on the front side of the house at a convenient location for use.

5-14.7 Exterior ceilings and soffits. Exposure of roof framing and underside of roof/floor decks are not permitted. Exterior ceilings and soffits will be trimmed or otherwise architecturally treated and be coordinated in color to exterior wall color with Kynar 500 finish. Exterior ceilings and/or soffits may be pre-finished metal panels, minimum of 24 gauge. All panels shall be perforated (ventilated), except the ceiling over the porches/patios, which shall be solid panels.

5-14.7.1 Refer to 4-11.1 for installation of metal mounting brackets for small satellite dishes. Reference chapter four section 11 for specific mounting instructions.

5-14.7.2 The residents will furnish their own satellite dishes. One mounting bracket for each single-family living init shall be installed. The dishes shall have an unobstructed path so as to achieve clear signals. The brackets are to be located on the rear elevation or one of the side elevations: whichever gives a clear unobstructed signal. The brackets are not to be located on the front elevation of any of the units.

5-14.8 Patios. Patios shall be sloped to drain away from the dwelling units and have a broom-finished concrete floor surface.

5-14.9 Porches and stoops shall be sloped to drain away from the unit and have a concrete floor surface which provides a waterproof and non-slip surface. Plastic coating or films over concrete decks are not acceptable. Exposed wood decks, stained or painted, are not acceptable. Exposed rails and trim shall be iron bar stock, painted with rust inhibiting black paint.

AMEND 3 5-15 Glazed Openings. Windows and glazed door (50 percent or more glass) units shall meet the following standards and must be certified by an independent testing laboratory. Windows that slide (double-hung, single-hung, and horizontal sliding) and glass exterior doors shall meet the standards for hung units. Standards for casement windows shall apply to all hinged or fixed windows. **AM3** ~~A~~bronze anodized aluminum windows shall be provided. The Contractor shall provide the manufacturer's certification that the window provided meets the following test requirements:

5-15.1 Required tests. Hung units will meet a National Fenestration Rating Council (NFRC) design pressure rating of 25. Casement windows will meet NFRC design pressure rating of 40. Evidence of passing the following specific tests and minimum standards are required to achieve these design pressure standards.

5-15.1.1 Structural testing. Using ASTM E330 test results shall demonstrate no glass breakage, damage to hardware, or permanent deformation that would cause any malfunction or impair the operation of the unit. Residual deflection of any member shall not exceed 0.4 percent of its span. Hung windows shall be tested at pressures of 37.5 lb/ft^2, and casement windows shall be tested at pressures of 60.0 lb/ft^2.

5-15.1.2 Operating force. The force necessary to unlatch and open units shall not exceed 20 lb for hung units and 25 lb for casements.

5-15.1.3 Air infiltration. Using ASTM E283 leakage rate shall not exceed 0.25 $ft^3/min/ft^2$for hung units and 0.15 $ft^3/min/ft^2$ for casements, at a test pressure of 1.57 lb/ft^2.

5-15.1.4 Water penetration. Using ASTM E547, no leakage shall be evident when tested in three, five-minute cycles with a one-minute rest period between cycles at 3.75 lb/ft^2 for hung units and 6.0 lb/ft^2 for casements.

5-15.1.5 U-Value. Whole window U-values shall comply with Table 7-1 U-values shall be calculated using ASTM E1423 and NFRC 100-91.

AMEND 3 5-15.2 Glazed doors. Glazed doors shall have insulated steel or thermally broken aluminum frames conforming to the above requirements. Finish shall be factory applied and conform to 44-C-22431 in accordance with the requirements of the National Association of Architectural Metal Manufacturers (NAAMM) **AM3** ~~Metal Finishes Manual. Operable panels shall be equipped with screens. Sliding panel screens shall~~

~~have extruded aluminum tubular frames mitered at corners, channel-shaped corner angle reinforcement, and nylon bottom rollers. Doors shall have interior operated latch, and securing pin or throw-bolt in frame. Screening shall be nonferrous.~~ Kitchen and patio doors shall be double French style with one side operable, double glazed and one side stationary, double glazed. Both sides shall have operable venetian blinds enclosed between glass panes

5-15.3 Glazing. Units shall be double glazed with low E-glass. The design shall consider the work involved in repair and replacement of individual panes and overall window groups.

5-15.4 Interior window stools shall be solid-wood, paint-grades with a minimum thickness of 3/4-inch.

5-16 Screens. Screens shall be provided at all operable sashes. Screens and frames shall be aluminum, of window manufacturer's standard design, and conform to AAMA 1002.10, Voluntary Specification for Aluminum Insulating Storm Products for Windows. Sunscreens (screen composed of more dense mesh screening material than standard insect screens) fit in the same screen track and continue to act as an effective insect screen and also as a Solar Heat Gain Coefficient (SHGC) reducer should be considered for installation in west- and east-facing windows, and in south-facing windows that do not have passive solar overhang shading. In hot climates solar heat gain through the windows is often responsible for 50% or more of the air conditioning load, and sunscreen is an effective, low-cost, passive and persistent means of reducing it.

AMEND 3 5-17 Window Treatments. Provide 1 inch metal blinds at windows and glazed hung doors. Color shall be manufacturer's standard off white, and shall be coordinated with wall color. **AM3**~~Provide single draw traverse rod and draperies at sliding glass doors. Drapes shall not be provided~~. Shades are not permitted.

5-18 Doors. See Table 7-1 for thermal performance requirements for exterior doors.

5-18.1 Entrance doors. The housing unit primary entrance door shall be3 ft in width by 6 ft - 8 inches in height by 1-3/4 inch thick, thermal metal. Other housing unit entrance doors should meet this requirement but may be of lesser width. Equipment room entrance door shall be 3ft wide by 6ft-8inches in height by 1-3/4” thick, metal. Exterior door frames shall be painted hollow metal reinforced to accept door hardware.

5-18.2 Bulk storage doors. Exterior bulk storage doors shall be a minimum 1-3/8 inch thick, exterior grade, thermal metal, or hollow core metal.

5-18.3 Aluminum screen and storm doors: Screen and self-storing storm doors shall be provided for all housing unit exterior hinged doors. Frames shall be a minimum 1-1/4-inch thick and 2 inches wide. Aluminum alloy materials shall be not less than 0.05-inch thick and 2 inches wide. Doors shall have solid bottom panels and midsection protective grills. Screening materials shall be aluminum.

5-18.4 Interior doors. Interior doors shall be 6 ft -8 inches in height by 1-3/8 inch thick, hollow core wood or hollow panel. Wood doors will be painted. Door frames shall be paint grade solid wood construction. Pre-hung and pre-finished doors and frames may be used.

5-19 Builders Hardware. Hinges, locks, and latches will comply with the specifications indicated in Table 5-10, and the following subparagraphs:

TABLE 5-10 – HARDWARE SPECIFICATIONS

Hardware Type/ Specification	Specific Requirements
Hinges ANSI/BHMA A156.1	Hinges shall be 4 in x 4 in at exterior doors, and 3-1/2 in x 3-1/2 in at interior doors. Ball bearings shall be of a base material of brass or bronze except as noted for fire rated door.

TABLE 5-10 – HARDWARE SPECIFICATIONS

Hardware Type/ Specification	Specific Requirements
Locks & Latches ANSI/BHMA A156.2	Series 4000, Grade 1, at exterior doors. Grade 2 at interior doors. Provide trim of wrought brass, aluminum, or stainless steel.
Auxiliary Locks ANSI/BHMA A156.5	Series 4000, Grade 1. Provide matching trim of wrought brass, aluminum, or stainless steel.
Interconnected Lock & Latches ANSI/BHMA A156.12	Grade 1. Provide matching trim of wrought brass, aluminum, or stainless steel.
Closers ANSI/BHMA A156.4	Series CO2000, Grade 1.

5-19.1 Locks and keys. Lock cylinders shall have six pin tumblers and interchangeable cores which are removable by a control key. Provide a master keying system. Locks for each housing unit, including exterior storage and garage door(s), shall be keyed alike. The Contractor shall provide one extra set of cores for each 25 housing units and furnish four keys for each key change and for master key system and control key. Locks and keys shall conform to the standards and requirements of the Builders Hardware Manufacturers Association ANSI/BHMA A156.2 listed above.

5-19.2 Weather-striping and exterior thresholds: Provide nonferrous metal or vinyl weather-stripping for all housing unit exterior doors. Vinyl magnetic weather-stripping is acceptable for metal doors. Exterior thresholds shall be nonferrous metal.

5-19.3 Applications. Locks and hinges shall be applied as follows:

5-19.3.1 Exterior hinged doors shall have 1-1/2 pair of hinges, lockset, and an auxiliary lock.

5-19.3.2 Each main entrance door will have a viewer mounted at eye level. Handicapped housing units shall have an additional viewer located for wheelchair height.

5-19.3.3 Bulk storage doors shall have 1-1/2 pair of hinges and lockset.

5-19.3.4 Interior doors shall have one pair of hinges and latch set with ANSI/BHMA A156.2, F75 OR F76 operations.

5-19.3.5 Doors in fire-rated walls, housing unit to garage, shall have 1-1/2 pair of steel ball-bearing hinges, lockset, auxiliary lock or interconnected lock and latch and closer.

5-19.3.6 Hardware Trim. Lock trim shall be cast, forged or heavy wrought construction of commercial plain design. In addition to meeting the test requirements of BHMA/ANSI A156.2 or 156.13, lever roses and escutcheons shall be a minimum of 0.05 inches thick. If reinforced, the outer shell shall be a minimum of 0.035 inches thick and the combined thickness shall be a minimum of 0.07 inches except the knob/lever shanks, which shall be a minimum of 0.06 inches thick.

5-19.3.7 Garage side exterior doors shall have 1-1/2 pair of hinges and lockset.

5-20 Postal Service and Building Signage.

5-20.1 Postal Service. Each housing unit shall be provided with an individual mailbox, grouped and located in Neighborhood Delivery & Collection Box Units (NDCBUs) as manufactured by National Mailboxes (1-800-676-5161) or approved equal. Units shall be manufactured from heavy duty aluminum and stainless steel construction, providing protection against rust and with a hood to protect against most weather conditions. Door sizes shall be 5" H x 6" W. Also provide large package mailboxes (one for each 8-10 housing units). Provide within units a mail slot to receive outgoing mail. Units shall be rear loading and include pedestals.

5-20.2 Building Signage. All new units shall be provided with building identification signage in accordance with the Installation Design Guide requirements.

5-20.3 Housing numbers. Provide a five-digit number for each dwelling unit. Provide a minimum 4 inch high house identification numbers/ letters in Helvetica medium font colored black on an illuminated white background mounted on 12-gauge aluminum for each dwelling unit. The house identification shall be mounted near each entry. The government will assign housing numbers.

5-20.4 Occupant Identification Signage. Provide occupant identification signage similar to existing family housing signage. Signage shall be interchangeable and made of plastic with routed letters. Total sign height shall be 2 inch overall including the frame. Signs shall be mounted 5 feet above finish grade at side of entry. All signage should conform to the guidelines established by TRADOC sign standards (TRADOC Reg. 420-14). Names and rank shall be as directed by the government.

5-21 Kitchen Cabinets. Cabinets may be pre-fabricated and pre-finished or be factory manufactured of wood. Wall cabinets shall have adjustable shelves. Cabinets shall have magnetic catches except where spring-loaded self-closing hinges are provided. Cabinets shall include knobs/handles and or pulls and shall conform to ANSI A161.1, Recommended Performance and Construction Standards for Kitchen and Vanity Cabinets, except where modified below. Wall and base cabinets shall be essentially of the same construction and appearance. Provide cabinet drawer slide system that meets or exceeds ANSI A156.9, TYPE B05111. All cabinet shelf brackets to meet A156.9 TYPE B04073. Refer to Table 5-5 for minimum kitchen cabinet area requirements. Additional cabinet space may be achieved with tall wall cabinets.

5-21.1 Cabinets construction. Construct cabinets with frame fronts and solid ends, or of frame construction throughout. Frame members shall be mortised and tendoned, dove-tailed or doweled, and glued together. Brace the top and bottom corners with hardwood blocks that are glued with water-resistant glue and nailed in place. Cabinet interior plywood surfaces exposed to visibility and use, including drawer bottoms and cabinet sides, backs and bottoms shall be covered by non-stick plastic laminate finish. Wood cabinet materials and dimensions - Materials and minimum dimensions and thicknesses for cabinet construction materials shall comply with Table 5-11.

TABLE 5-11 – KITCHEN CABINET SPECIFICATIONS

Element Description	Specific Requirements
Frame Members	3/4 in x 1-1/2 in kiln-dried hardwood.
Base Cabinet Toe Space	2-1/2 in x 4 in high.
Cabinet Bottoms, Backs & Tops (Unexposed)	3/16 in hardwood plywood or 1/8 in tempered hardboard. Provide bottoms in kitchen sink cabinets. Brace bottoms with wood members glued in place.

TABLE 5-11 – KITCHEN CABINET SPECIFICATIONS

Element Description	Specific Requirements
Cabinet Ends & (Exposed Backs/Bottoms)	Hardwood plywood, 5 ply, good grade for natural finish. Base Cabinets: 1/2 in Wall Cabinets: 3/8 in
Doors	5/8 in hardwood plywood, good grade for natural finish, with hardwood trim. Raised panel or recessed panel.
Drawer Slides/Glides	20 gauge metal. Grade 2 ANSI/BHMA A156.9 TYPE B05111
Drawer Fronts	5/8 in solid hardwood, matching doors.
Drawer Bottoms	1/8 in softwood plywood, Grade A-B veneer or 1/8 in tempered hardboard. Bottoms 15 in wide shall be braced and glued in place.
Interior Partitions	1/2 in hardwood or softwood plywood, Grade A-A or comparable veneer.
Shelves	1/2 in softwood plywood (Grade A-B Veneer), hardwood plywood (good grade veneer), or glued-up solid wood. Support shelves on ends and on 24 in centers. Shelf edges exposed to view shall be rounded, filled, sanded, and finished. Shelves and interior-surfaces of cabinets shall have non-stick plastic laminate finish.

5-21.2 Countertops. Countertops shall be ½" thick, pure acrylic polymer, non-porous, solid surface material with 2" turndown front face. Minimum backsplash height is 4 inches. The entire area behind the oven-range and range hood shall be protected with same material. Countertop and backsplash edges shall be beveled.

5-22 Appliances. Provide the following equipment in accordance with specifications listed, one each per housing unit. A listing of currently labeled Energy Star appliances is available through the internet at the EPA website: http://www.energystar.gov/products/appliances.html. All appliances shall be white in finish color.

5-22.1 Refrigerators. Comply with UL 250, Household Refrigerators and Freezers and shall bear the EPA "Energy Star" certified label. Provide refrigerator with frost proof top freezer, automatic defrosting, and ice maker with water filter. Refrigerator shall have two vegetable bottom baskets, at least four adjustable shelves, at least two shelves and egg container in door; freezer compartment shall contain separate interior shelves, multiple door shelves, and ice maker. Provide reversible (left swing and right swing interchangeable) doors. Refrigerators shall conform to the energy compliance standards of 10 CFR 430, including those refrigerators manufactured before the code took effect. The use of refrigerants with an Ozone Depletion Potential (ODP) of .05 or less is required. Minimum refrigerator volume shall be 21 cubic feet. Energy efficiency shall not exceed 722 kWh/yr.

5-22.2 Ranges and ovens. Ranges shall be 30 inches wide and provided with porcelain enamel cook top, oven, clock and timer, oven light, and cooking surface light. Oven shall have black glass window door, broiler pan, and self-lock racks.

5-22.2.1 Gas ranges shall have two, 6-inch and two, 8-inch burners, a self-cleaning oven, and AGA-approved electronic ignition. Provide utensil drawer in each range. Gas ranges shall be in accordance with AGA z21.1, American National Standard for Household Cooking Gas Appliances.

5-22.3 The kitchen in each unit shall have one tube-type solar skylight, minimum 10" diameter.
Skylight shall be equal to that manufactured by Solatube, 2210 Oakridge Way, Vista, CA 90283-8341,
and having the following salient features:
a) high impact polycarbonate dome to block harmful UV rays, and be resistant to debris
impacts from high winds
b) interior tube surface to be 95% light reflective
c) flexible tube design to bypass attic obstacles
d) water, bug, and dust leak-proof seamless flashings
e) minimal heat gain and loss
f) 10-year warranty against breakage and yellowing.

5-22.4 Range hoods. Provide metal range hoods, the same length and finish as the range, with separately switched light and exhaust fan. The hood shall have a washable filter. The fan shall have a capacity of not less than 50 cubic ft per minute per linear foot of range hood. The sound level shall not exceed 6 sones. Duct the fan above the roof and provide back-draft protection. Each range hood shall be equipped with a fire-protection (extinguishing) system installed within the hood, and shall comply with NFPA 96. The use of battery operated suppression devices is not acceptable. The system installed shall be of re-usable thermal link type. The wet chemical agent shall conform to the requirements of National Fire Protection Association (NFPA) Standard No. 17A for Wet Chemical Fire Extinguishing Systems. The extinguisher cylinder and valve assembly shall be provided fully charged with chemical, and pressurized with dry nitrogen in accordance with Listed requirements. The pressure gauge attached to the valve assembly shall be positioned to allow visual inspection, where installed within the kitchen cabinet. Fire-extinguishing system shall be compatible with gas range provided, and shall provide an appliance shut-down U.L. Listed device to automatically shut-off the gas or electric supply to surface burners on the kitchen range top upon actuation of the fire extinguishing system. (If an electrical range is ever to be used in these kitchens, this fire-extinguishing system must be adjusted!) Provide with each system an audible alarm with minimum 85-dbA rating. Alarm shall be U.L. Listed or U.L. recognized component, supplied complete with back box ready for installation. Unit shall be Guardian I, Model # 1384A as manufactured by 21 Century fire www.21centuryfire.com (1-800-786-2178) or approved equal.

5-22.5 Garbage disposals. Garbage disposals shall conform to UL 430; Waste Disposers; continuous feed, minimum 3/4 HP motor, stainless steel grinding elements, two 360-degree stainless steel swivel impellers, manual motor reset, and sound insulation. A plug connector is required. Garbage disposal shall be InSinkErator model 555ss, Waste King Gourmet Series model SS3100, or approved equal.

5-22.6 Dishwashers. Dishwashers shall conform to UL 749, Household Electric Dishwashers, and be UL listed, electric type, with air gap, racks, lift-out utensil holder, spraying arms, and detergent dispenser. Unit shall be listed as “Energy Star” compliant and shall bear the “Energy Star” label. The automatic controls shall cycle through the Wash, Rinse, Dry / Heat, and Stop phases, and shall be capable of rinse and hold cycle as well as a no heat drying feature. The unit shall contain instantaneous, or in-line, water heater booster, with automatic thermostat set for 140 degrees F. Rated energy use for standard capacity models will not exceed 620 kWh/yr. The dishwasher shall have factory applied sound isolating and insulating features for a sound rating no greater than 5 sones

5-22.7 Water heater. See paragraph 8 - UNIT DESIGN- PLUMBING.

5-22.8 Ceiling Fans. Provide ceiling fans in all bedrooms and living spaces. See Chapter 9 Electrical, paragraph 9-7.2.3 for additional requirements.

5-22.9 Color. Kitchen appliances, except disposals, shall be of matching finish, white in color.

5-23 Maintainability. The design of housing units including the selection and specifying of exterior and interior

finishes, equipment, appliances, and systems shall include consideration of maintenance ease and cost. Avoid products that require continuing maintenance at high cost. Avoid products with finishes that cannot sustain frequent and harsh scrubbing.

5-24 Fireplace and chimney. Fireplaces and chimneys are not to be used.

End of 01001-5.

9. UNIT DESIGN - ELECTRICAL.

9-1 Conformance to Code. The electrical system shall be designed in compliance with the rules and recommendations of ANSI C2, National Electrical Safety Code, and NFPA 70, National Electrical Code (NEC), and applicable model codes, whichever is more stringent. Provide main circuit breaker in the main panel for each housing unit, sized in accordance with the NEC, or 150 amp whichever larger. Panel-board shall be 120/240 volt, 1-phase, 3-wire.

9-2 Service Entrance. Service entrances, exterior meters, and panels shall be enclosed or sight screened. Service feeders shall be underground with exterior automated meters reading system. Panel-boards shall be dead-front, painted galvanized steel and furnished with main breakers. Panel-board doors shall be flush one-piece fronts. Panelboards shall be recessed. Tandem circuit breakers shall not be used. Printed labels, in the panel board, shall be provided for all installed circuits.

9-3 Panel-board Locations. Each dwelling unit shall have it's own distribution panel-board. Panel-board shall be located inside the garage on an exterior wall.

9-4 Conductors. Conductors shall be copper and not smaller than #12 AWG. Separate ground wire shall be provided for each circuit.

9-5 Outlet Circuits. All outlet circuits shall be fed by 20 Ampere circuit breakers. Receptacles on opposite sides of common walls shall be horizontally offset a minimum of 12 inches to maintain integrity of the fire wall and sound deadening rating of the wall.

9-5.1 Separate Circuits. Each bedroom, bathroom, kitchen, living and dining room, family room, shall be on a separate circuit; if there are more than 6 current consuming devices in one room, then additional circuits are allowed. Circuit is not allowed to share between rooms. The circuit may include duplex receptacles, lighting, ceiling fans, and exhaust fans for each individual room.

9-5.2 Outlets Per Circuit. Circuits for general-purpose receptacles shall be limited to a maximum of six (6) current consuming duplex receptacles. This requirement shall supersede any others.

9-5.3 Outlet grounding. All outlets shall be grounded by an equipment-grounding conductor which shall be terminated at a grounding screw in the outlet box. A grounding jumper shall connect the equipment, fixture, or receptacle to this grounding screw.

9-6 Exterior Lighting and Outlets. Provide energy efficient high quality lighting for each dwelling unit. The minimum efficiency standard for lighting is 50 lumens/watt. This efficiency can be achieved with fluorescent and compact fluorescent lighting. Lighting must also be color corrected with a Color Rendering Index (CRI) of 60 or better. Provide a minimum of one lighting fixture in each dwelling unit's entry, and patio area, fixture shall be Light Process Company, model LP-WSC-JAR-13 or approved equal. **(AM#3)** In addition to patio area lighting, provide ~~Provide~~ one exterior fluorescent light fixture with wire frame, one 22-watt lamp, for each dwelling unit to illuminate back yard; fixture shall be Light Process Company, model LP-SW413Q22 or approved equal. Exterior lighting on the dwelling units shall be switched both manually by indoor switches and by motion detection; manual switches have override capability. Provide a fixture in the patio area, except that the patio area light shall not be provided where the patio is adjacent to an exterior entrance and is adequately served by the lighting fixture required herein before. Provide lighted house street number.

9-6.1 Illuminated House Street Numbers. Provide exterior light fixture with integral dwelling unit numbers. Fixture shall turn on automatically at dusk and turn off at dawn using a photocell that activates by minimum ambient lights levels of 0.5 foot-candle. Dwelling numbers shall be of rigid impact resistant plastic material. Dwelling number shall not be adhesive type. This unit is not

required to meet the 50 lumens/watt requirement. Fixture shall be Digecon, model #54833-Address-O-Lite or approved equal.

9-7 Interior Lighting, Switched Outlets, and Fans.

9-7.1 Efficiency. Interior lighting will be both efficient and color corrected. Color Rendering Index (CRI) of 85 or better and a standard lighting color of 3500 K are required. Incandescent fixtures are allowed only in dining rooms. Minimum efficiency standard for lighting are as follows:

9-7.1.1 Fluorescent tubes longer than 4 ft: 90 lumens/watt.

9-7.1.2 Fluorescent tubes 4 ft: 85 lumens/watt.

9-7.1.3 Compact fluorescent and other lamps: 50 lumens/watt.

9-7.1.4 Fluorescent tubes less than 4 ft: 80 lumens/watt

9-7.2 Locations. Provide light fixtures operated by wall switches for all rooms except living rooms. Living room shall have a duplex receptacle, half controlled by a wall switch, located at the room entrance. Wall-switch operated ceiling lights shall be provided in dining and utility rooms, halls, bedrooms, kitchens, auxiliary dining room, walk-in closets, interior storage rooms, and garage. Additional light fixtures shall be provided in rooms whose configuration requires them for adequate lighting. Wall-switch operated wall-mounted lights shall be provided in bathrooms and half baths located above the mirror over the lavatory. Exhaust fans are to be separately switched from the lights. A minimum of two lighting fixtures, ceiling mounted shall be provided in garage, each mounts directly above each car's parking space, each fixture shall have its own two 3-way switches: one located near utility room entrance (total 2 at this location), the other near back door leading to backyard (total 2 at this location). Motorized garage door control switches (total 2) shall be mounted near utility room entrance.

9-7.2.1 Dining room ceiling light fixtures (hanging type) shall be movable by means of chain and hooks, or other means in order to accommodate other than the typical dining room furniture arrangement. Fixtures may be designed for incandescent use, and do not have to meet the 50 Lumens/Watt requirement.

9-7.2.2 The general lighting intensity in kitchens shall be 30 to 50 foot-candles. Supplementary lighting shall be provided at the sink and under one of the wall cabinets for a work center to produce a composite lighting level of 75 foot-candles using either down-lights, surface fluorescent fixtures surface-mounted below wall cabinets or wall-mounted fixtures (5 ft and higher above the floor) as appropriate. Kitchen range hood shall be provided with a light, fan, and switches.

9-7.2.3 Ceiling mounted fans shall be provided in auxiliary dining room, family room, and all bedrooms. Fans shall have light kit included, lamps shall be fluorescent type. Fan switch shall be provided next to light switch to allow for independent wall switch control of the fan and light.

9-8 Smoke Detectors. A household fire warning system, per NFPA 70, National Electrical Code; NFPA 72, National Fire Alarm Code; and NFPA 101, Life Safety Code, shall be installed in each unit. Hard-wired smoke detectors shall be located and installed on the ceilings of each dwelling unit in accordance with the requirements of NFPA 70, 72, 101, and UL 217. Each sleeping room and hallway shall have a separate smoke detector. All smoke detectors shall be of the photoelectric type. All smoke detectors shall have audible annunciation using the temporal 3 pattern. (AM#3) Next to each smoke ~~Smoke~~ detectors in handicapped adaptable units (AM#3) provide provision for future installation of visual indicator; this provision shall have a junction box with pre-wired conduit, ~~wiring,~~ and cover plate ~~shall also have visual annunciation with a 177 Candela rating~~. The mounting bases shall be permanently wired and supplied by a dedicated circuit. Circuit breaker for smoke detector circuit shall be clearly labeled (AM#3), and shall be lockable ~~and provided with a warning for occupants not to shut off~~. All smoke detectors within a

living unit shall be interconnected so that operation of any smoke detector shall cause the alarm audio and visual devices in all smoke detectors in that unit to activate. There is no requirement to transmit a fire alarm signal to Fire Dispatch. All smoke detectors shall be interconnected with battery backup. Smoke detectors shall not be located near air exchange vents, and ceiling fans. Additional consideration in the technical evaluation will be given to designs that provide smoke detectors with pull out trays for changing batteries. This type of smoke detector allows the occupant to change the battery without having to remove the detector from its mounting. Activation of a smoke alarm shall not cause activation of a carbon monoxide alarm.

9-9 Carbon Monoxide Alarms: Provide carbon monoxide (CO) alarms equipped with a fuel-burning appliance inside of the dwelling unit. Activation of a CO alarm shall not cause activation of a smoke alarm. CO alarms will be provided as follows:

9-9.1 One CO alarm shall be located in each dwelling unit. The required alarm shall be located in vicinity of the bedrooms, such as in the corridor outside of the bedrooms. CO alarms will not be provided in furnace rooms, or unfinished attics.

9-9.2 CO alarms shall be hardwired and wall-mounted at the same height as the thermostat, approximately 52 inches off the floor. Dead air spaces such as corners shall be avoided. Units may be powered from circuits powering smoke detectors. In all cases, manufacturer's guidelines and recommendations shall be followed.

9-9.3 CO alarms shall be equipped with an audible alarm, continuous digital display, peak level memory, test button, and test-reset button and shall be UL listed by passing standard test UL 2034.

9-10 Communication. Communication system for each dwelling unit shall consist of outlets, conduits, pull wires, and a Gold Package-Base from Siemon Home Cabling System or approved equal. Gold package shall contain the following:

- 1 Command Center, 36” steel enclosure to house the main panels that distribute voice, data, and video signals.
- 2 Telephone Patch Panels, makes up a total of 4 incoming telephone lines.
- 1 Voice/Data Distribution Panel.
- 1 Video Distribution Panel distributes incoming TV service.
- 12 Faceplate Kits in 4-bed room unit, (10 Faceplate Kits in 3-bedroom unit). Each faceplate kit includes two category 6 modular jacks, and one 75-ohm F-type connector. In kitchen, separate faceplates shall be provided for voice, data, and CATV.

Command Center shall be located in utility/laundry room.

9-10.1 Telephone. Provide 2 dual jack outlets (each dual outlet has 1 telephone, 1 LAN jack) in family room, living room, and each bedroom of each dwelling unit. Provide 1 telephone and 1 LAN jack in the kitchen. Eight position modular jack connectors shall be provided. The telephone jack provided in the kitchen shall be for a wall-mounted phone. Jacks shall be Category 6 per TIA/EIA 568A, Commercial Building Telecommunications Cabling Standard. Provide a conduit, minimum ¾”, and pull-wire from each outlet box to command center. Each conduit and pull-wire shall terminate on the command center. Provide a conduit between the command center and telephone terminal box. Telephone terminal box (Demarcation Box) shall be located next to electric meter. The telephone terminal box cover shall be provided with means for padlocking, shall be accessible from the outside, and shall be permanently labeled, "Telephone". Gas protected telephone terminals shall be provided in telephone terminal box. A single #10, CU, green 10, CU, green equipment grounding conductor shall be run in 1/2-inch non-metallic conduit from the electric metering equipment to the telephone terminal box. No conduits shall be routed on the interior surfaces of dwelling units. Outlet boxes shall be 4-11/16 inches square by 2-1/8 inches deep.

9-10.2 Commercial Cable TV (CATV). CATV type F connector: 1 CATV outlet shall be provided in the kitchen. 2 CATV outlets shall be provided in living room, family room, and bedrooms.

Provide a conduit, minimum ¾" and pull-wire from each outlet box to command center. This conduit is in addition to the one required for telephone. Each conduit and pull-wire shall terminate on the command center. Provide a conduit between the command center and a surface mounted, weatherproof, protected television terminal box ("Demarcation Box") located on an outside wall adjacent to the protected telephone terminal box. The protected television terminal box cover shall be provided with means for padlocking, shall be accessible from outside and shall be permanently labeled "Television". A single #10, CU, green equipment grounding conductor shall be run in 1/2-inch non-metallic conduit from the dwelling unit electric metering equipment to the protected television terminal box. Sizes of protected television terminals and conduits shall be coordinated with local cable TV Company.

9-10.3 Satellite Television. Brackets shall be installed on each dwelling unit's fascia for satellite dish to allow easy access for maintenance without walking on the roof and shall make for a pleasing appearance. A conduit, minimum ¾" with pull-wire shall be installed in the soffit for future cabling wire from the dish to the command center. Conduit shall be concealed.

9-11 Door Bell. The front entrance to each dwelling unit shall be provided with a low voltage bell. Doorbell shall be hard-wired. Five handicapped adaptable dwelling units (random pick) shall also be provided with wall-mounted strobe visual enunciators in the entry hallway and kitchen.

9-12 Convenience Duplex Receptacles. In addition to duplex receptacles required by NEC, provide additional duplex receptacles in the following areas:

9-12.1 Utility Room

9-12.2 Hallway outside bedrooms

9-12.3 A minimum of 2 in garage

9-13 Special Outlets. Provide 240V electric outlets for electric dryer (this is in addition to the 120v receptacle required for gas dryer), and electric range. Provide a switched 120 V receptacle under kitchen sink for garbage disposal.

9-14 Wiring. Maximum use shall be made of nonmetallic-sheathed cable for branch circuit wiring, and of service entrance cable for heavy-duty interior circuits and for service entrance conductors. Installed conductors in conduit shall be used only where specifically required by the NEC.

9-15 Branch Circuit Conductors. Branch circuit conductors and over current devices shall be as rated by NEC. A minimum of one spare circuit space in the panel shall be provided per housing unit. Individual circuits shall be provided for the washer, dryer (with receptacles located behind the washer and dryer), dishwasher, garbage disposal, freezer, electric range, furnace, condensing unit, and water heater. Two utility circuits (20 amp) shall be provided in the kitchen area for the convenience duplex receptacles for small appliances serving the kitchen, dining area, and family room area. The furnace and condensing unit shall be provided with disconnect switches in addition to the branch circuit breaker.

9-16 Exterior Receptacles: Exterior receptacles shall be weatherproof type, rated NEMA 3R with hinged cover, protected by ground fault interrupting circuit breaker.

9-16.1 One duplex receptacle shall be provided in each dwelling unit's entry, and patio.

9-16.2 One duplex receptacle, fed and switched with the front entrance door light, shall be provided for holiday lighting. This is in addition to the one required by paragraph 9-16.1.

9-17 Ground Fault Protected Receptacles. All receptacles that are required to have ground fault protection shall be fed by a ground fault interrupting circuit breaker except that the dedicated receptacle in the bathroom shall itself be the ground fault interrupting type.

End of 01001-9.

10. UNIT DESIGN - HEATING, VENTILATING, AND AIR CONDITIONING.

10-1 Design. Heat gain and loss calculations shall be, as a minimum, in accordance with the current edition of the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Handbook of Fundamentals or ACCA Manual J. The cooling load calculations shall be in accordance with ASHRAE Residential Cooling Load Calculations. Computer-generated load calculations shall be provided, and shall include complete input and output summaries. Design shall be based on the weather data shown in Table 10-1. HVAC system shall be designed to minimize noise transmitted to the habitable space. The design noise criteria (NC) shall be no greater than 40 in any habitable space.

TABLE 10-1 – WEATHER DATA[1]

Type of Design / Design Information	-	Inch-pound
Heating[2]		
Weather Region		11
Indoor Design Temperature	-	72 ºF
Outdoor Design Temperature		15
Annual Heating Degree[3] Days	-	2526
Largest Number of Monthly Heating Degree Days[2]		2243
Cooling		
Indoor Design Temperature	-	75 °F
Outdoor Design Dry Bulb Temperature[1]	-	105
Outdoor Design Wet Bulb Temperature[1]	-	68

Note[1]: Weather data from TM 5-785, Engineering Weather Data.-
-
Note[2]: Inch-pound data are based on degree days Fahrenheit to a base of 65 degrees F.

10-1.1 Load calculations. Computer generated load calculations shall be performed for each possible orientation up to four representative orientations for each building type included in the project. Room air-flow requirements shall be computed based on the individual room load. However, the minimum acceptable air-flow shall be -0.5 cfm/ft^2-for all spaces. The design for each individual housing unit shall be based on the heating and cooling loads as well as room airflow requirements computed for the building type and orientation which it most closely matches. Internal loads shall be included in the computerized load calculations in accordance with ASHRAE recommendations for residential analyses.

10-1.2 Duct system layout. For a given building type, a single duct layout may be used regardless of orientation, provided that the system is sized to provide the required air flow for each room at its worst case orientation. Balancing dampers shall then be used to reduce air flow to the appropriate level as required. Permanent access to dampers shall be provided.

10-1.3 Manufacture's Catalog Data: Furnish manufacturer's catalog data for all HVAC equipment to include Model number, Physical data, Dimensions, Performance data, Electrical data and Guide specification.

10-2 Equipment Safety and Efficiency. All materials and equipment shall be the standard cataloged product of manufacturer's regularly engaged in production of such materials and equipment, and shall be the manufacturer's latest standard design. Each major component of the heating -and cooling] system-s- shall have the manufacturer's information on a plate secured to the equipment.

10-2.1 All heating and cooling equipment proposed and installed in this contract shall bear the Energy Star Label.

10-2.2 Equipment shall comply with the requirements of American Gas Association (AGA), American National Standards Institute (ANSI), Air Conditioning and Refrigeration Institute (ARI), American Society for Testing and Materials (ASTM), Gas Appliance Manufacturers Association (GAMA), National Electric Manufacturers Association (NEMA), National Fire Protection Association (NFPA), Underwriters Laboratories, Inc. (UL) or other national trade associations as applicable.

10-2.3 Equipment efficiencies as listed in Table 10-3 below are minimum acceptable levels. Energy conservation as it relates to equipment operating costs will be considered in the evaluation process. Additional consideration in the technical evaluation will be given to designs which include higher than minimum efficiency equipment. -

TABLE 10-3 - MINIMUM EQUIPMENT EFFICIENCIES

	-	Natural gas fired equip	-	-		Electric cooling only split DX cond. Unit and matched coil -
Furnace AFUE	90%[1]					
- Combustion Efficiency[1]	-	-80%				
-SEER[3]				-	-	12.7

Note[1]: Efficiency is based on DOE test procedure 10CFR430, Sub-Part B, Appendix N.

Note[2]: Not Used.

Note[3]: Efficiency is based on DOE test procedure 10CFR430, Sub-Part B, Appendix M.

10-3 Heating and Cooling Systems. Each housing unit shall be provided with central heating and air conditioning-systems. Systems shall be designed, installed, balanced, and adjusted to distribute heat and cooling to all habitable rooms, as well as bathrooms, in proportion to the

calculated load requirements of these spaces. - Fans in air handlers and furnaces shall be multi-speed, direct drive type. System installation shall conform to SMACNA Installation Standards for Residential Heating and Air Conditioning Systems except as altered by this document. Additional consideration in the technical evaluation will be given to systems utilizing modular components, plugged power, drawer-type burner assemblies, additional space in the mechanical room, and other features which contribute to ease of system maintenance. Additional consideration will also be given to designs which provide measures beyond the requirements of this STATEMENT OF WORK to increase energy conservation or occupant comfort such as division of each housing unit into more than one conditioning zone for increased control.

10-3.1 Equipment sizes selected for installation shall not oversized more than 125 percent of the calculated loads (exception, gas fired furnace heating capacity may exceed 125 percent of the calculated heating load in order to match air handler selection with required cooling loads).
-

10-3.2 Mechanical space shall be provided to house all mechanical equipment Exterior air conditioning units shall be concrete pad-mounted, with location selected based on site specific conditions and intended uses of outdoor space. Screen with shrubbery or wall, locate on sides of housing unit, avoid placement under windows, etc.). However, the primary concern shall be coordination with the mechanical area location. Mechanical equipment shall be located in an externally accessible utility room, and shall be arranged to allow for ease of maintenance, and for proper venting if required. This utility room shall be provided with a light and electrical receptacle. . The mechanical equipment room shall be a part of the dwelling structure. The mechanical equipment room shall be provided with a floor drain to accept condensate and will drain to the plumbing system. The mechanical equipment room shall have a 2 inch depressed floor to prevent condensate or leakage from entering the dwelling. The mechanical equipment room shall have a concrete pad outside the access door (minimum 3-foot by 4-foot). Mechanical equipment shall not be located in attic spaces. A desirable feature is to locate the mechanical equipment access on the side of the dwelling or otherwise accessible without traversing areas that may be fenced. See paragraph 5.d.(3) for additional requirements for mechanical spaces containing fuel-fired heating equipment.

10-3.3 Forced warm air systems. Warm air furnaces shall be -induced combustion, up-flow natural gas-fired furnaces--. Furnaces shall be equipped with electronic ignition. Natural gas fired furnaces shall be equipped with a flue to exhaust flue gases -. Where high efficiency (AFUE > 90 percent) gas furnaces are selected for use these units shall be vented in accordance with AGA requirements and the manufacturer's instructions. Condensate drains for high efficiency units shall be manufacturer approved, and shall be indirectly connected to the building sanitary sewer system. Combustion air shall be provided from the outside in accordance with the appliance listing. Furnaces shall be equipped with centrifugal fan, disposable filters, controls, and transformer. Fans shall be multi-speed, direct-drive type. It shall be possible to service and replace all controls and internal components from one side of the furnace. Heat exchangers shall be guaranteed for a minimum service life of 10 years.

10-3.4 Not Used

10-3.5 Split system Air -Conditioning

10-3.5.1 Electric air conditioning equipment shall consist of an air-cooled condensing unit and evaporator/blower as matched components with the furnace, all by the same manufacturer. Refrigerants used shall have an Ozone Depletion Potential (ODP) of .05 or less. The condensing unit shall contain, as a minimum, the features indicated in Table 10-4. Equipment shall be sized to meet the total load determined by computer calculation. Equipment may be oversized to no

more than 115 percent of the computer generated load. Fans shall be multi-speed, direct drive type.

TABLE 10-4 – SPLIT SYSTEM AIR CONDITIONING FEATURES

High and low pressure compressor protection.
Filter-drier.
Hermetically sealed compressor with built-in overloads and locked rotor protection.
Electric crankcase heaters.
Start and run capacitors.
Anti-short-cycle timer. (factory installed)
Testing and charging refrigerant connections.
Compressor guaranteed for a minimum service life of 5 years.
Fan and coil guards.

10-3.5.2 The evaporator coil shall be provided with a liquid strainer, expansion device, pre-insulated housing, copper or aluminum coil, and insulated condensate drain pan. Coil face velocity shall be limited to 550 fpm.

10-3.5.3 The condensing unit and matched coil shall deliver a Seasonal Energy Efficiency Rating (SEER), consistent with the minimum requirements shown in Table 10-3.

10-3.5.4 Not Used.

10-3.5.5 Refrigerant Charge Verification: When split-system air conditioning systems are selected for installation, the contractor shall check, calibrate, and charge the refrigerant system following installation and start-up of the equipment. These tests shall be accomplished on the same 15% of the units which undergo blower door and duct tightness testing. If the tested units show a low or excessive refrigerant charge, all new systems shall be checked after start-up, but prior to acceptance by the Government.

10-3.6 Not Used.

10-3.7 Not Used.

10-3.8 Not Used.

10-3.9 Not Used.

10-3.10 Unacceptable systems. Room unit heaters; space heaters, evaporative coolers, room (window) air conditioning unitsand electric resistance heaters are not permitted.

10-4 Air Distribution. Provide systems conforming to the recommendations of the ASHRAE Air Distribution Manual or the SMACNA Residential Comfort System Installation Standards Manual. Additional consideration in the technical evaluation will be given to designs which incorporate air distribution systems totally within the conditioned envelope.

10-4.1 Supply diffusers. ceiling, and/or baseboard supply diffusers shall be located to ensure that the air distribution will completely cover all surfaces of exterior walls with a blanket of conditioned air or may be of a compact design so long as 'dead spots' within the units are avoided. At least one diffuser shall be provided in each habitable room. Diffusers shall have louvered faces with individually adjustable blades, and shall be provided with integral opposed blade damper. Diffusers shall be provided with air deflectors as required for proper air flow in the space. Plastic diffusers are prohibited. Core velocity shall be limited to 600 fpm maximum, with a maximum pressure drop of 0.1 inch water. Airflow from any single diffuser shall be limited to 200 cfm maximum. Ceiling mounted units shall have factory finish to match ceiling color, and be installed with rims tight against ceiling. Sponge-rubber gaskets shall be provided between ceiling or wall and surface-mounted diffusers for air leakage control. Diffuser boots shall be sealed tight to the wall or ceiling they penetrate using duct mastic or caulking. Suitable trim shall be provided for flush- mounted diffusers. Duct collar connecting the duct to diffuser shall be airtight and shall not interfere with volume controller.

10-4.2 Return and exhaust grilles. Grilles shall be fixed horizontal or vertical louver type similar in appearance to the supply diffuser face. Plastic units are prohibited. Core velocity shall be limited to 400 fpm maximum, with a maximum pressure drop of 0.06 inch water. Grilles shall be provided with sponge-rubber gasket between flanges and wall or ceiling. Register/grille boots shall be sealed tight to the wall or ceiling they penetrate using duct mastic or caulking. Wall return grilles shall be located at least 6 inches above the floor. Return grilles shall be located in hallways, or other normally unoccupied spaces to minimize the sound level in occupied spaces.

10-4.3 Ductwork. Ductwork shall be externally insulated sheet metal or flexible metal. Length of flexible duct shall be limited to 6 ft Flexible ductwork shall not be spliced or joined and shall be a single continuous piece from diffuser boot to trunk/branch duct. Systems composed entirely of flexible ductwork with distribution boxes are prohibited. Sub-slab, intra-slab, or crawlspace ductwork is also prohibited. Volume dampers shall be provided at each branch take-off. All ductwork shall be concealed. No portion of the building construction (such as joist space in a floor or ceiling, wall stud space, etc.) shall be used as a duct. The requirements for ductwork set forth below apply to all ductwork installed in the housing unit, supply systems, return systems, exhaust systems, ventilation systems, and outside air supply ductwork.

10-4.3.1 Maximum velocity in supply ducts shall be limited to 900 fpm for mains and 600 fpm for branches.

10-4.3.2 Ducts shall be airtight with no visible or audible leaks to ensure quiet, economical system performance. Ductwork in conditioned spaces shall be constructed for a 1 inch static pressure construction class with seal class C, as described in the SMACNA HVAC Duct Construction Standard, unless a higher pressure class and/or seal class is required by actual, system operating conditions. Ductwork in unconditioned spaces shall be constructed for a 500-Pa 2-inchstatic pressure construction class with seal class C, unless a higher pressure class and/or seal class is required by actual, system operating conditions. All duct seams and joints shall be sealed using duct mastic. Tape shall not be used as a means for sealing ductwork.

10-4.3.3 For flexible ductwork, the inner core shall be mechanically fastened to all fittings, preferably using draw-bands installed directly over the inner core and beaded fitting. If beaded fittings are not used, then the inner core shall be fastened to the fitting using #8 screws equally spaced around the diameter of the duct, and installed to capture the wire coil of the inner liner (3 screws for ducts up to 12 inch in diameter and 5 screws for ducts over 12 inch in diameter). The inner core must be sealed to the fitting using mastic or tape. Tape used for sealing the inner core shall be applied with at least 1 inch of tape on the duct lining and 1 inch of tape on the fitting, and shall be wrapped at least three times. The outer sleeve (vapor barrier) must be sealed at connections with a draw-band and three wraps of approved tape. The vapor barrier must be complete without any holes or rips, and seams shall be sealed with mastic or approved tape. Pressure sensitive tapes used in conjunction with flexible duct connections shall be as

recommended by the duct manufacturer and shall be UL 181A listed and so indicated with a UL 181A mark or aluminum-backed butyl adhesive tape (15 mil minimum). Draw bands shall be stainless steel worm drive hose clamps or UV resistant nylon duct ties.

10-4.3.4 Provide a minimum of 2-inch thick mineral fiber insulation (or other listed insulation with an equivalent R value) on the exterior of all ducts in unconditioned spaces. Exhaust ductwork does not require insulation. Insulation shall be faced with a vapor barrier material having a performance rating not to exceed 1.0 perm. Insulation, vapor barrier, and closure systems shall be non-combustible as defined in NFPA 255, with a flame-spread rating of not more than 25, and a smoke development rating of not more than 50, as defined in ASTM E-84.

10-4.3.5 Return, exhaust, and ventilation air ductwork shall be sized for a maximum velocity of 900 fpm. Short runs of return air duct (5 ft or less) which directly precede the air handler or furnace shall be acoustically lined to minimize noise.

10-4.4 Not Used.

10-4.5 Filtration. Provide a pleated 1 inch panel filter, sized for and installed in the return air system in accordance with UL 900. Filter shall be rated for 20 percent efficiency as determined by ASHRAE 52, Method of Testing Air Cleaning Devices used in General Ventilation for Removing Particulate Matter. All filters shall be easily accessible for changing and maintenance and shall be installed in the return grilles whenever possible. Additional consideration in the technical evaluation shall be given to designs utilizing electrostatic filters. Kitchen exhaust hoods shall be provided with aluminum grease filters sized to fit the exhaust duct.

10-5 Thermostats: Thermostats shall be located on interior partitions, approximately 5 ft above the finished floor. Locating a thermostat on the wall, on an exterior wall, or where it is subject to unrepresentative temperatures is unacceptable.

10-5.1 Thermostats shall be Energy Star labeled, microprocessor-based, with built-in key pads for scheduling of day and night temperature settings. Thermostats shall be programmable for heating and cooling. When out of the scheduling mode, thermostats shall have continuous display of time, with AM and PM indicator, continuous display of day of week, and either continuous display of room temperature with display of temperature set point on demand, or continuous display of temperature set point with display of room temperature on demand. In the programmable mode, the display shall be used for setting and interrogating time program ON-OFF set points for all 7 days of the week. The time program shall allow two separate temperature-setback intervals per day. Thermostats shall have a means for temporary and manual override of the program schedule, with automatic program restoration on the following day. Thermostats shall have a replaceable battery to maintain the timing and maintain the schedule in memory for one year in the event of a power outage. Maximum differential shall be ±2 degrees F. For a listing of Energy Star labeled thermostats see http://www.epa.gov/appdstar/hvac/thermostats.html.

10-6 . Not Used.

10-7 Exhaust Fans. Bathroom and kitchen range hood exhaust fans shall be ducted to the outside. Exhaust fans shall not discharge near the air conditioning condensing unit, entry doors, patio ,or garages. Fans shall be tested and rated in accordance with AMCA 210, and shall operate with 120-volt, single-phase power supply. Exhaust fans shall be provided with backdraft damper. Bathroom exhaust fans shall be ceiling mounted and shall be sized to provide not less than 10 air changes per hour in the space served. Maximum allowable noise level for bathroom exhaust fans shall be 2 sones as installed. Kitchen range exhaust fans shall be two-speed, and shall be sized for an exhaust rate of 1.5 cfm/ ft^2 . Maximum allowable noise level for range hood exhaust fans shall be 6 sones as installed.

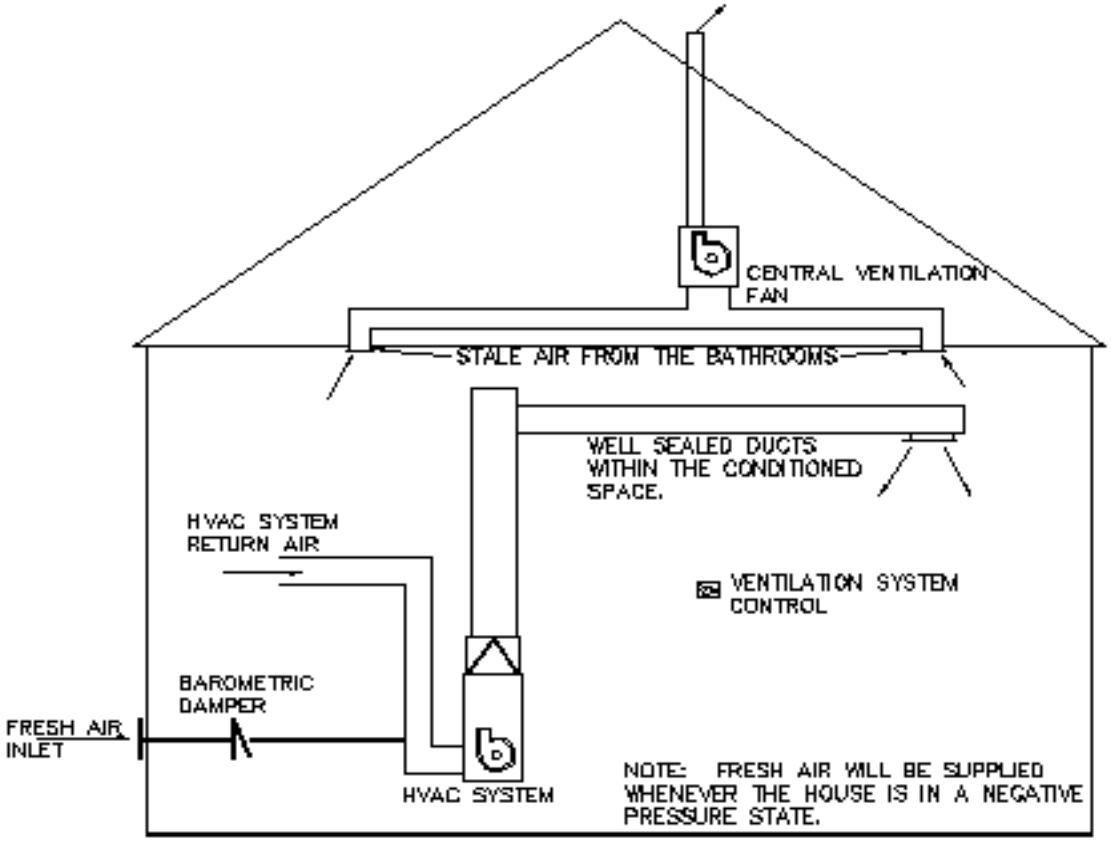
10-8 Dryer Vents. A 4-inch diameter dryer vent shall discharge to the exterior, and provide connection to occupant-owned dryer (one dryer per vent). The vents shall be rigid aluminum with exterior wall cap and back-draft damper. Vent pipes shall be a maximum horizontal run of 6 ft.. Dryer vents shall not exhaust near the air conditioning condensing unit, entry doors, patio, or garages. Dryer vents shall not run through non-accessible spaces or garages. A clean – out is required in accordance with ETL 1110-3-483.

10-9 Not Used.

10-10 Piping Requirements. Air conditioner condensate drains, refrigerant suction, and exterior refrigerant liquid lines shall be insulated with 1 inch (minimum) thick cellular glass or unicellular foam pipe insulation. (See subparagraph 10.f. for pipe insulation requirements in humid areas.) Exterior refrigerant line insulation shall be encased in either an aluminum or PVC jacket to prevent damage. Condensate lines shall be one size larger than the drain pan connection, be properly trapped, and not directly connected to a sanitary sewer system (air gap fitting required).

10-11 Ceiling Fans. Provision of ceiling fans is encouraged as a means of increasing occupant comfort, and as an aid to improve the performance of heating and cooling systems. Ceiling fans with lights may be substituted for ceiling fixture requirements in bedrooms and in the dining room. Ceiling fans will be low profile 42-52 inch, four-blade type. Motors shall be three speed reversible~~, with air volume range between 1300 and 7000 CFM and speeds between 75 and 225 rpm. Maximum power consumption shall be 80 Watts and 0.7 amps~~. (AM#3) Manufacturer's 20 year warranty is required.

10-12 Active Ventilation Engineered IAQ Enhancement. The bathroom exhausts, within each unit, shall all be ducted together to a common exhaust plenum equipped with a single long-life, low cfm, fan. This is a separate system from the standard exhaust system required in paragraph 15.1. The fan shall be sized to provide the required exhaust rate in each bathroom space when operated. Control for this fan shall be accomplished from a wall mounted pressure sensor, located in the mechanical room next to the control switch. The OFF position of the pressure sensor shall illuminate a “RED” LED to indicate the off condition of the ventilation system. The supply ventilation portion of the system shall consist of a small duct providing a connection for fresh (outdoor air) air to the furnace return duct. This duct shall contain a barometrically-controlled vent which shall admit outdoor air to the unit whenever the housing unit is experiencing a negative pressure. ASHRAE 62-2001, “Ventilation for Acceptable Indoor Air Quality” recommends ventilation air supply rate at a minimum of 0.35 air changes per hour (ACH) but not less than 15 cfm per person. This is supplied by either natural infiltration or a combination of natural infiltration plus active ventilation. The fresh air supply duct shall be sized to provide no more than this minimum 0.35 Air Changes per hour maximum ventilation rate (but in no case shall the ventilation air introduced into the unit from the combination of natural infiltration and active ventilation be less than recommended by ASHRAE 62 with consideration for two (2) occupants per bedroom). This system is a recommended “Energy Star Homes” approach for improving indoor air quality in residential construction. The Active Ventilation Engineered IAQ Enhancement described in this paragraph is considered to be a minimum level compliance item (See Diagram below.) in weather regions 5 through 11. In weather regions 1-4 extreme cold conditions and energy efficiency considerations may require the use of alternate approaches, some including heat recovery ventilators (HRV). Contractors are encouraged to present and propose other systems/methods which are enhancements/improvements to the system described and can ensure adequate fresh ventilation air (0.35 AC/Hr Max) is provided to the interior spaces of the housing units. Contractor are encouraged to review “Energy Star” materials and information available to them through the EPA and/or by visiting the Energy Star Web page. See for example, http://yosemite.epa.gov/appd/eshomes/eshaware.nsf/attachments/lib/$file/BalancedVentSys.pdf and http://yosemite.epa.gov/appd/eshomes/eshaware.nsf/attachments/lib/$file/SupplyVent.pdf.



ACTIVE VENTILATION SYSTEM SCHEMATIC

10-13 Testing, Adjusting, and Balancing. Adjusting and balancing of each housing unit shall be the Contractor's responsibility. Following adjusting and balancing, testing of air and water systems shall be performed on 10 percent of the project buildings (not to exceed 10 buildings), which have been randomly selected by the Contracting Officer. If buildings are to be turned over in phases, testing shall be performed on 10 percent of the buildings completed in each phase (not to exceed 10 buildings per phase). No additional testing will be required if at least 90 percent of the tested buildings pass the test requirements. If less than 90 percent of the tested buildings pass the test, an additional 10 percent of the project buildings (not to exceed 10 buildings) shall be tested. This process shall continue until 90 percent of the total number of tested buildings pass. The contractor shall correct all housing units not found in compliance, and shall be responsible for all labor and materials required for this effort. AABC MN-1, NEBB-01, SMACNA-07 or ASHRAE 111 shall be used as the standard for providing testing of air and water systems. The selected standard shall be used throughout the project. Instrumentation accuracy shall be in accordance with the standard selected. Testing shall be accomplished by a firm certified for testing by the Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB). Prior to testing, adjusting, and balancing, the Contractor shall verify that the systems have been installed and are operating as specified. Where specific systems require special or additional procedures for testing, such procedures shall be in accordance with the standard selected. Approved detail drawings and all other data required for each system and/or component to be tested shall be made available at the job site during the entire testing effort. Testing shall not commence until approved by the Contracting Officer. The facility shall be essentially complete with final ceiling, walls, windows, doors, and partitions in place. Doors and windows surrounding each area to be balanced shall be closed during testing and balancing

operations. Air systems, hydronic systems, and exhaust fans shall be complete and operable. All data, including deficiencies encountered and corrective action taken, shall be recorded. Following final acceptance of certified reports by the Contracting Officer, the setting of all HVAC adjustment devices shall be permanently marked by the Contractor's balancing engineer so that adjustment can be restored if disturbed at any time.

10-14 Duct Tightness Testing Requirements. The installation of the supply and return ductwork within the units is an item of prime concern with respect to the energy efficient operation of the housing unit as a whole. With that consideration in mind, for heating and air conditioning designs which include ductwork outside of the conditioned envelope, the contractor will be required to test the proto-type units and all units which are blower door tested for tightness (see paragraph 7.c.(2)) to ascertain the leakage levels from the ductwork in accordance with the following requirements. For system designs which place all the ductwork within the conditioned envelope of the structure or systems which utilize evaporative cooling, no ductwork testing will be required.

10-14.1 Duct tightness testing shall ensure that the leakage rate from ductwork (where the ductwork system is not entirely within the conditioned envelop) shall not exceed 0.03 cfm/ft ^{2}. If the units tested fail to meet this requirement, the ductwork installation shall be examined, corrections made, and the test redone until the installation passes this requirement. No ductwork systems may be installed in other units until the proto-type units ductwork systems have been validated. Several methods to accomplish this testing are acceptable

10-14.1.1 Testing may be done in accordance with ASTM Standard E 1554-94, “Determining External Air Leakage of Air Distribution Systems by Fan Pressurization”. This method describes the process and methodology required to accomplish basically a ‘blower door subtraction’ method of duct tightness testing.

10-14.1.2 Testing may also be accomplished utilizing “Duct Blaster” methodologies and pressurizing the ductwork to 0.1 inch of water.

10-14.2 The contractor is advised that the EPA may test, or hire a consultant to test randomly selected housing units constructed in this project. These tests will be completed without cost to the contractor, however, the contractor will be required to coordinate access to the selected unit. If accomplished, this testing is not expected to interfere or delay the construction contractor in any manner.

10-15 Bathroom Exhaust System. Each bathroom shall have a single exhaust system vented and equipped with a single long-life low cfm, single speed fan. The fan shall be sized to provide the required exhaust rate in each bathroom space when in operation. Control for this fan shall be a wall mounted switch, located in each bathroom adjacent to the light switch.

End of 01001-10.

ATTACHMENT 3

FORMAT FOR REQUIRED AREA CALCULATIONS

ACCOMPANYING AMENDMENT NO. 0003 TO SOLICITATION NO. W9126G-04-R-0042

ATTACHMENT 3

FORMAT FOR REQUIRED AREA CALCULATIONS

OFFEROR'S IDENTIFICATION NUMBER: _____

HOUSING UNIT TYPE:_____

1. NET AREA CALCULATIONS: See Tables 1-1, HOUSING UNITS and 5-3, MINIMUM AREAS AND DIMENSIONS – INTERIOR SPACES in the Statement of Work for required areas.

a. Gross Area: _____ sq ft (As defined by the AIA)

b. Exterior Wall Thickness: _____ inches

c. Interior Area: _____ sq ft
(Area within the inside finishes of exterior or party walls, excluding carport or garage.)

d. Complete the Spreadsheet below – length/width in inches and area in sq ft.

Deduct	Space	Length		Width		Area	
		RFP Min	Proposed	RFP Min	Proposed	Deduct	Non-Deduct
N	Living Room	38211		38211			
N	Dining Room (3 Br)	31215		31215			
N	Dining Room (4Br)	34445		34445			
N	Dining Room (GO)	39288		39288			
N	Family Room	31215		31215			
N	Kitchen	26372		26372			
N	Eat-In Kitchen	27986		27986			
N	Refrigerator/Freezer	9688		6458			
N	W/D	19375		9688			
N	Bedroom #1	38211		38211			
N	Bedroom #2	32292		32292			
N	Bedroom #3	32292		32292			
N	Bedroom #4	31215		31215			
N	One-half Bath	-		9688			
N	Full Bath #1	-		16146			
N	Full Bath #2	-		16146			
N	Vestibule	10764		12917			
N	Hallway	-		10764			
Y	Utility Room	-		-			
Y	Interior Bulk Storage	-		-			
Y	Mechanical Room	-		-			
Y	Accessibility Increases	-		-			

ACCOMPANYING AMENDMENT NO. 0003 TO SOLICITATION NO. W9126G-04-R-0042

Deduct	Space	Length		Width		Area	
		RFP Min	Proposed	RFP Min	Proposed	Deduct	Non-Deduct
N	*Proposed Space*	-		-			
N	*Proposed Space*	-		-			
TOTAL DEDUCTABLE AREAS							

Notes on Completing Table:

~~1.~~ **(AMEND 3)** ~~Room dimensions are exclusive of circulation. Circulation paths along one side of a room are permitted by add 1000 ft in to the minimum dimension. Note applies to Living, Dining and Family Rooms only.~~

2. Minimum dimensions are taken from face of cabinets to walls. This note applies to kitchens and eat-in kitchens.
3. Minimum dimensions shown for washer/dryer are for a W/D closet only. This area may be provided in a utility room. When so provided, area and dimensions are exclusive of circulation.
4. When the washer/dryer is included in a utility room, the W/D line shall be completed as N/A.
5. For hallways and stairs, clear width is measured between railings.
6. Accessibility increases must conform to UFAS.

e. Net Area Determination

Solicitation Requirements		Proposal	
Minimum Net Allowable Area		Interior Area from 1.c above	
Basic Net Area		Deductable Area from 1.d above	
Maximum Allowable Net Area		Interior Area less Deductable Area = Proposed Net Area	
These values shall be taken from Table 1-1 in the Statement of Work			

Note: All areas are to be shown in sq ft

2. FORMAT FOR KITCHEN CABINET SIZE VALIDATION: See Table 5-5 – Kitchen Cabinet, Counter, & Pantry Area in the Statement of Work.

Element	Required Area (sq ft)	Proposed Area (sq ft)	Percent of Required Area
Wall Cabinets			
Base Cabinets			
Drawer Area			
Counter Area (Exclusive of area occupied by sink and range.)			

3. **FORMAT FOR CLOSET SIZE VALIDATION:** See Table 5-6 – Minimum Closet widths in the Statement of Work.

Element	Required Area (sq ft)	Proposed Area (sq ft)	Percent of Required Area
Coat/Entry Hall			
Master Bedroom #1			
Bedroom #2			
Bedroom #3			
Bedroom #4			
Bedroom #5			
Broom Closet			
Linen Closet			
Other			

4. **FORMAT FOR BULK STORAGE SIZE VALIDATION.** See Tables 5-4 and 5-7 – Minimum interior, exterior, & combined bulk storage in the Statement of Work.

Element	Required Area (sq ft)	Proposed Area (sq ft)	Percent of Required Area
Interior			
Exterior			

Totals			

5. FORMAT FOR PATIO AND BALCONY SIZE VALIDATION: See Table 5-4 – Minimum Areas and Dimensions – Exterior Spaces in the Statement of Work.

Spaces	Solicitation Requirements		Proposal	
	Area (sq ft)	Dimension (ft-in)	Area	Dimension
Balconies	72	70		
Patio – 2 Br	121	94		
Patio – 3 Br	146	118		
Patio – 4 Br	183	118		
Patio – 5 Br	220	145		

ACCOMPANYING AMENDMENT NO. 0003 TO SOLICITATION NO. W9126G-04-R-0042

ATTACHMENT 8

A Water Conservation Guide for Commercial, Institutional and Industrial Users

A Water Conservation Guide for Commercial, Institutional and Industrial Users

A Water Conservation Guide for Commercial, Institutional and Industrial Users

New Mexico Office of the State Engineer

July 1999

Prepared for the New Mexico Office of the State Engineer
by Schultz Communications, Albuquerque, New Mexico.
Financial assistance provided by the U.S. Bureau of Reclamation.

1-800-WATER-NM

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Section 1:
Introduction

SAVING WATER IS GOOD FOR BUSINESS

The importance of water to the State of New Mexico cannot be overstated. The quality of life for New Mexico's population and the future growth of the state depends on water.

Although rainfall varies throughout the state, New Mexico averages less than 13 inches of precipitation per year. Because of our arid climate, water is a precious and limited resource. Therefore, water conservation is every New Mexican's business.

This manual was developed to help commercial, institutional, and industrial water users conserve New Mexico's most precious natural resource. Therefore, this manual includes useful data that can be used by decision makers to develop comprehensive conservation plans, including:

— The elements required to implement a water conservation program
— Areas where major water savings are most likely to be realized
— Water conservation guidelines for specific water uses
— Case studies of businesses and institutions that have successfully enacted water conservation programs

While ensuring the wise use of the state's water resources is a smart idea for New Mexico, it is also smart for businesses and institutions concerned with the "bottom line." Efficient water management can reduce operating costs for water and energy without sacrificing production quality. In many cases the payback period for water conservation improvements is economicaly viable—ranging from one to five years.

Furthermore, site managers who have a thorough knowledge of their plant's water use will be better able to reduce the impact of any potential mandatory water regulations necessitated by drought or other water shortages. Perhaps best of all, a well-planned and efficiently implemented program of water conservation on the part of the commercial, institutional and industrial sector will help to extend community water supplies—and help to make future growth possible.

What Is Water Conservation?

Water conservation is defined as any action that reduces the amount of water withdrawn from water supply sources, reduces consumptive use, reduces the loss or waste of water, improves the efficiency of water use, increases recycling and reuse of water, or prevents the pollution of water (New Mexico Office of the State Engineer, 1997).

Conversely, water waste is the excessive use of potable water that is unproductive or does not reasonably sustain economic benefits or life forms, particularly where there is a shortage of potable water.

Drought combined with population growth places a burden on once-adequate water supplies. That is why water conservation is an important consideration as New Mexico begins a new millennium.

WHERE NEW MEXICO'S WATER COMES FROM AND WHERE IT GOES

Who Can Benefit From This Manual?

- government facilities, including military bases
- schools, colleges, and other institutions
- hospitals and medical offices
- hotels and restaurants
- office buildings and shopping centers
- service businesses
- manufacturers

In 1995, water withdrawals from surface and ground water sources in New Mexico totaled 4,449,167 acre-feet. Surface water accounted for 2,542,562 acre-feet or 57.15% of the total, while ground water accounted for 1,906,605 acre-feet or 42.85%. Perhaps most importantly, 62.09% of the water withdrawal (or 2,762,497 acre-feet) was depleted (i.e., consumptively used). Surface water supplies are already fully appropriated, and, in several areas of the state, ground water is being depleted faster than it can be replenished.

Facility managers have a tremendous responsibility to conserve our most precious resource. While commercial, institutional, and industrial water use (excluding irrigated agriculture) accounts for approximately 6% of total statewide water use, the total used by this sector amounts to an estimated 266,950 acre-feet or 86.98 billion gallons of water annually. Truly, every gallon of water saved is important.

Furthermore, New Mexico's population continues to increase. From 1990 to 1995, the state's population increased 10.49% from 1,526,318 to 1,686,477. Approximately 74% of the state's population lives in urban communities where demand for water is highest. As a result of this growth, communities are struggling to keep up with the demand for water and sewer services.

What Is Water Used For?

Water is used by commercial, institutional, and industrial customers for five primary purposes:

— indoor domestic use (restrooms, kitchens, and laundries)
— cooling and heating
— landscape irrigation
— processing of materials
— as an ingredient

While water use varies widely by industry type and by individual facility, virtually all sites can save water by re-evaluating the manner in which water is used.

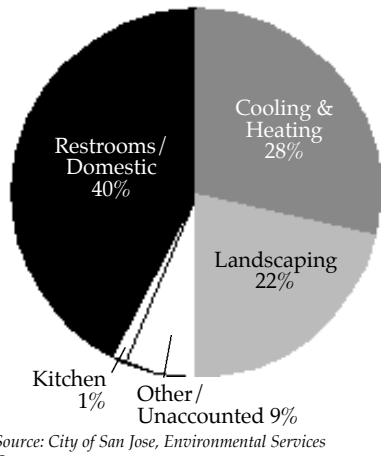
TYPICAL WATER USE BREAKDOWN

Here is an overview of some key industries and the areas in which they use water.

Office Buildings

Office buildings, service businesses, and other commercial establishments typically use water for these purposes: restrooms and other domestic uses, cooling and heating, and landscaping. Some office complexes and industrial parks also have restaurant or cafeteria facilities onsite, which may be leased to a foodservice company or may be operated by the corporate tenant or building owner.

Figure 1-1
Water Usage at Office Buildings



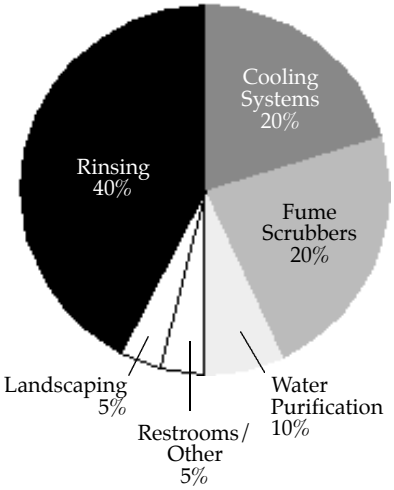
Source: City of San Jose, Environmental Services Department

Computer and Electronics Manufacturers

Rinsing in the printed circuit board and electroplating industry is a necessary process, but it consumes large quantities of water. At semiconductor manufacturing plants, the largest quantity of water use occurs in the rinsing and cleaning of silicon wafers. Because the products are extremely sensitive to even microscopic contaminants, water purity is vitally important.

The chart below shows a typical breakdown of water use in the computer and electronics industry. Many water conservation opportunities exist within this business category which will be discussed at length in later sections of this manual.

Figure 1-2
Water Usage at Computer/Electronics Manufacturers



Source: City of San Jose, Environmental Services Department

Food Processors

Food processing companies typically use water for washing and sanitation, cooling and heating, processing food products and miscellaneous other functions. Typically, the opportunities for water conservation include:

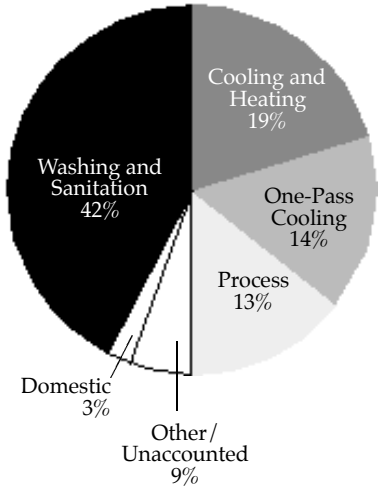
— Reusing water in another process (i.e., using rinse water in cooling towers)

— Modifying processes to consume less water

— Recycling water within a specific process (where health regulations allow)

— Modifying cooling towers to recycle water

Figure 1-3
Water Usage at Food Processors

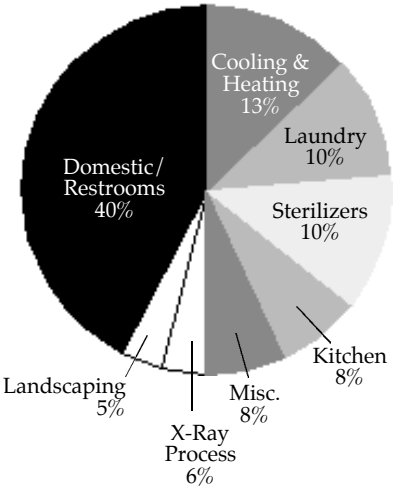


Source: Denver Water

Hospitals

Studies have shown that domestic uses (sinks, toilets, and showers) account for the largest percentage of water used in hospitals. Therefore, water-saving measures, such as ultra-low-flow toilets and low-flow showerheads, can have a significant impact on water use. Cooling and heating functions also provide a significant possibility for water savings, as do laundry and sterilization functions.

Figure 1-4
Water Usage at Hospitals

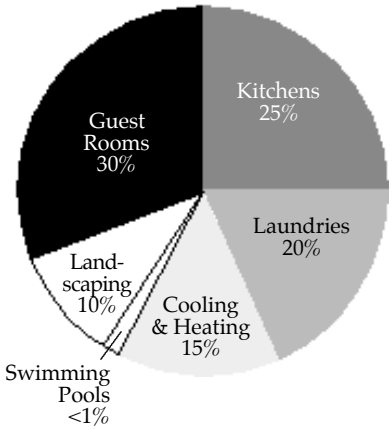


Source: City of San Jose, Environmental Services Department

Hotels and Motels

Hospitality industry businesses, primarily hotels and motels, use water for a variety of functions including laundry, preparation of food, cooling and heating, and landscaping. Typically, the largest percentage of water use occurs in guest rooms. Therefore, many of the water conservation approaches that have been successfully used to reduce water among residential customers (such as installation of ultra-low-flush toilets, low-flow showerheads, and faucet aerators) are recommended for hotels and motels.

Figure 1-5
Water Usage at Hotels and Motels

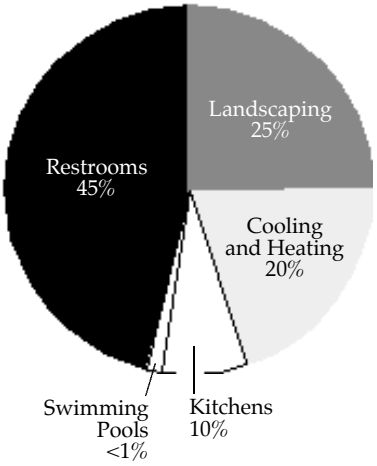


Source: City of San Jose, Environmental Services Department

Schools

School and educational facilities typically use water in these major areas: restrooms, landscaping, cooling and heating, and kitchens/cafeterias. Plumbing fixture standards for toilets and sink faucets should be followed, and cost/payback periods for installing ultra-low flow toilets and low-flow faucet aerators (or retrofitting existing plumbing equipment) should be among the first water conservation options considered.

Figure 1-6
Water Usage at Schools



Source: City of San Jose, Environmental Services Department

EIGHT KEYS TO SUCCESSFUL WATER MANAGEMENT

1. **Water management plans must be part of an integrated approach that examines how changes in water use will impact all other areas of operation.**

2. **Water conservation involves two distinct areas: technical and human.** The technical side includes collecting data from water audits and installing water-efficient fixtures and procedures. The human side involves changing behaviors and expectations about water usage and "the way things should be done." Both areas must be addressed for a water conservation program to succeed.

3. **A water conservation plan depends upon accurate data.** Before water-saving measures are implemented, a thorough water audit should be conducted to determine where water is being used. Then, water use can be monitored to track conservation progress.

4. **A successful water conservation plan follows a logical sequence of events.** Implementation should be conducted in phases, starting with the most obvious and lowest-cost options.

5. **An effective plan examines not just how much water is being used, but how it is used and by whom.** When analyzing a water audit, ask the next question: "Can this process be done as well or better using less water?"

6. **The quality of water needed should be matched with the application.** Many commercial, institutional, and industrial applications do not require the use of potable water. Whenever possible, substitute recycled water used in one process for use in another. (For example, spent rinse water can often be reused in a cooling tower.)

7. **The true cost of water must be considered when conducting a cost analysis.** The true cost of water is the amount on the water bill PLUS the expense to heat, cool, treat, pump, and dispose of/discharge the water.

8. **Life-cycle costing is the key to evaluating water conservation options.** Don't just calculate the initial investment. Many conservation retrofits that appear to be prohibitively expensive are actually very cost-effective when amortized over the life of the equipment.

Common Water Units

1 cubic foot (cf) = 7.48 gallons

1 ccf (commonly used by water utilities as "1 unit") = 748 gallons

1 acre-foot = 325,851 gallons

1 million gallons per day = 3.07 acre-feet per day

Section 2:
How to Create a Successful Water Conservation Program

ESTABLISH SUPPORT AND SECURE RESOURCES

Water conservation is a cost-effective component of efficient site operation for virtually all commercial, institutional, and industrial facilities. Conserving water can result in additional resource and cost savings in areas that include wastewater treatment, energy use, and chemical consumption.

However, a comprehensive water conservation program cannot be established overnight. Careful planning and systematic implementation are needed to ensure success.

This section of the manual provides a step-by-step guide to developing a successful water conservation program for virtually any type of facility.

Voluntarily reducing water use today—by installing low-water-use xeriscapes—may help mitigate the effects of tomorrow's drought restrictions.

Top Management Support
The full support of top management—both ideologically and financially—is essential to the success of any water conservation program. Although water conservation programs are a proven way to save money and resources in the long term, your program may require an initial investment. In addition, water conservation measures can also impact ongoing facility operations. Without management support and the necessary resources, a comprehensive water conservation plan is virtually impossible.

The primary reasons that top management should support a strategic, comprehensive water conservation program include:

1. Cost Savings. Water-conserving technologies are cost-effective. Investing in a long-term water conservation strategy can significantly reduce water costs. In addition, other operating costs can also be reduced, including charges for:
— water heating
— water softening
— wastewater disposal
— chemical treatment
— reverse osmosis filtration
— disposal of aqueous toxic waste

The payback period (the time it takes for water savings to pay for the up-front costs of renovations and improvements) can be as short as a year or less.

2. Production Efficiency. Using water more efficiently may make additional water available for increased production without necessitating the purchase of additional water.

3. Public Relations Benefits. Water-use issues are important throughout New Mexico, so the news media report positive stories about water conservation. A successful water conservation program can generate positive media coverage and an enhanced public image for your business or institution. Conversely, water waste can generate negative publicity for your organization. As water supplies increasingly become viewed as a "public" resource, it will be even more important to be viewed as a responsible steward of the water supply.

4. Drought Allowances. Droughts are an inevitable part of New Mexico's weather pattern. However, your facility may feel little drought impact if you have already made water conservation a regular daily practice. Some U.S. water utilities have enacted mandatory drought reductions that allow firms which demonstrate ongoing water conservation to maintain their regular water use levels.

5. Mandatory Compliance. Throughout New Mexico, water utilities are examining water used by the commercial-institutional-industrial sector in an effort to promote conservation. In some communities, such water conservation is voluntary; in others, water conservation is either a requirement or it is "economically encouraged" by placing water surcharges on high-volume users. If current trends continue, complying with water conservation regulations will be mandatory for a majority of commercial establishments.

ACTION ITEMS FOR MANAGEMENT

Once top management has committed its support to a water conservation program, the following actions should be taken to turn that commitment into a tangible plan:

1. Establish the major goals and priorities of the water conservation program. These broad-based goals will set the tone for the specific water conservation measures which will later be identified and enacted.

2. Appoint a Water Conservation Manager who is empowered to enact a comprehensive water management plan. (See section below.)

3. Issue an organization-wide directive announcing the appointment of the Water Conservation Manager. A strong message of support for the facility's comprehensive water conservation program should be included in this announcement.

4. Provide funding for the program. Initial funding will be needed to launch the program, and continued funding will be required to implement water-saving infrastructure and process changes.

5. Emphasize the importance of the water conservation program to all employees. (See the section entitled "Getting Employees to Participate.")

6. Recognize and publicize achievements in conservation, both large and small. Ongoing communication will reinforce management's continued support for the water conservation program.

Figure 2-1
Before Conservation

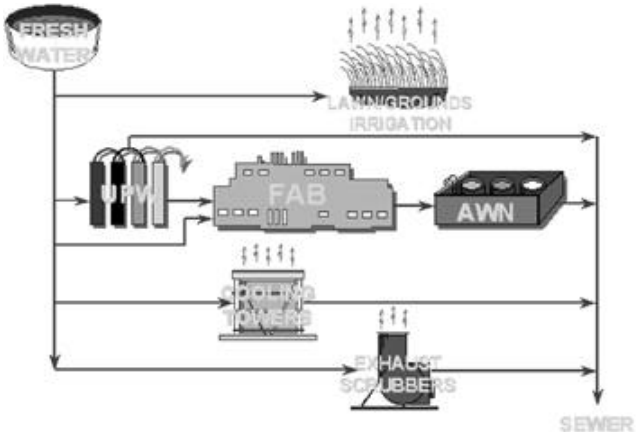
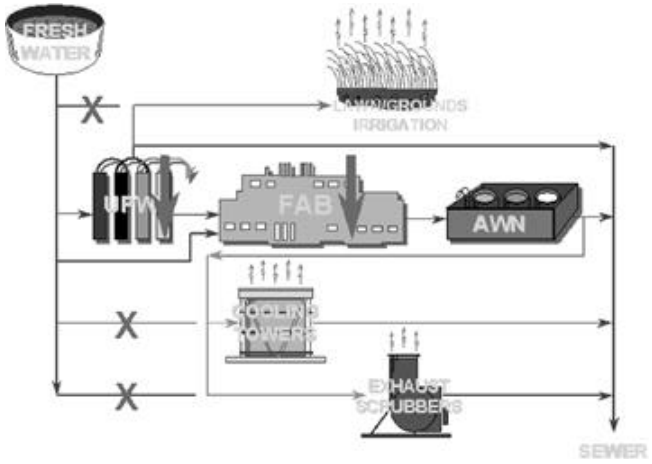


Figure 2-2
After Conservation



Water conservation measures enacted at Intel's plant in Rio Rancho have dramatically changed the way water flows through the facility.

RESPONSIBILITIES OF THE WATER CONSERVATION MANAGER

The Water Conservation Manager is responsible for transforming a commitment to water conservation into a workable plan designed to systematically achieve an organization's water reduction goals. The Water Conservation Manager, as empowered by top management, should have the resources available to create and implement specific water conservation plans and measures.

The Water Conservation Manager should:

1. Research institutional and regulatory considerations and constraints that will have an impact on water use decisions.

2. Review and evaluate the organization's existing or previous water conservation programs. Rate previous conservation efforts and determine their overall effectiveness. Note areas that were successful and areas that were not effective.

3. Establish a budget for the water conservation program. Secure the necessary funding. (Seek outside funding, if needed.)

4. Schedule onsite water audits of all water-using equipment and processes. Oversee the auditing process, both initially and during follow-up and routine inspections. (See "Conduct a Water Audit" section for more information.)

5. Create the water conservation action plan. This plan should include establishing the goals of the program as well as the details for implementing specific water conservation measures.

6. Establish the process by which the water conservation plan will be documented and evaluated.

7. Establish and coordinate an employee communications program (in conjunction with the organization's communications staff, if any). To realize maximum effectiveness, employees should be informed about the program and its goals. Employees should also be told how they can participate in the organization's conservation efforts.

8. Implement the water conservation program. Install water conservation equipment and begin water conservation measures.

9. Evaluate the water conservation program on a regular basis. Make any needed modifications to improve water reduction efforts.

10. Report water conservation progress to top management. Fine-tune the plan if necessary to make additional water-use reductions.

SETTING SPECIFIC WATER CONSERVATION GOALS

The water reduction goals should be specific, measurable, and achievable. Goals should be stated in terms of gallons saved and percentage of water saved. Goals should also include the time frame for achievement, the area of the facility where the water savings will be realized, and by what means the savings will be achieved. Support each specific action item with a cost/benefit analysis where applicable.

An example of a specific goal:

Reduce water used to irrigate the company's landscaping by 50% by August 1. To achieve this goal, two-thirds of turfgrass area will be converted to low-water-use xeriscape. The irrigation system will be modified so that turfgrass and xeriscapes will be watered using separate irrigation zones to achieve the maximum water savings.

Cost: $6,000

Annual water savings: 350,000 gallons

Payback period (water savings plus landscape maintenance savings): 2 years

Three Areas of Water Savings

Water conservation falls into three general areas:

1. Reducing losses (i.e. fixing leaky faucets and pipes)

2. Reducing use (for example, installing ultra-low-flush toilets and automatic shut-off faucets or eliminating once-through cooling)

3. Reusing water that is currently being discarded (such as using treated rinse water to irrigate landscaping)

CONDUCT A WATER AUDIT

Unless you know how much water your facility is now using, there's no way to know how much water—and money—you can save.

In order for a water conservation program to succeed, it is imperative that a recordkeeping system be established to monitor operation and maintenance costs, revenues, and water use.

The first step in the quantification of water use is a water audit—a detailed examination of where and how much water enters the system, and where and how much water leaves the system. Water system audits facilitate the assessment of current water uses, provide data needed to reduce water and revenue losses, and forecast future demand. With this information, a facilities manager can target system improvements where conservation efforts are most needed.

A major objective of a water system audit is estimating and reducing unaccounted-for water use. Unaccounted-for water includes losses through leaks, inoperative system controls (such as blowoff valves and altitude-control valves), and water used from unmetered sources such as wells.

The following Water Audit Checklist provides a step-by-step approach to conducting an accurate and thorough examination of current water usage.

(See next page)

Figure 2-3

Potential Water Savings from On-site Water Audits

Type of Business	Number of Site Audits	Average
Car Wash	12	27%
Church–nonprofit	19	31%
Communications & Research	10	18%
Corrections	2	14%
Eating & Drinking	102	27%
Education	168	20%
Healthcare	90	25%
Hospitality*	222	22%
Hotels & Accommodations	120	17%
Landscape Irrigation	6	26%
Laundries	22	15%
Meeting/Recreation	20	27%
Military	1	9%
Offices	19	28%
Sales	56	27%
Services	58	30%
Transportation & Fuels	24	31%
Vehicle Dealers & Services	12	17%
Total Sites	741	

**Hospitality includes "eating and drinking" and "hotels and accommodations"*

Data from the Metropolitan Water District of Southern California, the City of Tucson, and the Massachusetts Water Resources Authority were tabulated to determine the average potential savings available by implementing cost-effective conservation measures. ("Cost-effective" was defined as measures that "would have a simple payback [period] usually acceptable to the type of business where the audit was conducted.")

Source: "Study of Potential Water Efficiency Improvements in Commercial Businesses" (April 1997). U.S. Environmental Protection Agency and the State of California Department of Water Resources.

WATER AUDIT CHECKLIST

STEP 1: Preparation and Information Gathering

Before beginning the actual water audit, collect pertinent information from company and utility records. Identify the people who are familiar with daily operations—particularly operations and maintenance supervisors and staff. Collect the following information:

— building and location information, including physical size of the facilities, floor plans, plumbing schematics and drawings
— operating schedules, including total number of employees and number of employees per shift
— location maps identifying each water supply meter that measures incoming (source) water, plus each water meter that records onsite use. (As commonly defined, a "submeter" measures water use for specific processes and individual buildings within a site.)
— inventory of plumbing fixtures
— inventory of all water-using equipment with manufacturers' flow rates
— outdoor water use data, including irrigation systems, watering schedule, and water volume
— utility records (water and sewer) for the past two years
— records that show actual water use during the past two years (including meter and submeter readings, water wells and water tank deliveries)
— any prior water and energy audits
— anticipated water and sewer billing rates for the next two years (from utility)

Use the above water records to determine the amount of water used to provide services or produce products. Graph the results to show monthly water use.

— for service establishments (i.e., restaurants, hotels, hospitals, military bases and schools): get records for meals served, rooms occupied, etc. Using monthly water use data, determine the water used per patient, guest room occupied, meal served or applicable service rendered.
— for manufacturing sites: divide the amount of water used by the quantity of product manufactured to determine the gallons per ton or gallons per unit produced.

NOTE: If your facility or organization has not attempted significant water conservation measures in the past, it may be beneficial to seek experienced outside assistance. Information and professional help may be available from other sites of your own company or organization, outside water and energy consultants, the New Mexico Office of the State Engineer's Water Use and Conservation Bureau, and local water, wastewater and/or energy utilities. Another source of information is the Water Wiser Website at www.waterwiser.org.

WATER AUDIT CHECKLIST (CONT.)

STEP 2: Conduct Facility Survey

After the information in Step 1 has been collected, the next step is a physical survey of the facility.

— Walk through the facility with production people and supervisors to understand how water is used in the various areas and production centers.
— Identify and list all equipment that uses water, including water-using process equipment, cooling towers, boilers, reverse osmosis filters, rinsing tanks, kitchen equipment, faucets, toilets, showerheads, etc.
— Check the water-using equipment against your inventory information. Compare floor plans, plumbing drawings, and schematics with actual conditions. Note discrepancies so an accurate record of equipment can be created.
— Record hours of operation for each piece of water-using process equipment. Whenever possible, verify schedules of use with operating personnel familiar with the building use and equipment.
— Note devices, equipment, and/or plumbing fixtures that use water for more than one operation. (For example, some ice makers use water for making ice and for cooling.)
— Calibrate all existing water meters to ensure accuracy.
— Measure the amount of water used by each water-consuming fixture or piece of equipment. If permanent meters have not been installed, a temporary strap-on flow meter that uses ultrasonic waves to measure water flow can be used. In some cases, a bucket and a stop-watch can be used to measure the flow rate in gallons per minute (gpm).
— Compare your water-use measurements with the manufacturers' listed and/or recommended flow rates. Note any discrepancies.
— Ask for water conservation suggestions from employees who are familiar with each water-use process.
— Measure water quality, too. Knowing the quality of water as it flows through a facility may point out areas where water discharge from one process can be rerouted for use in another process. (For example, reverse osmosis reject water might be suitable for use as initial rinse water.) Water quality considerations include: chemical make-up, pH level, conductivity, total dissolved solids (TDS/ppm), waste content, and temperature.
— Measure exterior water use, especially water used for irrigation. Obtain diagrams of all irrigation systems and inventory all sprinkler heads and water-delivery devices to determine flow rate.
— Determine daily water usage for the major operating and production areas. Add these area totals to get total facility usage. Make sure that your total consumption figures match the total usage figures from your water utility, water well meters, and other water source records.

"Implement high-payback measures now. You don't need a complete audit to know that fixing a leaky toilet is smart water conservation."

—Darell Rogers
Water Conservation Officer
Sandia National Laboratories

WATER AUDIT CHECKLIST (CONT.)

STEP 3: Prepare An Audit Report

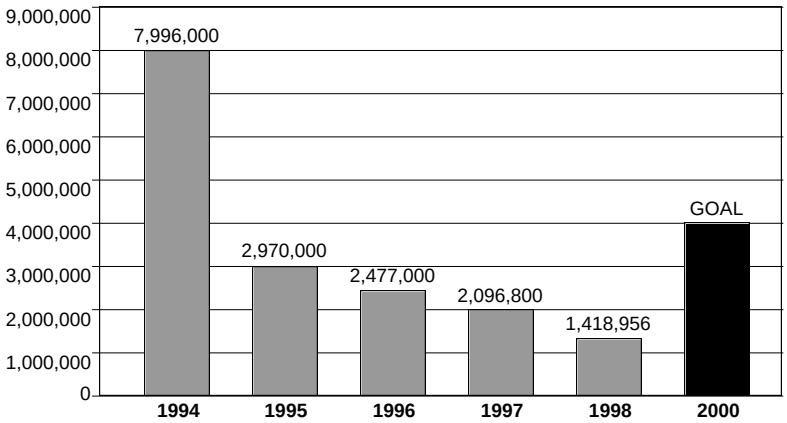
After the completion of the physical inspection of the facility, in which each water-use area was carefully examined and water-use data was recorded, it is time to collate the data into a final audit report. This report will provide the "baseline" by which your water conservation efforts will be measured.

Your report should include the following:

— an updated set of facility diagrams, blueprints and water flow charts.
— a current list of all water-using equipment with manufacturers' recommended input/output flow rates and the actual flow rates recorded during your water audit.
— a current schedule of operation for all areas and equipment, including shift scheduling, number of employees per shift, production levels, average occupancy rates, etc.
— a month-by-month landscape irrigation watering schedule (landscape irrigation varies dramatically by month and by season)
— a water flow chart that shows the movement of water from the time it enters the facility until it is discharged
— water use figures (total facility, and broken out by operating areas and processes)
— any additional water-use observations revealed by the walk-through audit and analysis
— an evaluation of the total cost of water used by the entire facility (see Step 4)

NOTE: Major discrepancies between your facility's total water consumption figures and the sum of each water-using area may indicate underground leaks in your water delivery system. Further (more detailed) water measurement may be required to pinpoint the leak. Make sure your Plan of Action includes these leak-detection activities.

Figure 2-4
Honeywell Annual Water Use



"We want to send the message to others that water conservation can be done with limited resources and money. We reduced our overall water consumption 82% without spending a lot of time, brainpower or money. We found we really can make a difference."

—Dave Colton
Facility Services Manager
Honeywell

WATER AUDIT CHECKLIST (CONT.)

STEP 4: Determine Total Water Cost

The line item on your utility bill is the most obvious expense associated with water use, but it is far from the total cost of water use. Some water utilities charge a fixed fee or an environmental surcharge in addition to the cost for actual water used. (Water quantity is typically billed in "units" that equal one hundred cubic feet [ccf], which is equal to 748 gallons.)

The cost of water can also vary. Some utilities charge different rates based upon the amount of water used. And water rates may vary seasonally. (Summer rates may be higher than winter rates, because water demand is greater during the summer months.)

In addition to the utility cost, the total cost of water also includes the cost of:

— heating
— cooling
— energy cost of pumping water from wells or to onsite locations
— pretreating, including filtering, purifying, and softening
— chemical treatment, including treating boiler feed and cooling tower water
— predisposal treatment
— disposal of hazardous aqueous substances
— sewer discharge, which can be based on the amount of water discharged, total dissolved solids, and other water-quality considerations

Using the above information, add up the total annual cost for water and water processing. This total will be your current baseline for water cost. Calculate the cost for each unit of water consumed by dividing the total cost by the quantity of water used.

It may also be advantageous to calculate the cost of water used per production unit. To calculate that figure, divide the total cost of water use for a production run by the number of units produced during that run.

NOTE: Be sure to note monthly differences in water costs, if any. Your "per unit" cost of water may be higher in the summer months, which could make water conservation efforts even more cost effective during these months.

PREPARE A PLAN OF ACTION

Now that you know how much water your facility uses—and exactly how much that water costs—you can begin to formulate a plan of action to implement water conservation measures.

As you begin to prepare your conservation plan, determine which equipment and fixtures will produce the most cost-effective water savings while maintaining or improving production quality and water services to employees, occupants, and customers. Keep in mind that your most cost-effective water conservation activities will typically be in areas which use the most "expensive" water (i.e., water that requires the most pre-use treatment, heating or cooling, and predisposal treatment).

Evaluate each possible water conserving measure by using these guidelines:

— potential annual water savings (water costs only)
— potential annual savings from reduced water processing
— implementation costs (annualized)
— ongoing operational costs (if any)
— time required for implementation
— payback period (the time required for the cost of the conservation measure to be paid for by water cost savings)

Also keep in mind that water rates are likely to increase in the future. With increasing water rates, it may be cost effective to implement some water conservation measures now to ensure future savings.

After you've estimated the cost and potential payback for your major water conservation options, you can begin the process of classifying potential actions. You may find it valuable to use the following categories:

1. *Cost Effective and Practical—* Water-saving measures that should be enacted as soon as possible.

2. *Potentially Viable—* Measures that need further evaluation. Additional data may need to be collected during a testing period.

3. *Not Recommended—* Based upon current information, these measures are not currently cost effective. However, they could be implemented as a response to drought conditions or as cost/benefit ratios change.

Where to Look for Water Savings

Most water conservation measures fall into four broad areas:

1. Domestic plumbing fixtures
2. Cooling and heating
3. Landscape irrigation
4. Processing of materials

Your plan of action should examine each of these areas. Review all equipment and water-using devices for possible water-efficiency improvements. In some cases, water-using equipment can be replaced. In other cases, retrofitting existing equipment will be a better solution.

Procedural changes can often result in substantial water savings. For example, some companies have found that discharge water from rinse tanks can be rerouted for use in nearby cooling towers.

NOTE: Your organization's water conservation measures must meet all regulatory and public health requirements. Check with applicable municipal, state, and federal agencies.

Dollars and Sense

Cost-effective water conservation measures pay for themselves in reduced utility and energy bills. Bottom-line savings may be the most obvious way to justify enacting changes that conserve water, but there are additional reasons to make water-wise changes that make sense and provide benefits:

1. *High visibility—* Measures that will communicate your organization's commitment to water conservation in a very "public" way can help your organization's public image.

2. *Ease of implementation—* Water conservation measures that can quickly be enacted, even those with longer payback periods, are a good way to show that your organization is serious about saving New Mexico's most precious natural resource.

3. *Employee/customer goodwill—* Enacting water conservation measures suggested by your employees, customers, or the public is also a good way to generate goodwill and positive employee/public relations.

ACTION PLAN CHECKLIST

An Action Plan should typically contain:

1. A statement of the organization's commitment to water conservation.
2. The organization's water conservation goals, including the time frame for realizing the goals.
3. Alist of the water conserva tion actions that will be taken, prioritized by effectiveness and implementation cost. Include the anticipated implementation dates.
4. Recommendations for additional (future) measures for consideration, including process changes and new water-saving equipment.
5. Funding sources for specific measures that will require capital expenditures. Indicate whether loans or rebates are available from water utilities.
6. Review and evaluation process. Schedule follow-up water audits of specific areas (especially high water-use areas) and report on water conservation results.

Sample Payback Period Calculation

COOLING TOWER IMPROVEMENTS

Specifications:
250 tons of refrigeration capacity, operating 150 days per year. Current efficiency is 3.0 cycles of concentration before water is flushed from system.

Proposed Conservation Action:
Add conductivity controller and pH controller. Treat water with chemicals to increase cycles to 5.0.

Water Consumption (Before Improvements):
22,000 gpd for 150 days/year = 3.3 million gal/year

Water Consumption (After Improvements):
18,000 gpd for 150 days/yr = 2.7 million gal/year

Annual Water Savings:
600,000 gallons/year

Cost Savings:

Water & Sewer	$2,200
Chemicals	$1,900
TOTAL:	$4,100

Capital Cost of Improvements:
$5,500

$$\textit{Payback Period (in years)} = \frac{\text{Capital Cost (\$)}}{\text{Net Annual Savings (\$)}}$$

$$\frac{\$5{,}500}{\$4{,}100} = 1.34 \text{ years}$$

(sample for illustrative purposes)

EMPLOYEE EDUCATION AND PARTICIPATION

Employees can have a major affect on the success (or failure) of a water conservation program. Therefore, it is imperative that they be informed about the program and made an integral part of all water reduction efforts. The following steps can serve as a guideline for effectively informing employees of the program and enlisting their full support and participation on an ongoing basis.

1. Distribute a letter to all employees from the leader of the organization. The letter should announce the conservation program, introduce the Water Conservation Manager, detail specific goals, ask for employee support, and invite feedback.

2. Establish an employee water education program. The education program should communicate information about:

— the importance of and need for water conservation in New Mexico
— the company's water conservation program, including specific goals
— the importance of each individual's contribution to the success of the water conservation goals of the entire organization
— how specific water savings measures by individuals can reduce consumption
— how specific water savings measures by employees working together as a "team" can result in major water use reductions
— new procedures and water conservation equipment

3. Use a wide variety of methods to communicate the ongoing water conservation message. Utilizing many communications media will help to keep the message current, and it will reinforce the importance of the organization's water conservation efforts. Consider using the following communications vehicles:

— company newsletter
— memos
— paycheck stuffers
— email
— posters and signs
— water conservation "progress reports"
— new and/or revised operating guides and manuals that describe changes made to implement water-saving measures

4. Establish a schedule for regular communication with employees about water conservation. Even with the best of intentions, the initial excitement of a new program will begin to fade unless the importance of water conservation is regularly communicated. Make sure that employees are kept abreast of the specific water reduction measures that have been enacted and the water and energy saved by these measures.

5. Get employees involved.

— Establish incentive programs to encourage and reward participation.
(One option: offer employees a percentage of the first year's direct savings from water and energy conservation.)
— Create a "Water Conservation Ideas Box" where employees can submit suggestions on how the organization can save water.
— Promote slogan and poster contests.
— Create friendly "team" competition between shifts, operating areas, divisions, and/or locations.
— Reward employees with a "pizza party" or similar celebration when water goals are met.
— Reward employees who spot leaks and other instances of water waste.

6. Implement effective new ideas submitted by employees. Recognize and reward the contributions made by individual employees, groups, and the organization as a whole.

BEGIN WITH CERTAIN SAVINGS

Now it's time to begin to implement your water conservation plan. The best place to start is with the most obvious ways to save water.

Leak Detection and Repair
Using the information in your water audit, locate and fix leaky faucets, faulty fittings, and broken pipes and hoses. New water pipes and fittings are generally water tight when they are first installed. However, as pipes settle, some joints can become partially opened, which can cause leaks. Leakage tends to increase due to pipe corrosion and deterioration of joint compounds. Faucets can also develop water-wasting leaks from compacted washers and faulty handles.

A systematic program of leak detection and repair can prevent future water waste. On a regular basis, thoroughly check the following areas:

— restrooms and shower facilities (in tank-type toilets, conduct dye tests to locate hidden leaks)
— kitchens, dishwashing facilities and food-preparation areas
— washdown areas and janitor closets
— water fountains
— water lines and water delivery devices
— process plumbing, including tank overflow valves
— landscape irrigation systems

NOTE: Shut off water supply and check meter readings. If the meters continue to advance, you could have underground leaks.

No-Cost Adjustments
Check your water audit for any changes that can be made quickly and at no cost—and make these modifications as soon a possible. Here are a few suggestions:

— Close down restrooms and other potential water-using areas that are not being used.
— Recalibrate machinery and water flows to perform to the manufacturers' original specifications.
— Eliminate water usage if an alternative exists.
(i.e., stop hosing down sidewalks, use a broom instead)
— Decrease frequency of vehicle washing (unless you recycle the water).
— Keep lines of communication open with employees and water users, and implement their suggestions whenever appropriate.

Installing Timers
In areas where water use is periodic, consider installing timers to automatically shut off water flow when water is not required. For example, timers could be installed on process equipment to automatically shut off water flow at the end of a production cycle and/or the end of a work shift.

Use of Cold Water
For many uses, particularly hand washing, thousands of gallons of water can be wasted every year when employees let lavatory water run while waiting for hot water. Where feasible:

— Convert restroom sinks to cold water only.
— Post signs informing users that only cold water is available.

NOTE: This would not be applicable in facilities that are required to provide hot water for health reasons.

Efficient Landscape Watering
Even before you begin a major retrofit or redesign of your irrigation system, you can make sure that it is not wasting water.

— Adjust sprinkler heads to ensure that landscape plants are being watered, not pavement.
— Water during the early morning hours to reduce evaporation.
— Install rain/moisture sensors to turn the irrigation system off when rainfall occurs.
— Manually adjust irrigation timers to eliminate unnecessary watering after rainfall (if system has no rain sensors).
— Use hose nozzles that automatically shut off when not in use.

LOCATE AREAS OF MAJOR WATER SAVINGS

After the most obvious, lowest-cost, and "easiest" water-savings procedures have been implemented, the next logical step is to begin to implement the long-term measures that will result in the greatest water savings. These measures may include replacing outdated equipment, making modifications to existing equipment, establishing more efficient operational procedures, and exploring new procedures that will use significantly less water without negatively impacting production and/or service quality or quantity.

Many of the long-term conservation measures require time, effort, and additional expense to implement. However, after the initial payback period, these measures will result in cost savings every year. As utility rates for water, energy, and wastewater disposal increase, the annual conservation savings also increase.

The following approaches can be applied to water usage at virtually any site. Use these areas of focus, along with your facility's specific water conservation plan, to begin to generate significant long-term water reductions.

Install Meters and Controls

As you discovered during your facility's water audit, the first step in water conservation is knowing how much water is being used—and where. Meters can determine current water use and monitor any subsequent changes in consumption. Other controls and switches can ensure that the water supply is shut off when appropriate.

— Install water meters wherever water use is not currently being measured.
— Install "submeters" to measure water use by subprocesses and specific pieces of equipment.
— Install interlock solenoid valves with power switches or time clocks to shut off water flow when equipment is not in use.
— Install temperature control valves.
— Install limit switches on tanks to eliminate over-filling.

As part of your ongoing water monitoring process, regularly inspect all meters, controls, valves and other devices for leaks and improper settings.

Adjust Metered Flow

Sometimes equipment is operated with higher water flows than necessary. Where input water flow to equipment is higher than manufacturer specifications, reduce water flow to match manufacturer's recommendations.

— Install flow restrictors to ensure a constant, specified flow throughout a range of water pressures.
— Once metered flow has been reduced to manufacturer specifications, carefully experiment with slightly reduced flow rates to further improve water efficiency.

(Record flow rates before and after changes to evaluate the effects of using less water on production quality.)

Reduce Water Pressure

Water pressure higher than that required for specific applications will unnecessarily result in increased water consumption.

— Survey the water pressure at specific points and through specific lines at your site.
— Contact your local water utility for assistance in measuring the water pressure in pounds per square inch (psi) at key delivery and usage points at your facility.

Excessive water pressure will also increase leakage rates. For example, an increase in water pressure from 25 psi to 45 psi can be expected to increase water use (and water lost to leakage) by 30% (AWWA, 1986).

LOCATE AREAS OF MAJOR WATER SAVINGS (CONT.)

Reuse and Recirculate

Whenever possible, use water more than once. High-quality water, not seriously affected by one process, can typically be used in another process to achieve direct and immediate water savings.

— Water used for heat transfer—heating and cooling water that is otherwise unchanged and not chemically altered—can be pumped into holding tanks and used in another process.

— Water used for rinsing can often be reused in applications that do not require high-quality water. For example, spent rinse water can often be reused in other rinsing applications or in cooling towers.

— Water can be reused sequentially. Examine your facility for processes where water can be used in one process, then pumped to another process location for reuse. (Treatment may be required between processes to maintain minimum water quality.)

— "High value" or "high quality" water, such as deionized water, can be treated and reused.

Water that is chemically altered in its use, such as rinsing and cleaning water, may also be reused. In some cases, the initial rinse water is highly contaminated and must be discarded. However, subsequent rinse water that is minimally contaminated can be reused for further rinsing or for other uses.

NOTE: To ensure that all water quality specifications are met, test the quality of all water before it is reused, and treat wastewater (if necessary).

Switch from Potable to Nonpotable

Many water use applications do not require potable (drinking quality) water. When pure water is not required, consider switching to alternate water sources including:

— reclaimed municipal water

— treated process water (onsite)

— treated process water (offsite)

— collected rainwater (particularly for landscape irrigation)

PUBLICIZE YOUR SUCCESS

In addition to saving water, energy and money, there is an additional benefit to conservation: positive public opinion. Because New Mexico is an arid state, water conservation is of ongoing public interest. News media throughout the state routinely cover "good news" stories about companies, institutions, and industrial facilities that take a proactive stand on water conservation.

Internal Communication
Keep your employees informed about your commitment to water conservation, your ongoing conservation program, and your water conservation successes. Reinforce the message that they are helping your organization reach its water conservation goals. Congratulate them for their efforts and ask for their continued support and action. (For more information see the "Employee Education and Participation" section on page 25.)

Intel published a brochure to answer questions about its water use and water conservation efforts in New Mexico.

External Communication
Conducting a public information campaign can help create a positive public image of your facility and organization. Tell the public about your commitment to wise water use!

The following activities can serve as a guide to "spread the word" about your successful water conservation program:

— Invite members of the local news media to a news conference at your site to announce the inauguration of your water conservation program.
— Invite members of the local news media to tour your facility to see first-hand the conservation measures that you've enacted.
— As conservation goals are reached, send news releases to local and trade media. These news releases should detail the specific water conservation measures enacted and the number of gallons (or percentage of water) saved annually.
— Participate in water conservation advisory committees sponsored by local utilities or state and federal agencies.
— Attend workshops and seminars, and share your organization's water conservation strategies and successes.
— Create displays presenting your water conservation results for posting in your lobby and other public reception areas.
— Distribute water conservation materials to local schools and organizations. (Tell the media in advance of any public appearance to be made by an organizational representative.)
— Develop printed brochures and materials for distribution at trade shows and other public forums.
— Serve as a "water conservation mentor" for other organizations or facilities.
— Sponsor water conservation events for the public. Consider hosting a Water Fair at your facility.
— Contact local radio and television talk shows to offer an organization leader or representative as a guest "expert."
— Phone local reporters to keep them abreast of your ongoing successes.

The news media and the public deserve to know about an organization that is a socially responsible member of the community. Your water conservation program is good news, because every gallon of water your organization saves means more water is available to help improve the quality of life in your community— for today's residents and for future generations.

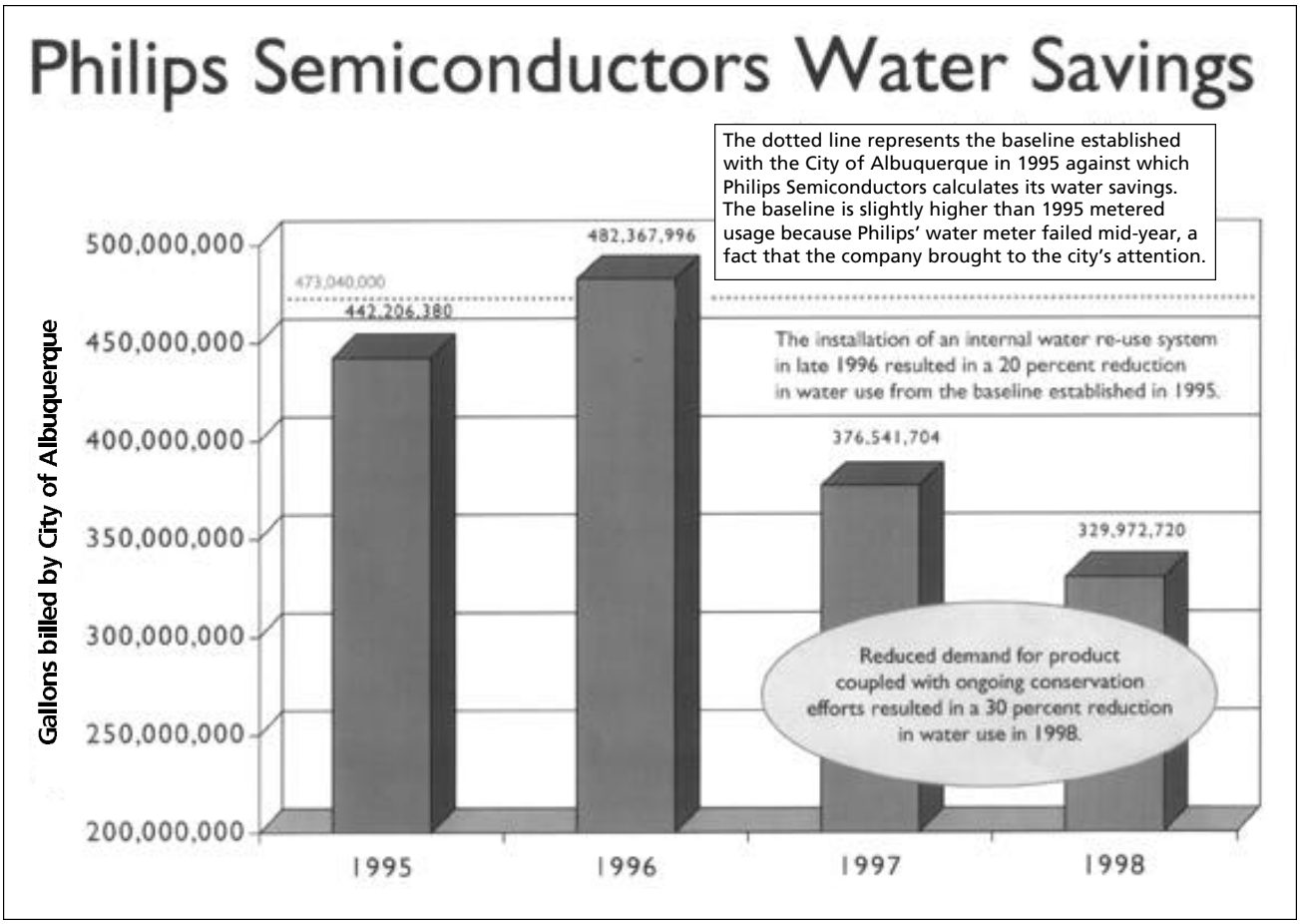


Figure 2-5
Results of the Philips Semiconductors Water Conservation Program

Section 3:
Water Conservation Guidelines for Indoor/Domestic Use

In commercial and institutional settings, indoor/domestic activities can account for the largest amount of water use. In office buildings, for example, estimates for restroom and kitchen water use range from 41% to 80% of total water use (Denver Water; Department of Water Resources, State of California, p. 40). Table 3-1 shows the percentage of water that is typically used in restrooms, kitchens, and laundries at selected commercial and institutional facilities.

Table 3-1

DOMESTIC WATER USE AT VARIOUS FACILITIES

Facility	Restrooms	Kitchens	Laundry
Hotel	30%	25%	20%
Restaurant	15%	60%	N/A
Hospital	40%	8%	10%
School	45%	10%	N/A

Source: City of San Jose

There are three primary approaches to saving water indoors:

1. **hardware solutions**, such as replacing a high-flow fixture with a water-efficient version
2. **operational solutions**, such as finding alternatives to using water for cleaning tasks, instituting a regular leak inspection and repair program, and optimizing the water efficiency of appliances
3. **personnel solutions**, such as educating employees to conserve water and to report leaks.

Clearly, not all solutions will fit every situation. Conservation actions at hospitals and convalescent homes, for instance, may be limited by health concerns. Before implementation, make sure the water conservation measures are consistent with health department regulations.

On the other hand, some water conservation steps are mandated by law. The National Energy Policy Act of 1992 stipulates that toilets and other plumbing fixtures manufactured after January 1, 1994 meet low-water-use standards (see Table 3-2). Your city or municipality may have similar, perhaps even more restrictive, requirements. The City of Santa Fe, for example, requires that low-use fixtures be used in all remodeling and construction. Santa Fe also stipulates that water conservation signs be posted in public restrooms.

Some of the water conservation measures discussed below are inexpensive, yet they can have tremendous potential paybacks. For example, instituting a monthly water audit, conducting weekly leak detection surveys, or serving water only upon request in a restaurant can make significant contributions to water conservation. Also, do not forget that reducing water use often leads to additional cost savings in energy, maintenance, and consumable chemicals. When looking for ways to save money, be sure to ask your city or water utility if it offers rebate programs on plumbing fixtures and/or free audits. (NOTE: Use the worksheet on page 43 to compute the cost savings of proposed indoor/domestic water conservation changes.)

One conservation idea that is often overlooked is the installation of a pressure-reducing valve on the domestic water supply line. High water pressure can waste water and damage plumbing, which is why the Uniform Plumbing Code requires a pressure-reducing valve when the main pressure exceeds 80 pounds per square inch (psi). Reducing pressure further, to 60 psi, will further reduce water use. In fact, most plumbing systems perform adequately at pressures as low as 40 psi. (Arizona Municipal Water Users Association, 1997, p. 39.)

RESTROOMS/SHOWER FACILITIES

Most toilets, urinals, showerheads and faucets in use today were designed with little regard to water conservation. These devices are responsible for much of the domestic water needlessly washed down the drain. As noted previously, Table 3-2 shows the degree to which plumbing fixtures have become more water efficient over the last decade and gives an idea of the considerable water savings that can be achieved in restrooms and showers. Table 3-3 lists the approximate costs of these water efficient fixtures. In some cases, saving water may be as simple and inexpensive as adding a $2.00 aerator to a faucet.

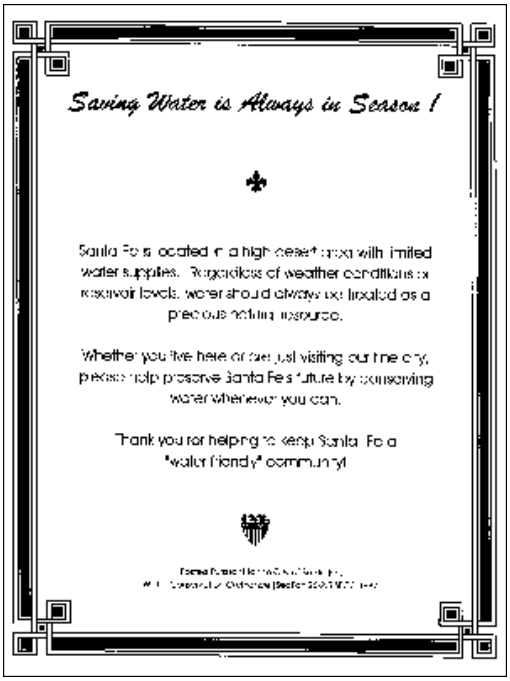
Table 3-2

*FLOW RATE COMPARISONS: CONVENTIONAL FIXTURES VS. FEDERALLY MANDATED STANDARDS FOR NEW FIXTURES IN COMMERCIAL FACILITIES**

(Units are gallons per flush (gpf) or gallons per minute (gpm)

	Federal Standards	Conventional Models
Toilets (all types)	1.6 gpf	3.5 to 7 gpf
Urinals	1.0 gpf	2 to 3 gpf
Lavatory Faucets	2.5 gpm	3 to 5 gpm
Kitchen Faucets	2.5 gpm	3 to 5 gpm
Metering faucets	0.25 gallons per one-time use	n/a
Lavatory and kitchen replacement aerators	2.5 gpm	n/a
Showerheads	2.5 gpm	5 to 7 gpm

** mandated by the National Energy Policy Act of 1992*



The City of Santa Fe's Water Conservation Ordinance requires hotels and motels to post water conservation messages in every guest room.

Table 3-3

APPROXIMATE COSTS OF LOW-FLOW PLUMBING FIXTURES AND RETROFITS

FIXTURE	COST RANGE
Kitchen faucet 2.0, 2.2, 2.5 gpm	$40-$260
Lavatory faucet 2.0, 2.2, 2.5 gpm	$25-$170
Lavatory faucet (metering type)	$120-$210
Showerhead 2.0, 2.2, 2.5 gpm	$15-50
ULF toilet	$80-$600
Urinal flush valve	$100 and up
Urinal fixture	$100-$350
Infrared faucet control (or ultrasonic) and faucet	$300 and up
Infrared toilet/urinal control	$250 and up
Toilet tank displacement device (bag)	$3-$5
Toilet tank dam	$7 for a pair
Toilet insert device	$3-5
Toilet valve replacement device	$15-$20
Toilet early closure device	$5-13
Faucet flow restrictor	$5-7
Faucet aerator 2.0, 2.2, 2.5 gpm	$2-$10

Toilets and Urinals

Americans flush nearly 4.8 billion gallons of water down the toilet each day. In many buildings, toilets are responsible for one-third of the water use (U.S. General Services Administration, p. 3-6), so they make an attractive target for conservation. There are several low-cost retrofits available, and you may find that replacing older toilets with newer models has a reasonable payback period of a few years compared to the 20-year life of the commode (ibid, p. 3-6). If the toilets in your facility were installed before the 1970s, they probably consume between 5 and 7 gallons per flush (gpf). By the 1980s, "water-conserving" 3.5 gpf models were available. As of January 1, 1994, the federally mandated standard became ultra-low-flush (ULF) 1.6 gpf. The first ultra-low-flow toilets experienced several flushing-related problems; newer models address these difficulties by having steeper sides and an exposed trapway, which increases the velocity of the flush and eliminates the need for double flushing.

Two kinds of toilets are common: gravity tank and flushometer. In gravity-fed tank toilets (the type usually found in homes), the flow of water down from the tank creates a siphon action which carries waste from the bowl to the soil pipe. In a flushometer toilet, the flush valve (also known as the flushometer) opens to a pressurized water supply pipe, from which a measured amount of water is released, forcing wastes into the sewer system. Many institutions

and large facilities utilize this latter type of toilet.

There are also several types of urinals. One common type is the siphonic jet urinal, in which an elevated flush tank provides enough force to flush out foreign matter such as cigarette butts and gum wrappers. These urinals operate through the use of a siphon device, which automatically discharges the tank's contents when the water level in the tank reaches a certain height, thereby periodically rinsing the urinal without the need for user assistance. This makes siphonic jet urinals more sanitary than other urinals, but it also means they consume more water than washdown or washout urinals, which must be activated by the user.

To reduce water use in commodes, consider these options:

- Keep toilets in good working order. Periodically inspect and replace valves and ballcocks in tank toilets. (Flapper valves are prone to deterioration, which can cause toilets to leak and thereby waste water.) Inspect diaphragms or other worn parts in flush valve toilets, and inspect the pin hole and rubber diaphragm in siphonic jet urinals.

- Test for leaks. A federal study once estimated one in five toilets leaks, (Schultz, 1996, p. 19) and leaks may account for up to 20 percent of a toilet's water use (Wilson, 1996, p. 8). Dye-test all tank type toilets for "silent leaks" every six months by putting a dye tablet or several drops of food coloring in the tank. Do not flush. Wait 10 minutes to see if any of the dye has leaked into the bowl. Deteriorated flapper valves are a common source of leaks; they are inexpensive and easy to replace. Also make sure that the chain connected to the valve is not so long that it can become lodged under the valve.

- Adjust flush valve. Ideally, the valve should be adjusted to use as little water as possible per flush without impeding waste removal or violating the manufacturer's recommendations. In general, though, valve adjustment is not as effective as retrofitting. In urinals, existing flushometer valves can be fitted with hardware that reduces water consumption in the valve.

- Retrofit tank-type toilets by:

— installing a commercial displacement device in the tank, which enables the toilet to flush using about 0.75 gpf less water. One popular type of displacement device is a toilet tank dam, which consists of flexible sheets of metal or plastic that prohibit some water in the tank from flushing, saving about 0.5-1.0 gpf. NOTE: Before installing any tank device, make sure it is compatible with the specific toilet.

— replacing or amending the flush valve in the tank with an early closure device that uses less water while maintaining the original pressure and flush force. These devices, which must be installed by a plumber, reduce consumption by 1.0-2.0 gpf.

— installing a dual-flush adapter, which saves as much as 0.6-1.2 gpf by using two different flushes, one for solid waste and the other for liquids and paper. (NOTE: Signs must be posted to instruct users how to operate toilets retrofitted with these devices.)

• Retrofit flush valve toilets by:

— installing an insert or valve replacement device to reduce flush volumes by 1.0 gpf. Some of these devices consist of plastic orifices perforated with holes in a "wheel and spoke" pattern, while others actually replace existing valve mechanisms

— replacing or amending the existing valve with an early closure device to save 1.0-2.0 gpf (see tank toilet retrofits above)

— installing a dual-flush adapter (see tank toilet retrofits above)

— adding an infrared or ultrasonic motion sensor to control flushing. Besides eliminating double flushing, these devices help prevent the spread of disease and are more easily used by individuals with disabilities.

• Retrofit urinals by:

— installing timers to shut them off when the building is not occupied (not necessary for washdown or washout urinals)

— installing infrared or ultrasonic sensors to control flushing (see flush valve toilets)

• Replace old toilets with ultra-low-flush (ULF) toilets and urinals. Replacing 5.0 gpf toilets with ULF 1.6 gpf models may save your facility hundreds of thousands of gallons of water a year. (See Table 3-4.) Manufacturers now offer ULF toilets in the $80-$300 range, comparable in price to conventional models. Check with your utility or city for toilet rebate programs.

• Install a waterless (no-flush) urinal. Made of a urine-repellant material, a waterless urinal has no handles, sensors or moving parts. A trap made of an immiscible liquid floating on top of a urine layer blocks sewer gases and urine odors from escaping into the bathroom. Replacing a 2.0 gpf urinal with a waterless variety in a typical office building can save 44,000 gallons per year (assuming urinal was used 200 times a day for 220 days per year).

COMMODE USE PER CAPITA

How many flushes a day should you assume in calculating how much water toilets flush down the drain? For the nation as a whole, 6 flushes per capita per day is a reasonable assumption (Wilson, 1996, p. 8). For work day alone, one source estimates commode use per capita as follows: Women flush toilets 4 times a day on average and run faucets for 2 minutes; men flush toilets once a day, use urinals 3 times a day and run the faucet for 1.2 minutes; janitors flush toilets and urinals once each and run the faucet for 30 seconds. *(Source: Darell Rogers, Sandia National Laboratories)*

Table 3-4

WATER SAVINGS EXAMPLES: REPLACING 5.0 GPF TOILETS WITH 1.6 GPF MODELS

	# of Toilets	# flushes per day per toilet	# days used per year	Water savings per toilet flush (gpf)	Total annual gallons saved
Restaurant	6	20	365	3.4	148,920
Manufacturer	10	20	300	3.4	204,000
Office Building	25	20	260	3.4	442,000
School	30	20	200	3.4	408,000
Hospital	60	6	300	3.4	367,200
Hotel	70	5	300	3.4	357,000

Source: Based on City of San Jose examples

Faucets

To save water, try a number of easy, low-cost modifications to conventional faucets. Another option: replace old fixtures with newer faucets that control the length of time water can run and prevent water flow when not in use.

- Check frequently for leaks. A faucet leaking one drip per second wastes about 36 gallons a day (U.S. General Services Administration, p 3-21).

- Modify conventional faucets:

— **Install an aerator.** Attached to the faucet head, an aerator reduces water use by adding air to the water stream. Many faucets with aerators consume as little as 1.0 gpm. This low-cost option is attractive when the entire faucet does not need to be replaced.

— **Adjust flow valve** to reduce water flow.

— **Add a flow restrictor**, a washer-like disk that installs in the faucet head, which reduces maximum flow to 0.5-2.5 gpm.

- Replace existing faucets with water-conserving faucets (especially if the existing faucets need to be replaced due to wear and tear). The following types of water-conserving faucets are available:

— **metered valve faucet**— delivers a preset amount of water before shutting off

— **self-closing faucet**— features a spring-loaded knob that automatically shuts off the water when the user releases the knob.

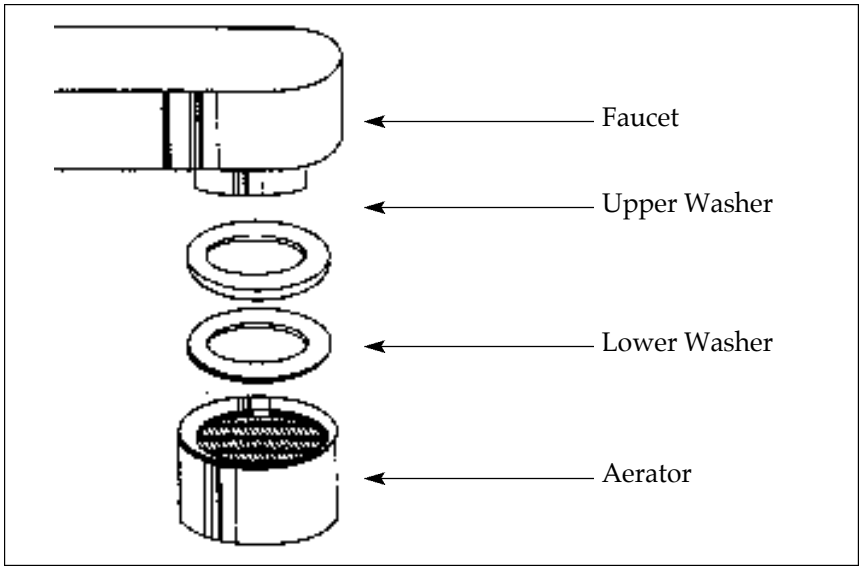
— **infrared and ultrasonic sensor faucets**— are activated when the user's hands are placed beneath the faucet; they shut off the water flow when the user's hands are removed from underneath the faucet. An added advantage of this system is that it minimizes the spread of disease and helps people with disabilities.

Showers

Ordinary showerheads typically use from 5-7 gallons of water per minute, which means a 5-minute shower will use 25-35 gallons. To save water:

- Retrofit showers with new water-conserving showerheads or aerators to reduce use to 2.5 gpm or less.

- If showers are connected (i.e., not operated individually), install individual control valves on each one.



KITCHENS, CAFETERIAS, & STAFFROOMS

Kitchens are a choice target for water conservation because they contain many high-water-use appliances—from dishwashers and garbage disposers to ice makers and frozen yogurt machines. Here is a menu of conservation ideas:

Dishwashing Machines

- Check your dishwasher to ensure that it is not using more water than is specified by the manufacturer. Most commercial machines require from 2.8 to 8.0 gpm to both clean and sanitize. (Black & Veatch, 1993, p. 11.) Consider installing pressure or flow regulators to limit water flow to the manufacturer's specification.

- At prewashing stations, which are used to dislodge large food particles, reduce water flow to the minimum required. Manual pre-wash units, which shut off when the operator lets go of the nozzle, are the most water efficient, using between 1.8 and 2.5 gpm instead of the 4.5 gpm of conventional sprays. Make sure the nozzle is accurately directing rinse water. For automatic prewashers, which typically use between 3.0 and 6.0 gpm, conservation options include installing low-flow, high-pressure spray heads or a flow reduction valve in the water supply line. Check prewashing fixtures frequently for leaks since they tend to receive a lot of rough handling.

- Run only full loads in rack-type dishwashers.

- For conveyor-type machines, make sure that water flows only when dishes are present. Some machines are designed to dispense water if the conveyor moves, whether it is carrying dishes or not. If this is a problem, install an "electronic eye" sensor system, which will turn on water only when dishes are moving on the conveyor belt.

- Recycle final rinse water to be used in the next dishwasher load or prewash load, or for use in the garbage disposer.

- Channel dishwasher wastewater to the garbage disposer and food scrapping troughs.

- Consider replacing the scrapping trough system, which typically relies on a 3-5 gpm flow of water to wash garbage to the garbage disposer. Instead, install a conveyor system that uses no water. If this is not cost effective, use the scrapper system only when needed (or eliminate the system altogether because it is not necessary to dispose of food waste to the sewer system).

Garbage Disposers

Commercial disposers use 5-8 gpm, or even more if connected to a scrapping trough. Since food waste does not have to be discharged to the sewer system, many commercial and institutional facilities have eliminated these high-maintenance fixtures altogether. Instead, they use a garbage strainer, which requires far less water, about 2 gpm. Food waste accumulates in a strainer basket as a recirculating stream of water passes through, washing out the soluble material and small particles to the sewer. The remaining waste is dumped in the garbage.

If replacement with a strainer is not possible, consider the following:

- Make sure the flow of water to the disposer is controlled by a solenoid valve, which automatically closes when the disposer motor turns off. Check that the valve is working properly. Keep in mind that many disposers have two water supply lines, one to the bowl and one to the grinding chamber.
- If the unit is set to operate for a preset duration every time the disposer is turned on, reduce the run time to the minimum necessary.
- Determine from the manufacturer the minimum acceptable water flow rate and adjust the disposer accordingly. Install flow regulators to avoid excess flow due to high water pressure.
- Recycle. Use dishwasher or other wastewater in the disposal.

Ice-Making Machines

Icemakers use water in two ways: for cooling the machine and for freezing water into ice. A water-cooled ice machine producing 800 pounds of ice per day and running at 75% capacity will consume about 900 gallons of water a day just for cooling. That amounts to 328,500 gallons a year. As for the ice-making process itself, there is a wide range of water consumption depending on the manufacturer and type of machine.

Ice cube makers use the most water, typically 20-25 gallons to produce 100 pounds of ice cubes; but some machines use considerably more, up to 90 gallons of water per 100 pounds of ice. Machines that make ice flakes, on the other hand, consume far less, about 15-20 gallons of water to produce 100 pounds of ice. The reason for this disparity is that ice cube makers bleed off more than half of the water to remove impurities and minerals, which would cloud up the cubes. In contrast, ice flakes are not expected to be clear, so no bleed-off is required.

Here are some options aimed at reducing water use in icemaker cooling and ice production:

- Retrofit water-cooled machines. Many water-cooled units employ single pass cooling. Save water by tapping into an existing recirculating chilled water system or by cooling the machine with an existing remote air-cooled condenser. These changes are relatively inexpensive and have quick payback periods.
- Reuse spent cooling water. If retrofitting isn't possible, find other uses for the water after it has cooled the unit instead of letting it go down the drain.
- Replace water-cooled units with air-cooled versions. The typical useful life of icemakers is five years, so replacement is a near-term option. The downside of air-cooled units is that they use slightly more electricity and do not produce quite as much ice as water-cooled models.
- For ice cube makers, use softened water if available. This will reduce the amount of bleed-off needed to make clear cubes.
- Use ice flake machines instead of ice cube makers wherever possible.
- Adjust machine to dispense only the amount of ice required.

KITCHENS, CAFETERIAS, & STAFFROOMS (CONT.)

Frozen Yogurt and Ice Cream Machines

Like ice makers, frozen yogurt and soft serve ice-cream machines can be cooled by either water or air. Water-cooled units use 2-3 gpm when they are in use, and many of these employ single-pass cooling. Consider replacing a water-cooled machine with an air-cooled model that does not require any water for condenser cooling. Alternately, retrofit the unit to be cooled by an existing chilled water system or by remote air-cooled condensers.

Additional Ideas for Kitchens, Cafeterias, and Staffrooms:

- Presoak utensils and dishes in a basin of water rather than in running water.
- Instead of using fresh water to wash down the cooking area, use water from the steam table.
- Turn off the continuous flow used to wash the drain trays of coffee/milk/soda beverage islands. Clean as needed.
- Reduce the flow to dipper wells or troughs for ice cream and butter scoops.
- Turn off food preparation faucets that are not in use. Consider installing foot triggers.
- Use the refrigerator to thaw frozen foods instead of thawing under running water. If water-thawing is required, use a low-flow stream. Do not use running water to melt ice in bar sink strainers.
- Use a water softener only where needed, such as a water heater feed line or ice cube maker. Optimize regeneration and rinse cycles for ion-exchange water softeners to minimize calcium-laden reject water or sodium-laden rinse water. Use a hardness sensor rather than a timer to control regeneration so that soft water will be produced only when it is needed. Check settings so that the flow rate and the duration of flushing cycle are correct.
- Install aerators or water-saving faucets.
- Install a hot water on-demand system at sinks if obtaining warm water requires employees to keep the water running for a long time. To avoid higher energy costs, choose a system that doesn't require that a recirculating pump run constantly.
- Serve water only on request.

LAUNDRIES

Laundries are another high-water-use area, especially for hospitals, convalescent homes, hotels and motels, diaper services, and commercial linen services. Washer-extractors are the most common type of commercial washing machine, varying in size from 25 to 400 dry pounds per load. These machines typically consume about 2.5-3.5 gallons of fresh water per dry pound of laundry. There is no internal recycling; fresh water is added for each wash and rinse cycle.

To reduce water consumption:

- Wash full loads only.
- Consult your laundry chemical supplier for laundry methods that require fewer wash and rinse steps. Changing chemicals or your washing program can eliminate several fills of the washer-extractor for wash or rinse steps. Provide laundry scales to weigh loads if none are available.
- Install a rinse water reclamation system. These computerized systems divert rinse water to a storage tank for reuse as wash water. Expect water savings of 25 percent or more.

The Santa Fe Lodgers Association and the City of Santa Fe provide guest room cards that encourage guests to forego daily linen changes.

- Reduce water use by up to 50 percent by installing a reclamation system that recycles both rinse water and wash water. Wastewater from the laundry process is treated and then reused in initial wash cycles.
- Replace your conventional washer-extractor with a continuous batch-washer ("tunnel washer"). Since batch-washers reuse rinse water from all but the first rinse, this type of washer uses only 1.0-2.0 gallons of water per dry pound of laundry— a 60 percent savings. Additional benefits include energy savings due to the recovery of heat from the load itself during rinse cycles, reduced labor costs because the system is automated, and, in some cases, reduced chemical usage.
  The disadvantages are high initial capital costs and the need for careful scheduling of loads to avoid having to reset equipment controls.
- Install coin-operated washing machines in common rooms of rental housing. In a recent study, the Multi-housing Laundry Association, a not-for-profit trade association, found that each washer in apartments used an average of 11,797 gallons of water annually versus 3,270 gallons per apartment unit served by coin-operated machines in common laundry rooms.
  (From the LaundryWise Home Page, www.laundrywise.com)

CLEANING & MAINTENANCE

Replacing a water-cooled ice-maker with an air-cooled version or installing an ultra-low-flow toilet immediately produces significant and readily observable reductions in water use. But changing the way in which your facility goes about doing myriad routine operations such as cleaning and maintenance can also add up to impressive water savings. Consider making the following changes and adjustments:

- Think about how floors and other areas are cleaned. Is water necessary? Would brooms or wet wash rags work as well as hoses?
- Find alternative cleaning methods that require little or no water for washdowns.
- Switch from "wet" carpet cleaning methods, such as steam, to "dry," powder methods.
- Clean windows only when they are dirty, not on a rigid schedule.
- If it is necessary to use water (e.g., grocery store meat cutting rooms, commercial kitchens, and medical facilities), employ high-pressure, low-volume sprays (which work better than low-pressure, high volume sprays). Use portable high pressure pumps where needed to reduce the amount of water used for cleaning by up to 40 percent. When cleaning with water, stick to budgeted amounts for each job.
- Install spring-loaded valves or timers on all manually operated hoses.
- Install an on-demand water heater near sinks and other places where warm water is needed to avoid having customers and employees run water while waiting for hot water.
- Reuse reject water or process wastewater from other parts of the facility to clean areas requiring grease removal (provided this complies with health regulations).
- Inspect steam lines and traps, all plumbing fixtures, hot and cold water lines, drinking fountains, and water-using appliances routinely in order to catch problems early and to keep these devices operating optimally.
- Read water meters monthly and compare to previous years to ferret out leaks.
- Set up an easy procedure for employees to report leaks. Establish water conservation teams to search for water conservation options. Place a "Water Conservation Suggestion Box" in a conspicuous place and ask for employee suggestions. Assign an employee (or a water conservation team) to evaluate water conservation opportunities.
- Repair leaks and malfunctions promptly, not only to save water but to show employees that their reports of leaks are taken seriously.
- Shut off the water supply to equipment in areas that are not currently in use.

"The maintenance staff needs to understand that they are an important part of the (water conservation) program, and that they need the proper training for the program to be successful."

—Lonnie Burke
Water Conservation Coordinator,
Presbyterian Healthcare Services

Table 3-5. Quantification of conserved water for indoor domestic use exclusive of evaporative cooling at commercial/institutional facilities. Note that for many facilities (such as schools, universities, and office buildings) the number of operating days per year will be less than 365.

Name and address of facility:

Building Identification:

Primary Use of Building:

	Restrooms					Kitchen			Laundry	
Item	Faucets	Shower Heads	Toilets	Urinals		Faucets	Dish Washers		Washing Machines	Total
1. Existing flowrate (gpm) or gallons per use (gpu)										
2. Proposed gpm or gpu										
3. Reduction in gpm or gpu = (1 - 2)										
4. Uses per device per day										
5. Minutes per use										
6. Operating days per year										
7. Number of devices										
8. Gallons of water conserved per year = (3 x 4 x 5 x 6 x 7)										
9. Cost of water per 1000 gallons										
10. Dollar value of water conserved per year = (8/1000 x 9)										
11. Cost of retrofit or replacement										
12. Rebate amount (if any)										
13. Net cost = (11 - 12)										
14. Payback period in years = (13 ÷ 9)										

Source: Wilson, January 1998. Procedure for Quantifying Conserved Water for Commercial/Institutional Facilities.

Table 3-6

SAMPLE SAVINGS CALCULATION: HOTEL WATER CONSERVATION

Action	Annual Water Savings		Other Savings ($/yr)	Total Savings ($/yr)	Annual Costs ($/yr)	Net Savings ($/yr)	Capital Costs ($)	Payback Period (yr)
	Gal/yr	$/yr						
Toilet Retrofit	650,000	2,470	0	2,470	0	2,470	3,700	1.5
Showerhead Retrofit	2,840,000	10,790	6,450	17,240	0	17,240	5,550	0.3
Cooling Tower Improvement	650,000	2,470	2,000	4,470	0	4,470	5,000	1.1

Source: Arizona Municipal Water Users Association. (1997). Facility Manager's Guide to Water Management.

Section 4:
Water Conservation Guidelines for Landscaping

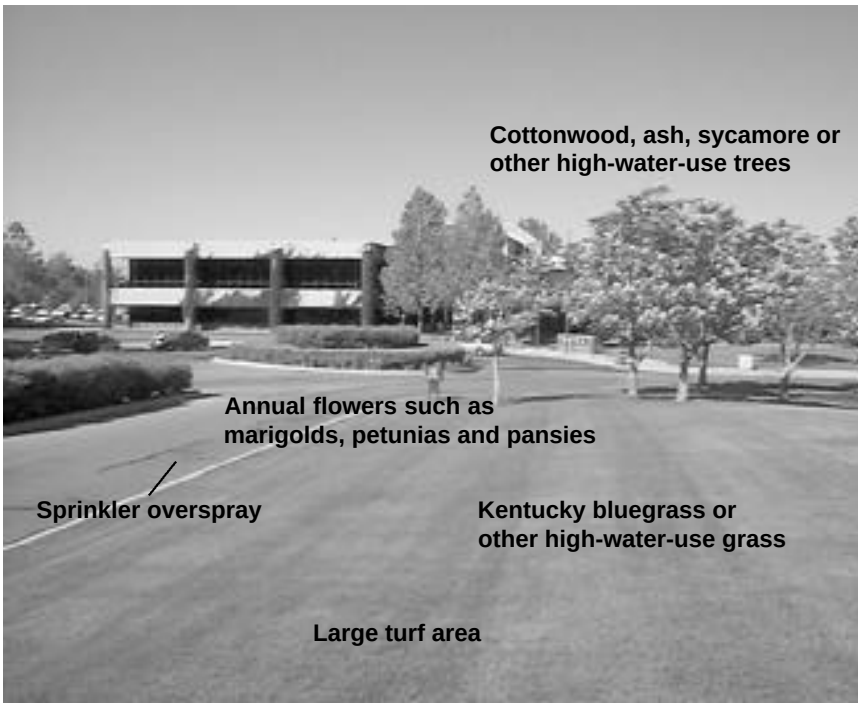
The natural landscapes of New Mexico are varied and beautiful. From the cool northern mountains to the hot deserts of the south, New Mexico's native plant life has one thing in common: the ability to survive on very little water. Although rainfall varies throughout the state, New Mexico averages less than 13 inches of annual precipitation.

Most of the plants used in traditional landscaping require supplemental water to thrive in New Mexico. For example, Kentucky bluegrass is native to regions that receive in excess of 40 inches of annual precipitation. To make up the difference between a plant's water requirements and the natural precipitation it receives, additional water must be added in the form of irrigation.

If your facility maintains any landscaping, then exterior water-use management should be an important part of your overall water conservation program. The following pages offer an overview of water-saving strategies for landscaping and other exterior applications.

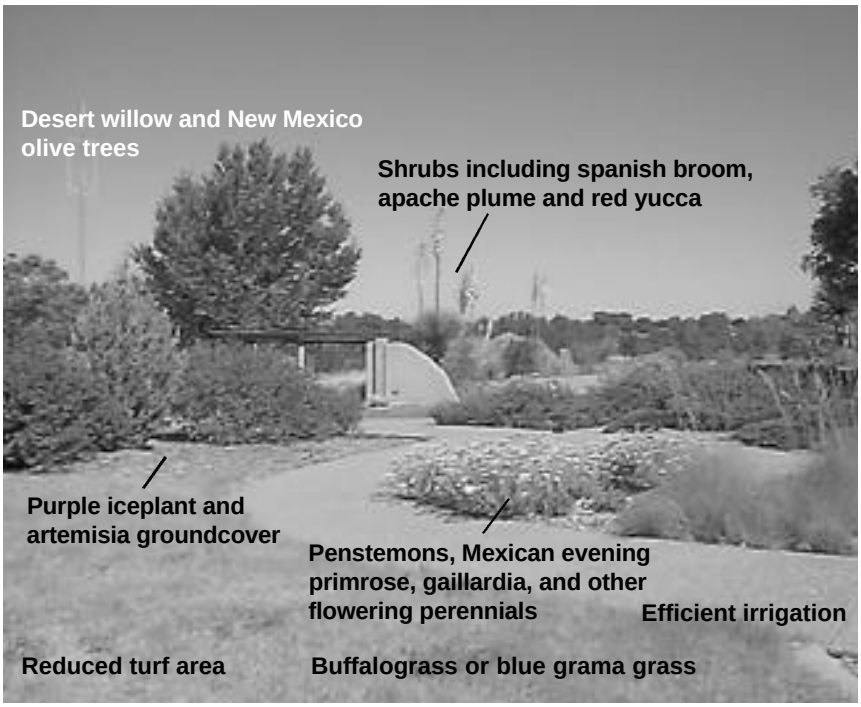
NOTE: An increasing number of municipalities in New Mexico are enacting landscape ordinances to encourage and/or require exterior water conservation. Check with your local water utility to learn whether a landscape ordinance is in effect (or is in the development stages) for your community.

A Typical "Water-thirsty" Landscape



Typical supplemental water needed: 25 gallons per square foot per season
The traditional Midwest-inspired landscaping is appropriate in areas which receive more than 40 inches of annual precipatation. But, in New Mexico, particularly during the hot summer months, this type of landscape requires a tremendous amount of supplemental water.

A Typical "Water-wise" Landscape



Typical supplemental water needed: 5-10 gallons per square foot per season
Southwestern landscaping respects our state's natural, dry environment. Using the prin - ciples of xeriscaping (water-saving landscaping with native and drought-tolerant plants), a water-wise landscape can reduce supplemental irrigation by more than 50%.

GET PROFESSIONAL HELP

A landscape architect and a landscape installation firm can be invaluable resources in the design, planning, and implementation of a new, water-wise landscape for your facility. Some firms can even provide "turn-key" services that include installing a complete water-efficient xeriscape and training on-site maintenance personnel on the proper care of plants and the use and upkeep of the irrigation system.

Water-wise landscapes use eficient drip irrigation and micro-sprayers wherever appropriate.

AN INTRODUCTION TO XERISCAPE

The term "xeriscape" is derived from the Greek word "xeros," which means dry. Xeriscape can be defined as "water-efficient landscaping appropriate to the natural environment." The goal of a xeriscape is to create a visually attractive landscape that uses plants selected for their water efficiency. Properly designed and maintained, a xeriscape can use less than one-half the water of a traditional turf-dominated landscape.

The Principles of Xeriscaping

1. Planning and Design
An efficient and beautiful xeriscape begins with proper planning and a good design. Consider the physical characteristics of the site. Where are the "micro-climates," i.e., the areas that naturally receive the most sun, rainwater run off, and shade? Also consider your organization's needs. For example, do you need a shaded patio for employee breaks and/or special events? Your plan should reflect the natural characteristics, design preferences, and goals for your landscape.

2. Soil Improvements
To enable your soil to better absorb water, you may need to add soil amendments before you plant. The water-retention abilities of most New Mexico soils is improved with the addition of organic matter. If you're landscaping with native and water-wise plants, however, soil amendments may not be necessary (unless you're dealing with heavy, hard-packed clay). For these hardy natives, just loosen the soil before you plant.

3. Appropriate Turf Areas
Reduce the area devoted to turf-grasses. Instead of using cool season grasses that need lots of supplemental water (such as Kentucky bluegrass), consider drought-tolerant grasses such as buffalograss and blue grama. Also consider replacing some turfgrass areas with water-wise groundcovers.

4. Low-Water-Use Plants
Whenever possible, select native and low-water-use plants. A delightful variety of water-wise plants can grow in all of New Mexico's climatic regions. Some add year-round greenery; others are perfect for adding seasonal color.

5. Efficient Irrigation
Awell-planned and well-maintained irrigation system can significantly reduce landscape water use. Design your landscape using the "zoning" concept to group plants together which have similar water requirements. Then design irrigation zones so low-water-use plants are drip irrigated and turf areas are watered separately from other plantings.

6. Mulching
Mulches cover and cool the soil, minimize evaporation, reduce weed growth, and slow erosion. Covering the soil with mulch (such as shredded bark or crushed rock) also provides visual interest to the landscape while offering a protective cover until plants mature.

7. Proper Maintenance
Xeriscapes are low maintenance but they are not no maintenance. Your facility's maintenance staff will still need to periodically fertilize, prune, weed, mow, and control pests. To ensure continued water savings, keep irrigation systems properly adjusted and maintained.

CREATING A WATER-WISE XERISCAPE

One of the keys to creating a successful xeriscape is planning for different areas of landscape function and use. By grouping plants of similar water needs into specific zones, landscapes can be created which are both functional and reflect the natural beauty of New Mexico.

Typically, there are three xeriscape zones:

Zone 1—Arid
The Arid Zone features the most drought-tolerant vegetation. Choose native plants and other species that require very little supplemental watering. Often land contouring can be used to direct rainwater to these xeric plants to provide virtually all the water they need.

Best Locations for Arid Zones:
— narrow strips of landscape (such as between curbs and sidewalks)
— farthest-removed areas of landscape
— hottest and sunniest areas of landscape

Zone 2—Transition
The Transition Zone features moderate-water-use plants. This intermediate zone is used to blend lush "oasis" areas with the "arid" areas of the landscape. Transition Zone plants need infrequent supplemental watering (typically once a week) after they have become established.

Best Locations for Transition Zones:
— sunny and mostly sunny areas near walkways, front entrances, etc.
— in between Arid Zones and Oasis Zones

Zone 3—Oasis
The Oasis Zone is where the highest-water-use plants are grouped, creating the lushest zone in the landscape. The Oasis Zone includes the lawn area, which is typically the landscape area that requires the most supplemental irrigation.

Best Locations for Oasis Zones:
— high-visibility, high-use areas (near employee break areas, sports and outdoor recreation areas, etc.)
— shady areas (such as the north and east sides of walls and buildings)
— anywhere water collects (where rainwater drains off a roof, at the base of a slope, etc.)

THREE GOOD REASONS TO XERISCAPE

1. Xeriscapes save water. Using native and other drought-tolerant plants can reduce water use by more than 50%.

2. Xeriscapes save time. Downsizing turf areas can significantly reduce the time spent mowing, fertilizing, and maintaining.

3. Xeriscapes save money. Reducing water use and maintenance time will reduce your water bill and your maintenance costs.

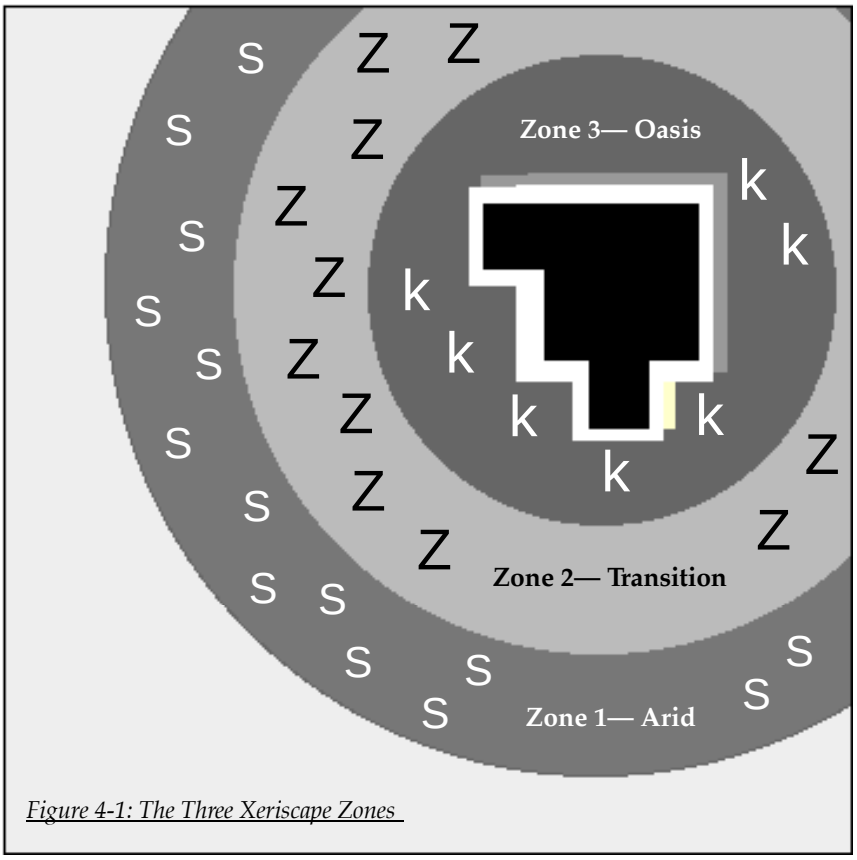


Figure 4-1: The Three Xeriscape Zones

DESIGN & OPERATION OF LANDSCAPE IRRIGATION SYSTEM

Regardless of the type of landscape at your facility, two primary guidelines of water conservation apply to landscape irrigation:

1. Apply water in the most efficient means possible.
2. Apply water only where and when it is needed.

This section of the manual reviews the basic types of irrigation systems and water-delivery devices and offers ways to conserve landscape water use.

Immediate Water Savings

The following tips and guidelines on efficient landscape irrigation can provide significant and immediate water savings:

— To minimize evaporation, water early. The best time to water during warm months is before 9:00 a.m.
— Adjust sprinklers to water landscape plants, not sidewalks, streets, and parking lots.
— Adjust sprinklers and other water-delivery devices to concentrate water at the root area of plants, not on trunks and leaves. Topical watering results in unnecessary evaporation and runoff. Also make sure that sprinkler heads are set at the proper height (as recommended by the manufacturer) to prevent them from becoming blocked by tall grass or other nearby plants.
— Refrain from watering when it's windy or raining.
— Water deeply and less frequently instead of lightly every day. Deeper watering encourages plant roots to grow deeper, which in turn will enable plants to become more drought-tolerant because they will be able to draw moisture from a larger volume of soil.
— Eliminate overwatering. Measure moisture at root level to determine when plants need water.
— If plants are being watered with a hand-held hose, attach a nozzle or sprayhead with an automatic shutoff option to avoid water waste.
— Stop using water to clean sidewalks, driveways, parking lots, tennis courts, pool decks, and other hardscapes.

Modifications That Can Provide Water Savings

The following maintenance, retrofit, and replacement options can provide additional landscape water savings:

— Select low-water-use trees, shrubs, perennials, and groundcovers instead of high-water-use turfgrass.
— Install separate valves for turf and for other types of plants (trees, shrubs, groundcovers, etc.) to ensure that each type of plant material receives only the amount of water it needs.
— Mow turfgrass higher—and never remove more than 1/3 of the turfgrass blade. Longer leaf surfaces promote deeper rooting and shade the plant's root zone, thus making the turfgrass more water-efficient.
— Don't plant turfgrass in areas less than 10 feet wide. Small turf areas are virtually impossible to water efficiently using sprinklers. For these small and uneven areas, use water-wise plants and a drip irrigation system instead.
— Carefully regulate when and how much water is delivered to each zone of the irrigation system.
— Install an irrigation timer to schedule watering times and durations. Select a timer with a manual override feature that will enable your maintenance staff to cancel a scheduled watering in the event of rain.
— Adjust watering schedules to compensate for changing seasons.
— Install a soil moisture sensor, called a soil tensiometer, to automatically test the soil moisture to determine when and how much water should be delivered.
— Inspect irrigation systems regularly. Replace or repair broken sprinkler heads, broken pipes, and other leaky, dirty, or damaged components.
— To prevent water lines from freezing, place shut-off valves in freeze-protected sites rather than running water continuously.

Sprinkler Systems

Sprinkler systems are the traditional method of irrigating turfgrass lawns. Although watering alternatives have been developed in recent years, most notably subsurface irrigation and turf bubblers, sprinklers are generally recognized as the most efficient and effective method of lawn irrigation.

In New Mexico, where cool-season turfgrass (i.e., Kentucky bluegrass and tall fescue) is definitely an "oasis" plant, lawns should be located where they can be the most visible and useful— such as near front entrances, employee break areas, and activity areas.

To maximize water conservation, replace old sprinkler heads with newer, water-efficient models— and choose the right sprinkler for the job:

— **Fixed-spray** sprinklers produce a tight, constant fan of water that is ideal for small landscape designs.
— **Pop-up** models retract when not in use, so they will not be damaged by lawn mowers or foot traffic.
— **Stream rotors** usually feature multiple rotating streams that are designed for medium-sized turf areas.
— **Impact rotors** are typically used to irrigate large turf areas such as golf courses and athletic fields.

Pop-up sprinkler heads

Impact rotor

Drip Systems

Drip irrigation is the perfect method for watering most xeric (water-efficient) shrubs, perennials, and trees. Drip irrigation systems save water because they deliver slow, steady amounts of water directly to plant root zones. As a result, drip systems reduce water lost to evaporation, runoff, and overspray.

Drip emitters— Each drip emitter connects to micro-tubing and delivers water to specific plants at a slow, consistent rate, typically from one-half gallon to four gallons. A drip emitter rated at "2 gph" will deliver two gallons per hour.

Multi-emitter Hydrant— In some cases, multi-emitter hydrants can replace existing sprinkler heads when converting a turf landscape to xeriscape. The four or eight independent outlets in a multi-emitter hydrant can be fitted with emitters that deliver different amounts of water.

Multi-emitter Hydrant

Drip Systems (cont.)

Micro-tubing

Micro-tubing— The micro-tubing (typically 1/4" diameter) delivers water to individual drip emitters.

Pressure regulator— Most drip systems require less water pressure than that of a typical sprinkler system. (A typical drip system operates best at 20 pounds per square inch [psi].) A pressure regulator ensures even water distribution throughout an irrigation zone.

Filter— Drip systems require a built-in filter to keep particles in the water (such as sand and silt) from clogging the small emitters.

Filter

Irrigation System Components

(Common to Sprinkler and Drip Systems)

The following components are common to both sprinkler and drip irrigation systems:

Controller/Timer— The controller (or timer) is the "brain" of the system. It regulates the water cycles to activate the control vales at the times and days you select. Electronic controllers enable you to precisely adjust watering times, program multiple cycles, and skip cycles when it rains.

Valves— Control valves are used to turn the water on and off. Automatic valves are wired to the controller and programmed to open and close at specific times and days. Manual valves must be opened by hand to water a specific zone.

Manual Shut-off Valve— Most systems have a manual shut-off (also known as an "isolation valve") that allows you to shut off the irrigation system for service or emergency repairs.

Backflow Preventer/Anti-Siphon Valve— A backflow preventer keeps irrigation system water from being siphoned back into potable water supplies. Backflow preventers are required by ordinance in most municipalities.

Pipes— The water pipes are the "skeleton" of an irrigation system. They send water underground throughout the landscape to the water-delivery devices (sprinklers, drip emitters, etc.). Most irrigation systems use PVC pipe or polyethylene tubing.

Controller/Timer

Valves

Backflow Preventer/Anti-Siphon Valve

LANDSCAPE IRRIGATION AUDITS

The first step in the quantification of water use is a water audit. Because landscape irrigation is a distinct area of water use with unique challenges and characteristics, many facilities choose to conduct separate audits and follow-up inspections of exterior water-use systems.

Purpose

A detailed examination of how much water enters the irrigation system and where it is used will help assess current water-use practices. Amajor objective of a landscape water audit is the identification of water waste and inefficiencies that can be immediately corrected. Included in this category are leaks and broken pipes, broken or malfunctioning sprinkler heads, areas of water overspray, etc.

A thorough water audit will also reveal landscape areas that, from a water conservation perspective, require redesign or retrofitting. Also note where water use appears to be both efficient and effective (as revealed by healthy plants and no apparent water waste).

Pre-Audit Checklist

1. Consult with facility personnel who are familiar with the landscape irrigation system.
2. Compile irrigation system plans, landscape plans, and maintenance records pertaining to the facility's entire irrigation system.
3. Assemble water-use records, including utility bills and meter readings, applicable to landscape watering for the past 12-24 months.
4. Obtain a current watering schedule, listed on a zone-by-zone basis.

Procedure for Conducting a Field Audit and Test

After the appropriate information and records have been assembled, conduct a walk-through inspection of the grounds with onsite maintenance personnel and outside irrigation auditors (if any).

— Turn on each watering zone individually. Identify and inspect all water-delivery devices (sprinkler heads, bubblers, drip emitters, etc.).

— Compare your irrigation system plans and blueprints to the actual water-using equipment in each irrigation zone. Update your plans to show the actual equipment. If possible, record detailed information about each piece of equipment. (For example, record spray pattern, throw distance, and water-delivery-rate for each sprinkler head.)

— During your walk-through survey, note the location of all faucets, shut off-on valves, flush valves, solenoids, booster pumps, timers, and other irrigation system components.

— Carefully record the landscape area served by each irrigation system zone. Include the plant types contained in the zone, soil types, terrain information, and other relevant data.

— Note problem areas where water is being wasted. Also observe areas where too little water delivery is causing the plant material to die or become stressed.

— With assistance from your local water utility (if necessary), test the water pressure at several key points in each irrigation zone. Too much water pressure will result in overwatering; too little water pressure can result in dead or stressed plants.

— Test sprinkler heads to make sure they are delivering consistent amounts of water over the entire area. (This can be done by placing "catch cans" of the same size and depth in various spots in a watering zone to collect water. After 10 minutes, compare the depth of water in each can.)

— Run each irrigation zone for its prescribed watering period. Then randomly choose areas for spot checks of irrigation depth to see if the plant materials are receiving proper water for their root zones.

EFFICIENT WATERING DEPTH

8-10 inches	flowers and lawns
2 feet	groundcovers and shrubs
6-8 feet *(once a month)*	established trees

Source: City of Albuquerque

Preparing an Audit Report

After you've fully documented your facility's existing irrigation system and landscaping, prepare a complete water audit report. Include an updated schematic of all irrigation system components and corresponding plant materials. Your report should also include:

— a list of repairs needed immediately to prevent additional water waste

— retrofit options that can be done in the short term to enhance water-use efficiency (e.g., replace older model sprinkler heads with newer, more-efficient models).

— long-term recommendations for landscape water conservation (e.g., turfgrass area reductions, conversion of curbside landscaping to xeric plantings, etc.)

NOTE: For more information about how to conduct a landscape irrigation audit, see the Landscape Irrigation Auditor Training Manual published by the Irrigation Association.

After completing a landscape audit, consider contacting an outside landscape architect and/or irrigation company for additional ideas about landscape water conservation at your facility.

TRAINING LANDSCAPE MAINTENANCE PERSONNEL

As noted in Section 1 of this manual ("Eight Keys to Successful Water Management," page 12), a successful water conservation program involves two distinct areas: technical and human. The technical side involves hardware and data collection. The human side involves changing behaviors and expectations about water usage. In short, a "cultural change" is necessary to move from established operating and maintenance practices to new, water-conserving practices.

The importance of educating your facility's landscape and maintenance staff cannot be overemphasized. Maintenance workers and trades people must be informed about the technical aspects of the program. They must also be convinced of the merits of the program in order for it to be successful. Part of the education process must position the water conservation program as a tool to improve workers' job effectiveness and performance—not a way to make them look bad or eliminate jobs.

Introducing the Water Conservation Program

Before embarking upon a water conservation program—and long before installing a xeric landscape—it is important to meet with the maintenance staff to educate them on the merits of water conservation. Ideally, this initial meeting should take place prior to the Landscape Audit described above. If it is not possible to meet with all maintenance personnel prior to the audit, make sure the maintenance staff knows that maintenance/landscape supervisors and managers played an active role in the audit.

Share with the maintenance staff the primary goals of the facility's water conservation efforts, the changes that will be made to the landscape plant materials (replacing turf with native and water-wise plants, for example), and changes that will be made to the irrigation system. Enlist their support in making the plan a quantifiable success.

Elements of a Training Program

A training program for landscape maintenance personnel will make them more effective water conservers. A training program should include:

— **Irrigation Scheduling**— Include an overview of the water requirements of different species of plants, signs of plant stress due to overwatering and under watering, use of soil probes and soil cores to check soil moisture, best time of day to irrigate, and an overview of evapotranspiration (ET) rates.

— **Irrigation System Operation**— Include a basic overview of the irrigation system and its components, water application techniques of the components, use of automatic controllers to turn water on and off, manual override of controllers, and the landscape's watering zones.

— **Irrigation System Maintenance**— Cover how to spot problems in irrigation equipment and make the necessary repairs or replacements. Include a basic checklist for a regular walk-through inspection. (See "Irrigation System Testing and Maintenance Checklist" on page 57.)

— **Landscape Maintenance**— Cover the practices that reduce the need for irrigation water. These practices include:
  — proper height for turf mowing
  — proper frequency of turf aeration and dethatching to increase water retention
  — proper fertilization schedules to maintain plant health and drought tolerance
  — soil preparation and mulching practices to increase water retention

Irrigation Certification

Ideally, your facility's landscape maintenance manager should be trained in exterior water use management and be a certified Landscape Auditor. Landscape Auditors are certified by the Irrigation Association. For more information about the organization and its certification classes, contact the Irrigation Association at 8260 Willow Oaks Corporate Drive, Suite 120, Fairfax, VA22031; phone (703) 573-3551.

FIVE LANDSCAPE WATERING TIPS EVERY MAINTENANCE PERSON SHOULD KNOW

1. If water runoff is a problem, particularly in turf areas, use a two-step watering process. Run the sprinklers for half the needed time, wait one hour, then water for the remaining time. This approach enables the first delivery of water to be fully absorbed into the soil.

2. Inspect plants regularly (daily if possible). Plants show signs of stress when they need water. Grass will lie flat after being walked on and will lighten in color when it needs to be watered. Shrubs, perennials, and trees will often drop leaves, droop, or lose their gloss when underwatered.

3. Avoid overwatering, which not only wastes water but can cause lawn and plant disease.

4. Irrigate trees and shrubs longer and less frequently than shallow-rooted plants such as grass and flowers.

5. Remember that new plantings need more water than established plants. After plants become established, however, make sure irrigation water is reduced.

What is Evapotranspiration (ET)?

Evapotranspiration (ET) refers to the combined process of evaporation from the soil and water transpiration through plant surfaces. ET is measured in inches of water per day (or week, month, or year), and it changes with the weather (i.e., the hotter and drier the weather, the higher the ET). Many weather stations and municipalities now provide daily, weekly, and monthly ET figures. Use local ET figures to help determine when and how much water must be added to your landscape.

Note that ET, for various types of landscape plants, is normally related to a reference ET_R for a cool season grass by a coefficient (K_L). Thus ET = K_L x ET_R. While the ET_R for grass may be 0.23 inches per day (Albuquerque in July), the ET for low-water-use plants may be less than 0.12 inches per day (i.e. K_L = 0.50).

To determine the amount of irrigation water (IR) required, take the ET and subtract the amount of effective rainfall (Re). Then divide that amount by your irrigation system's efficiency:

IR = ET - Re ÷ Ef

Sprinkler systems should generally be designed to achieve a 70% (i.e., .70) efficiency, and drip systems should achieve an 85-90% efficiency.

Field tests conducted by Sternberg (1967) suggest that evaporation and drift losses may range from 17 to 22 percent of sprinkler discharge in the daytime and 11 to 16 percent at night.

IRRIGATION SYSTEM TESTING & MAINTENANCE CHECKLIST

For peak efficiency, your facility's irrigation system staff should conduct regular inspections and make needed adjustments. Use the following checklist as a guide to routine testing and maintenance.

Monthly

— Check for leaks. Inspect water lines, sprinklers, emitters, and other components. Look for wet spots in the landscape to help locate broken pipes, leaky sprinkler heads, etc.
— Replace broken sprinkler heads, bubblers, micro-sprayers, and drip emitters immediately with identical or equivalent parts to ensure even water delivery throughout the irrigation zone.
— Locate and clean any dirty sprinkler heads, drip emitters, clogged tubing, etc.
— Use your water meter and water bills to help reveal the presence of hidden leaks.

Spring

— Set controller for watering times and durations. (Remember to adjust the timer clock for the beginning of Daylight Savings Time.)
— Replace back-up battery in controller.
— Test manual shut-off/isolation valve.
— Check the water pressure in each irrigation zone. Adjust as necessary to match the manufacturers' recommendations for the water-delivery devices in your irrigation system.
— Check and clean filters.
— Check and clean screen in sprinkler heads. Adjust pattern to eliminate water waste due to overspray.
— Test sprinkler heads to make sure they are delivering consistent amounts of water over the entire area.
— Inspect all drip emitters. Make sure emitters are applying water to the entire root zone of each plant.

Summer

— Adjust controller for watering times and durations during the hottest months.
— Check and clean filters.
— Inspect all drip emitters and clean if clogged.
— As plants grow bigger, move drip emitters to the edge of the plant's root ball to encourage additional root development.

Late Summer

— Adjust controller to shorten watering times and durations during New Mexico's rainy season.

Fall

— Adjust controller to further shorten watering times and durations as the weather cools.
— Adjust controller clock for the end of Daylight Savings Time.
— Test manual shutoff/isolation valve.
— Check and clean filters.
— Inspect all drip emitters and clean or replace if necessary.

Winter

— Adjust controller to further shorten watering times and durations.
— When daytime temperatures are below 40 degrees F., discontinue automatic watering and turn on irrigation system manually as needed.

IRRIGATION WITH RECLAIMED WASTEWATER

In their search for ways to reduce exterior water use, many of New Mexico's commercial, institutional, and industrial facilities have begun to use recycled water and reclaimed wastewater to irrigate their landscapes. Water can be collected, treated, and reused onsite. In addition, reclaimed wastewater is available from some water utilities (generally at rates far below those charged for potable water).

Water available for onsite recycling falls into two broad categories: graywater and blackwater. Graywater is water that is generated by bathroom sinks, showers, clothes washing machines, rinsing, and other processes. Blackwater is water flushed down toilets and urinals, and water discharged from kitchen sinks and other food processes that contains oil, fat, and/or grease. Graywater generally does not contain fecal matter and food waste; blackwater does. (U.S. General Services Administration, p. 4-2)

The presence of toxic chemicals and pathogenic microorganisms in untreated wastewater creates the potential for adverse health effects. Thus, the acceptability of reclaimed water for landscape irrigation depends on its physical, chemical, and microbiological quality. For this reason, graywater recycling is far more common than blackwater recycling because graywater generally requires less treatment before it can be safely reused.

Graywater Recycling Systems

In a typical graywater recycling system, water that would normally be discharged for municipal sewage treatment is collected, treated to remove suspended solids and contaminants, and reused. The basic graywater system will include the following components:

— storage tanks
— color-coded PVC piping (typically purple) to distinguish reclaimed water pipes from potable water pipes
— filters
— pump
— valves and controls

The need for reclamation facilities to reliably and consistently produce and distribute reclaimed water of adequate quality and quantity is essential and dictates that careful attention be given to the reliability features during the design, construction, and operation of the facilities. Graywater recycling and treatment systems must be installed in accordance with local plumbing codes and by professional, licensed plumbing contractors. (U.S. General Services Administration, page 4-7.) General guidelines for the reuse of wastewater in New Mexico have been prepared by the New Mexico Environment Department and may be obtained from that agency.

Opportunities and Challenges of Using Reclaimed Water

— Relatively clean water—reclaimed from process rinses, reverse osmosis reject water, and other uses—that is used to irrigate your site's landscape is essentially "free," and it can reduce your facility's water use substantially.
— Reclaimed water, particularly reclaimed municipal water, typically contains more salts than potable water. High salinity can have an adverse affect on plant life. Watch for salt accumulation on the soil surface where plants are drip irrigated.
— If high salinity is a problem when irrigating turfgrass, combine reclaimed water with potable water.
— When in doubt, consult with a professional water quality company for assistance in establishing a reclaimed water use program.

Section 5:
Water Conservation Guidelines for Cooling and Heating

COOLING TOWERS

Cooling and heating present great opportunities for water conservation. Not only do cooling towers, chillers, small evaporative coolers, boilers, and steam generators consume a great deal of water, but they frequently use water inefficiently. Understanding how to optimize the performance of heating and cooling equipment is essential to any industrial, commercial or institutional water conservation plan. These guidelines are designed to save water as well as reduce energy and chemical costs.

At hospitals, industrial plants, office buildings, and other facilities with large cooling needs, cooling towers can be the largest single water user. Cooling towers use huge volumes of water because they are designed to remove heat by evaporation. Just as human bodies cool off when sweat evaporates in a breeze, a cooling tower cools a circulating stream of water by exposing water droplets to an airflow. This causes a portion of the water to evaporate, taking heat with it. The remaining, cooled water then flows to an air conditioning unit or other equipment and a heat exchange occurs; the equipment is cooled and the circulating water is heated. The warmed water then returns to the cooling tower to be exposed to an airflow, cooled, and the cycle begins anew. (See "Typical Cooling Tower Operation" diagram in Figure 5-1.)

Water can be lost from a cooling tower in three ways: evaporation, bleed-off, and drift.

Evaporation. The primary purpose of a cooling tower is to take advantage of the heat transfer that occurs when water evaporates. When a portion of a circulating stream of water evaporates, it cools the water that remains. The rate of evaporation from a cooling tower is typically equal to approximately 1% of the rate of recirculating water flow for every 10 degrees F in temperature drop that the cooling tower achieves.

Bleed-off or blowdown. The water that evaporates from a cooling tower is pure; left behind in the water that remains are suspended and dissolved solids. As pure water continues to evaporate each time the water passes through the cooling tower, the concentration of dissolved solids increases. Ultimately, the dissolved solids must be removed in order to prevent damage to the system in the form of scaling, corrosion, and other problems. Bleed-off (also called blowdown) is the discharge of a portion of the circulating water to remove the suspended and dissolved solids.

Drift. Water droplets and mist carried out of the cooling tower by air flow is called drift. In well-maintained towers, water loss due to drift should be very small. (Typically, drift can vary between 0.05% and 0.2% of the flow rate through the tower.) Because the droplets still contain dissolved solids, drift is considered a part of bleed-off.

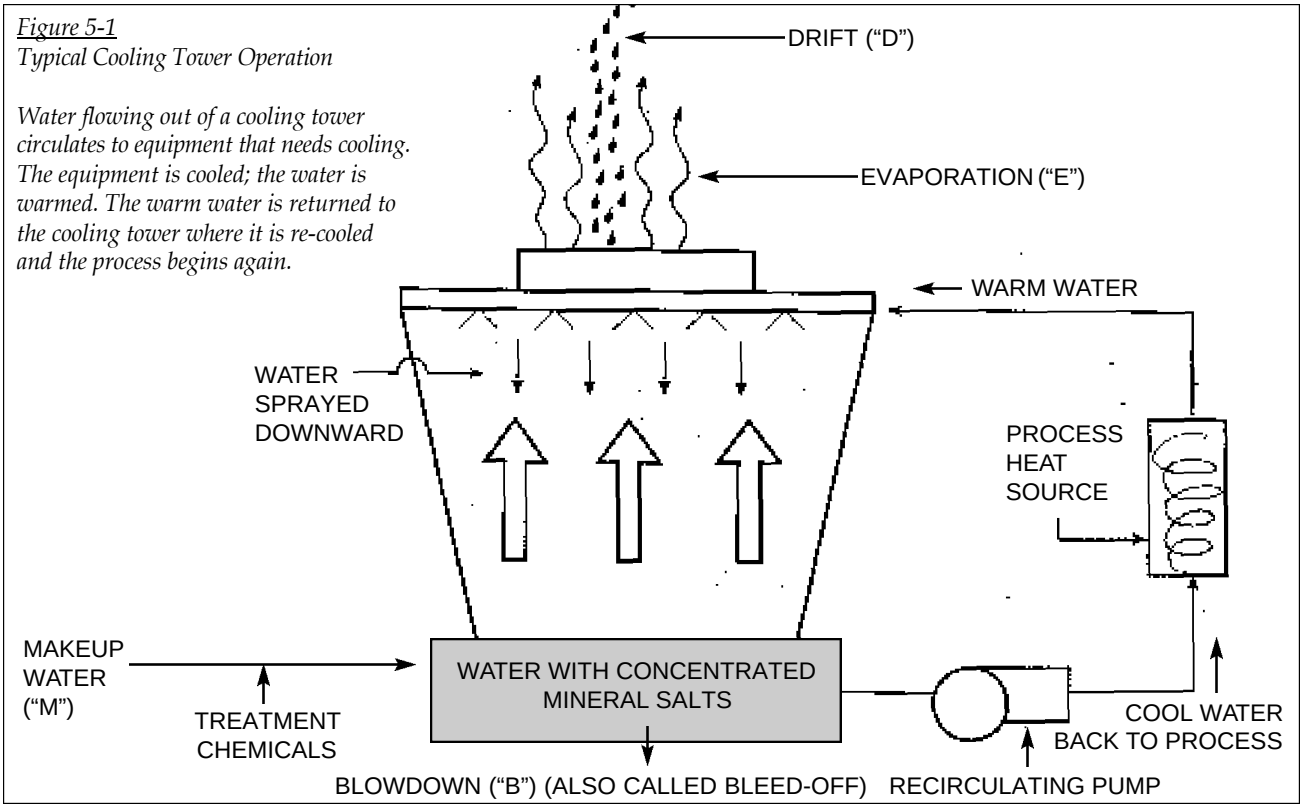
Water added to the system to replace water lost via evaporation, drift, and bleed-off/blowdown is called "make-up water." Therefore, the water balance in a cooling tower system can be stated as the relationship between make-up water (M), evaporation (E), bleed-off (B), and drift (D):

$$M = E + B + D$$

Since the evaporation rate depends on how much cooling is needed and, to a lesser degree, the weather, evaporative loss presents no viable opportunity for conserving water. Instead, facilities must focus on reducing the amount of water that is discarded as bleed-off from the system.

Figure 5-1
Typical Cooling Tower Operation

Water flowing out of a cooling tower circulates to equipment that needs cooling. The equipment is cooled; the water is warmed. The warm water is returned to the cooling tower where it is re-cooled and the process begins again.



Water Quality and Efficiency

Conserving water in a cooling tower is largely a function of water quality. Left uncontrolled, the quality of water circulating through a cooling tower system will deteriorate. Poor water quality—which includes water with high levels of dissolved solids—degrades the efficiency and longevity of cooling towers due to these problems:

Scale. When water-borne minerals such as calcium carbonate are deposited on the surfaces of the cooling tower, they form a film called scale. Scale reduces the cooling capacity of the tower by acting as an insulator. Excessive scale build-up can sometimes obstruct the flow of water, resulting in higher energy costs. Other scale-inducing minerals include silica, calcium sulfate, and iron oxides.

Corrosion. Corrosion of the metal surfaces of the cooling tower can be caused by a low pH (acidity) of the water due to contamination from air pollutants. High mineral concentrations in the cooling water may also generate a high conductivity, which leads to corrosion if the water passes by and conducts a current between two different metals. Finally, scale, dirt, and the water itself may wear away metals.

Biofouling. The warm, moist environment of a cooling tower beckons to algae, bacteria, slime, and fungi. These organisms can impinge or clog water flow, promote scaling and corrosion, and corrupt the heat transfer efficiency of the system.

As the concentration of total dissolved solids increases, a portion of the circulating water must be discharged as bleed-off to prevent the above conditions from damaging the system. Clearly, the less bleed-off water required, the greater the water savings.

To minimize bleed-off, facilities often rely on an outside water treatment vendor to supply chemicals for use in the cooling tower's circulating water. These chemicals include scale inhibitors (e.g. organophosphates) and corrosion inhibitors (e.g., polyphosphates). Inhibitors make it possible for the water to "hold" much larger concentrations of minerals in their dissolved state (commonly referred to as "total dissolved solids" or TDS), thereby postponing bleed-off until much higher mineral concentrations are reached. (An additional benefit of minimizing bleed-off is that treatment chemicals stay in the circulating water longer, thus reducing chemical cost.)

Water Conservation Measures
There are several ways to improve the water-use efficiency of a cooling tower by reducing the water lost to bleed-off:

— **Operate bleed-off** on a continuous basis, rather than by the "batch" method. Most cooling towers are bled-off automatically when the mineral concentration, as measured by conductivity, reaches a specified level. This is usually done by the batch method, releasing large quantities for a preset period of time or until the conductivity reaches a preset low level. Unfortunately, this method can lead to wide fluctuations in the conductivity, which wastes water. Instead, try to operate the bleed-off on a more continuous basis, keeping the conductivity closer to the limits. Set the bleed-off timer for a shorter time, or set the low-end conductivity higher, not much less than the bleed-off start level.

— **Install conductivity and flow meters on make-up and bleed-off lines.** This will allow the operator to closely monitor the volumes of water being used and verify that the system is operating at optimum parameters. Meters that display total water flow as well as current rate of flow are most useful.

— **Read meters regularly.** Keep a log of make-up and bleed-off consumption and dissolved solid concentration, evaporation, cooling load and concentration ratio.

— **Add an automatic control** to shut off the unit when it is not being used (i.e. at night or weekends).

— **Select your treatment vendor with care.** Tell vendors that water conservation is a high priority and ask them to estimate the quantities and costs of treatment chemicals and volumes of bleed-off water, as well as the expected concentration ratio. Keep in mind that some vendors may be reluctant to improve water efficiency because it means the facility will purchase less treatment chemicals.

— **Adjust pH by adding sulfuric acid.** Carefully adding a controlled amount of sulfuric acid to the cooling tower water lowers the pH and prevents scale by converting a portion of the scale-forming minerals into more soluble forms. This option may reduce water consumption by up to 25 percent. Make sure that workers are fully trained in the proper handling of acids. Also note that acid overdoses can severely damage a cooling system, so use a timer and add acid at points where the flow of water is well-mixed and reasonably rapid. Also be aware that lowering the pH may mean you may have to add a corrosion inhibitor.

— **Install sidestream filtration.** Routing cooling tower water through a rapid sand filter or high efficiency cartridge filter is a particularly good method for improving water quality in places where airborne contaminants and water cloudiness are common and for systems with narrow passages susceptible to clogging. Filtration improves cooling tower efficiency and cuts down on the need for maintenance. Sidestream filtration is particularly helpful if your cooling tower is subject to dusty atmospheric conditions.

— **Treat water with ozone.** Ozone not only kills viruses and bacteria, but it may also control corrosion by oxidizing inorganics and soluble ions. Ozonation can improve water quality without the need for additional chemicals. (NOTE: While ozone is a powerful oxidizing agent, its effective life is less than one hour. This means it must be produced at the site. Ozone is also highly corrosive. Materials compatibility must be considered in any system that uses ozone.)

— **Recycle and reuse.** Even if you have done everything possible to improve water quality, you can still save water by finding other uses for bleed-off water. You may also discover additional sources of make-up water such as single-pass cooling systems used elsewhere in the facility. Some high-quality municipal treated wastewater may also be acceptable provided the tower is operated at somewhat conservative concentration ratios.

— **Explore other options.** Some vendors claim that magnets and electrostatic field generators dislodge mineral deposits and scale without the use of chemicals. Be aware that these claims are unsubstantiated. Investigate these systems thoroughly before a possible purchase.

Figure 5-2
Pros and cons of Cooling Tower Conservation Options

OPTION	PROS	CONS
Improving Conventional Treatment	Low initial capital cost Low operating cost Low maintenance requirements	Concentration ratio is limited based on the quality of the make-up water (typically 3.5)
Sulfuric Acid	Low initial capital cost Low operating cost Concentration ratios up to 6 possible	Potential safety hazard Potential for system damage
Sidestream Filtration	Greater operating efficiency Longer periods between shutdowns Possibly reduced biofouling and scale	Moderately high initial capital cost Limited removal of dissolved solids Pumps add extra energy cost
Ozonation	Concentration ratio of 10 or higher possible Elimination of all or additional chemical treatment No treatment required for discharge to sewer system	High initial capital investment Complex system requiring outside vendor Additional energy costs Possible health hazards Highly corrosive—system materials must be compatible
Recycle, reuse	Drop in overall facility water consumption	Possible requirements for pretreatment with concomitant increase in energy and chemical costs Increased potential for biofouling if water quality is poor

Sources: Facility Manager's Guide to Water Management (Arizona Municipal Water Users Association) and Uses of Water and Water Conservation Opportunities for Cooling Towers (Black & Veatch)

COOLING TOWER TERMINOLOGY

Bleed-off or blowdown. The discharge of a portion of the circulating water to remove suspended and dissolved solids left behind when pure water evaporates from the tower. If untreated, these solids may cause scaling and other problems.

Concentration ratio (CR) or cycles of concentration. The concentration ratio is an indication of how many times water circulates in the cooling tower before it is discharged as bleed-off. The concentration ratio is expressed as a relationship between the concentration of total dissolved solids of the bleed-off (CB) and the concentration of total dissolved solids in the makeup water (CM): CR = CB/CM. From the standpoint of water conservation, a high CR is desirable.

NOTE: If CM and CB are not measured by a meter, CR may be calculated by dividing the concentration of one or more dissolved solids in bleed-off water by the concentration of dissolved solids found in makeup water. For example, if the incoming makeup water has 100 ppm of calcium carbonate and the tower bleed-off water has 300 ppm of calcium carbonate, then the cycles of concentration = 300/100 = 3.0.

Another way of estimating cycles of concentration is to use conductivity. If incoming makeup water has a conductivity of 400 and the bleed-off water conductivity is 1200, then cycles of concentration = 1200/400 = 3.0.

Drift. Water droplets and mist lifted out of the cooling tower by air moving through the tower. In well-maintained towers, water loss due to drift should be small. Because the droplets still contain dissolved solids, drift is considered a part of bleed-off.

Evaporation rate. The rate at which water is lost through evaporation. A approximate guideline states that cooling towers lose 2.4 gallons per minute per 100 tons of cooling. For example a 700 ton tower loses 16.8 gallons per minute (2.4 gpm/100tons X 700 tons).

Make-up water. Water added to the system to replace water lost via evaporation, drift, and blowdown. Drift is usually small, so if you meter the bleed-off (B) and makeup (M) rates, you can calculate the evaporation rate (E): E = M - B.

Tons. Unit of cooling capacity equal to 12,000 BTUs (British Thermal Units) per hour. Cooling towers in typical facilities range from 50 tons to more than 1,000 tons.

Total Dissolved Solids (TDS). The concentration of minerals and other dissolved solids in the cooling tower circulating water. As the concentration increases, a portion of the water must be discharged to prevent damage to the system.

HOW MUCH WATER CAN BE SAVED?

The graph in Figure 5-3 shows the relationship between the concentration ratio (CR) and the amount of water consumed by a cooling tower. To determine the percentage of cooling tower water consumption that can be conserved by increasing the concentration ratio, use the following equation:

$$\text{Percent conserved} = \frac{CR2 - CR1}{CR1\ (CR2 - 1)} \times 100\%$$

where: CR1 = concentration ratio before increasing cycles, and
CR2 = concentration ratios after increasing cycles.

EXAMPLE 1: Increasing the concentration ratio from 2 to 4 results in a water savings of 33%.

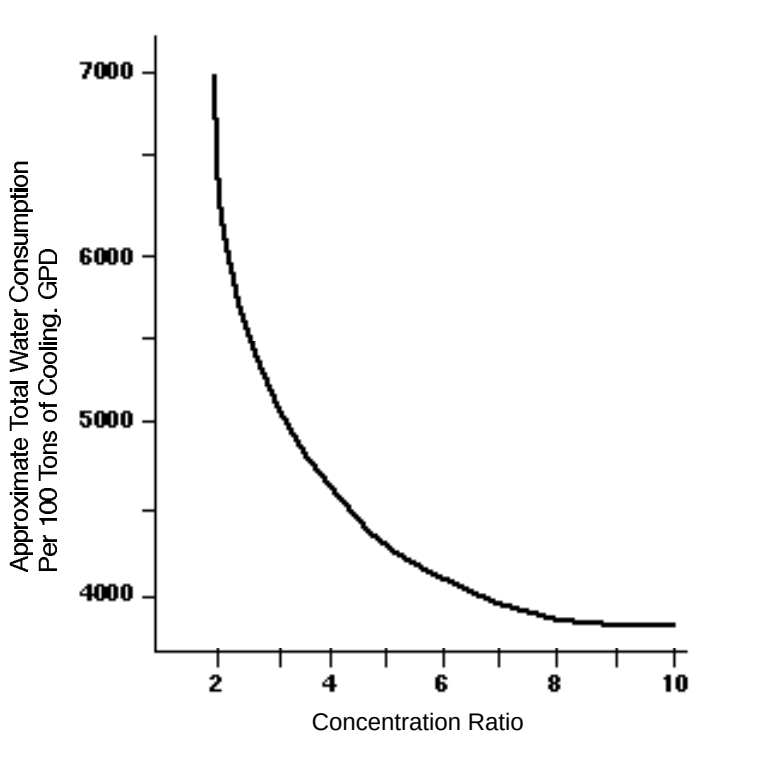


Figure 5-3:
Cooling Tower Water Consumption vs. Concentration Ratio

Sources: "Uses of Water and Water Conservation Opportunities for Cooling Towers" by J. Douglas Kobrick, P.E. and Mark D. Wilson, Black & Veatch; City of San Jose Environmental Services Department

SINGLE-PASS COOLING SYSTEMS

Single pass (also known as "once-through") cooling systems present another significant opportunity for conservation. In these systems, water is channeled through a piece of equipment and then disposed down the drain. The types of equipment that typically utilize single-pass cooling include: CAT scanners, degreasers, rectifiers, hydraulic presses, x-ray processors, condensers, air conditioners, air compressors, welding machines, vacuum pumps and viscosity baths.

Here are some ideas on how to save water in single-pass systems:

— Modify equipment to operate with a closed-loop cooling system that recirculates the water instead of dumping it. For small equipment, it may be possible to tap into an existing recirculating chilled water loop.

— Replace water-cooled equipment such as compressors and vacuum pumps with air-cooled models. Air-cooled ice makers, ice cream and frozen yogurt machines are available, as is other equipment that uses water-cooled condenser units.

— If the above options are not viable, try to find another use for the single-pass effluent, in boiler make-up supply or landscape irrigation, for example. Also look for other appropriate sources of water to feed single-pass cooling, such as reverse osmosis reject water.

SMALL EVAPORATIVE COOLERS

Evaporative coolers, also know as "swamp coolers" or "desert coolers," work on the same principle as cooling towers. Air is cooled and humidified as it passes through porous pads that are kept moist by water dripped on their upper edges. Unevaporated water trickles down through the pads and collects in a pan for either discharge or recirculation. Since the cooling relies on evaporation, these coolers work best in arid climates such as New Mexico's.

When water evaporates it leaves behind scale and mineral deposits on the pads. This reduces the volume of air flowing through the pads and compromises the performance of the cooler. In areas where water is very hard and/or the air is dusty, pads may become clogged very quickly.

Bleed-off water serves to dilute the mineral concentration of pan water and reduces scale and dirt build-up on the pads. There are two types of bleed-off systems. The once-through or pumpless type is simpler and less expensive than the recirculating or pump type, but it consumes more water and requires constant drainage. (Wilson, May 1996, Appendix B, p.1)

To reduce water used by evaporative coolers:

— Keep a tight rein on the amount of bleed-off water. For most small coolers, bleed-off volume should be less than a few gallons per hour for each 1,000 cubic feet per minute of air flow (Wilson, Appendix B, p.2). In addition to saving water, lower bleed-off rates also lead to greater thermal efficiency.

— Avoid single-pass or pumpless coolers. Recirculation saves water and increases the thermal efficiency. But if recirculation is not an option, consider using the bleed-off water for irrigation or other uses.

— Replace worn or torn pads.

— Inspect the recirculation pump and reservoir level controls periodically during the warm months when the system is running.

Figure 5-4:
Typical Evaporative Cooler

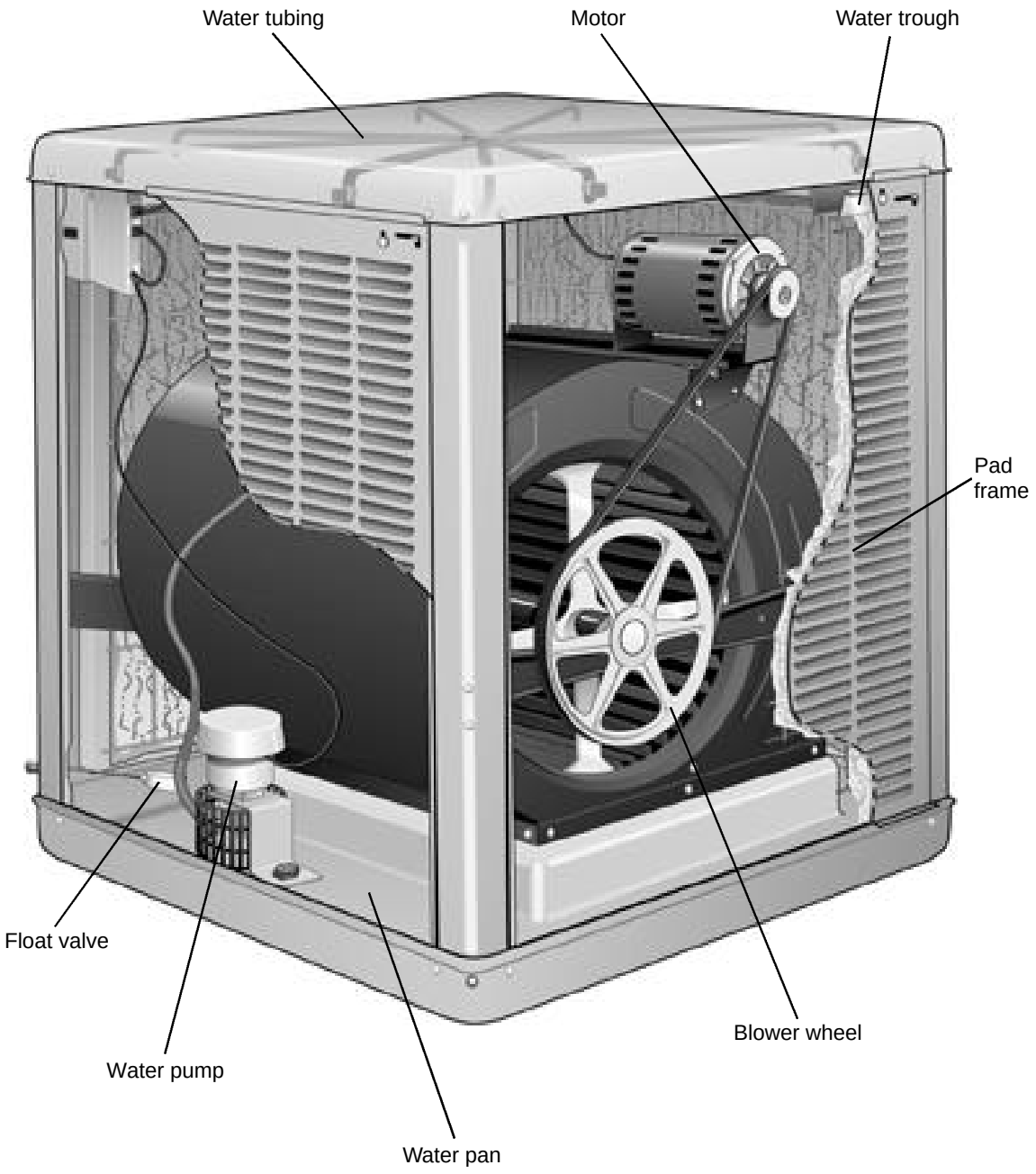


Illustration courtesy of Champion Coolers

BOILER AND STEAM SYSTEMS

Boilers and steam generators are used in large heating systems, in cooking, or in facilities where processed steam is required. Water consumption rates of boiler systems vary depending upon the size of the system, the amount of steam used, and the amount of condensate return.

Several different designs for boiler/steam generators are available. The most common is the fire tube boiler, called the shell and tube design. In this type of unit, a gas or oil fired heater directs heat to the tubes and water in the shell to produce steam. The water in the boiler is treated with various chemicals to inhibit corrosion and scale formation in the steam distribution system. In many systems, after the steam is used (for heating, cooking etc.) the condensate is returned to the boiler. This can be considered a water conservation measure because it reduces the need for boiler feedwater make-up.

Water is added to a boiler system to make up for the water lost as steam, and to periodically blowdown the boiler to expel any scale that may have built up. If the boiler system is not equipped with a condensate return system, all the water used to generate steam is lost, and make-up water must be added. (Black & Veatch, 1993, p. 25)

To conserve water:

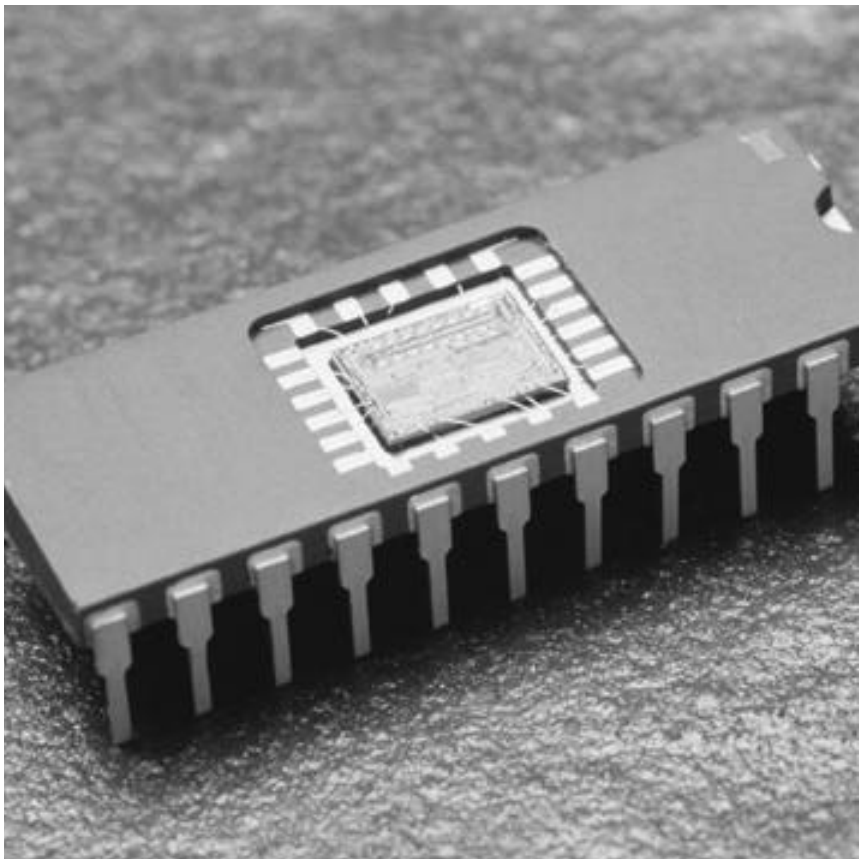
— Regularly check steam traps and lines for leaks and make repairs as soon as possible.

— If your system does not already return steam condensate to the boiler, consider making modifications that would do so. This conserves energy as well as water because the relatively hot condensate needs less heating to produce steam than make-up water from other sources. Recovering and returning steam condensate may cut operating costs by up to 70 percent.

— Install an automatic control to turn off the unit when it is not in use during nights and/or weekends.

— Install an automatic blowdown control for boilers to better manage the treatment of boiler make-up water.

Section 6:
Water Conservation Measures for Specific Processes and Industries



Water plays an integral role in many New Mexico manufacturing processes from metal plating and finishing to semiconductor chip fabrication. The above-mentioned facilities, with their heavy reliance on rinsing and reaction baths, are among the state's largest industrial water users. But many are also among New Mexico's most innovative and dedicated water conservationists; a few have even pioneered water-saving techniques or equipment that have been adopted by their other facilities outside New Mexico. (See, for example, the case studies in Section 7 on Intel and Tuscarora.)

Every industry's production line has its own unique elements and requirements. In this section, several specific industries are addressed. In addition, virtually every plant manager can obtain water savings by considering and adapting these more general guidelines:

— Review each process to determine if less water can be used and if the most recent water-saving technology is being employed. Pay particular attention to the rinsing steps; in many cases operators use an excessive amount of water, far more than what is required to ensure product quality.

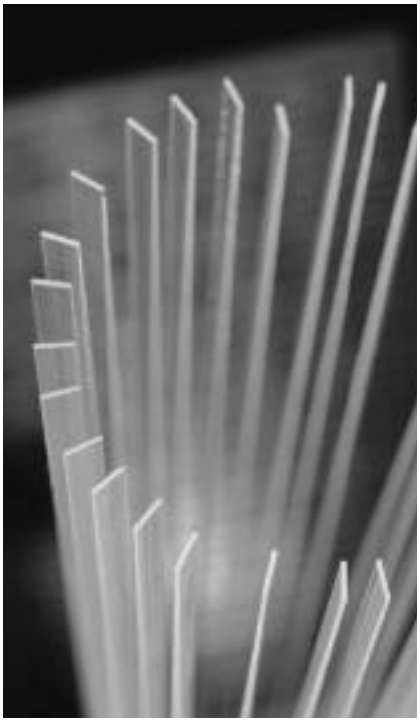
— Go beyond the standard information provided by equipment manufacturers to investigate the real need for water use.

— Install pressure reducers if high water pressure is not required.

— Use reverse osmosis and de-ionized water only where it is essential.

— Make sure all controls, sensors, and valves are checked frequently and repaired promptly.

— Investigate counter-current rinsing, spray systems, flow reduction devices, solenoid or timer shut-off valves, pH or conductivity probes, and batch processing for water-saving opportunities.



RINSING AND CLEANING

There are several types of rinse baths used to remove contaminants from the surface of a product or component. Static rinse baths wash away contaminants when the workpiece or product is dipped in to it. The bath must be periodically drained and replenished with fresh water.

Constant overflow rinse baths, also known as "running rinses," wash away contaminants with a continuous flow of water to the tank. The flow rate varies widely and is often not metered. The overflow of spent water is typically sent down the drain.

The most water-efficient rinsing system uses a counter-current or counter flow arrangement, in which the rinse water progresses from tank to tank in a direction opposite to the processing order. In this way the cleanest water is used for the final product rinse. It is then used again to rinse the product in earlier rinse steps where water quality is not as critical.

To conserve rinse water, focus on:

1. controlling water flow
2. increasing the efficiency of the rinse process
3. reclaiming spent water.

Water Flow

— Avoid excessive dilution. Determine the maximum allowable contaminant concentrations in the rinse tanks. Install flow meters or manually operated flow control valves instead of orifice plates for flow control. This will allow for greater operating flexibility, including the ability to respond to changes in supply pressure. These devices are inexpensive and simple to operate, but they do require operator attentiveness.

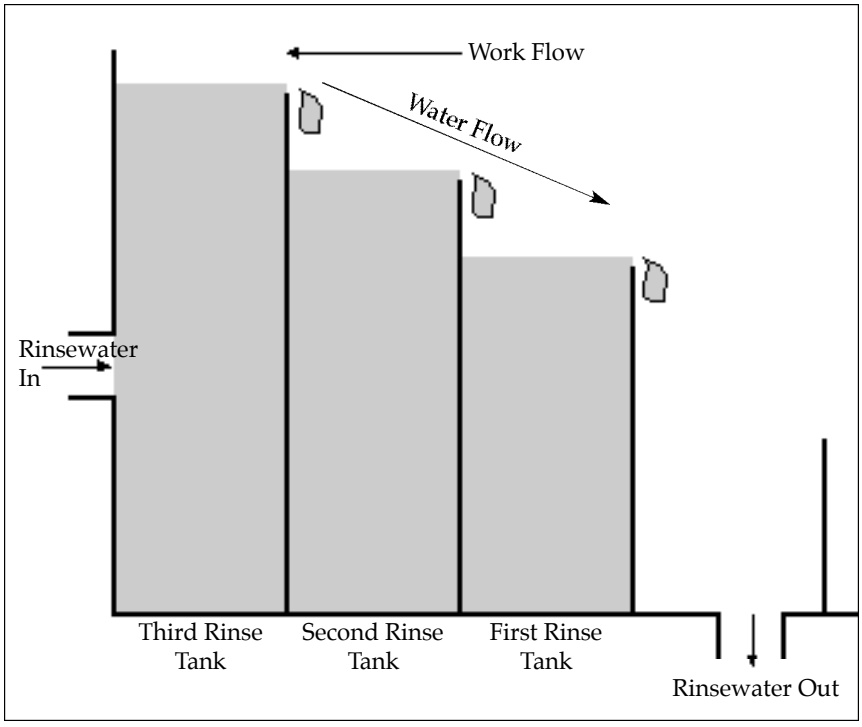
— Use measured amounts of water rather than continuous streams.

— For automatic flow control, use conductivity or total dissolved solid (TDS) meters to monitor rinse water concentration and to trigger electrically operated flow control valves. Be aware that this option will not work well if there are rapid variations in make-up water TDS due to changes in water supplier sources.

— Reduce the rate of "trickle flows" which run continuously even when processing is not taking place.

— If possible, install timers or shut-off valves to turn off water flow whenever a process is shut down or temporarily taken out of service.

Figure 6-1
Three-stage countercurrent rinse



Rinsing Efficiency

— Install spray rinse systems directly above the process baths where possible. Water savings of up to 60 percent (compared with immersion tank water use) may be possible (Arizona Municipal Water Users Association, 1997, p. 73). Spray rinsing is most effective for parts that are flat, have small holes, or are cup shaped. You may be able to adjust the flow rate so it equals the evaporation rates from the process bath.

— Use sequential rinsing, in which spent water from one process is used as rinse water for another compatible process. For instance, rinse from an acid bath might be used for rinsing in a caustic bath rinse.

— For multi-tank rinsing, consider making the first tank a static rather than continuous rinse. This conserves water because a high percentage of the contaminants is discharged into the first rinse tank, which is allowed to become more concentrated than the rinses that follow. Less water is used to periodically dump and refill the tank than is used for continuous overflow rinses.

— Use counterflow rinsing. Converting from one rinse tank to two counterflow tanks has been reported to reduce water consumption by over 50 per cent, in some cases. Adding a third tank can save another 10 percent. (ibid, p. 73). The disadvantage of this system is that it may require additional floor space as well as more tanks and piping.

— Eliminate plenum flushes where not required.

— Instead of cleaning one item at a time, consider batch processing. Processing several workpieces at the same time makes more efficient use of process water, saves time, and increases productivity.

— Schedule wet process production so rinses are operated fewer hours during the day.

— Reduce rinse water in solvent degreasing by installing tamper-proof conductivity meters to control make-up water to rinse tanks.

Reclamation and Other Ideas

— Reclaim spent rinse water; treat it if necessary. Reuse rinse water for lower-grade process steps or for other facility applications such as cooling tower make-up water (See Section 7 for the case studies on Intel and Sandia National Laboratories, for example). Water can be selectively separated from solids using a number of membrane technologies including reverse osmosis, electrodialysis, ultrafiltration, and microfiltration.

— Improve the quality of wastewater and reap the economic benefits of recovering chromium, copper, silver, and other valuable materials.

— If there is a circulating de-ionized water loop in the facility, consider returning the final portion of rinse water to it. The water that flows at the end of a rinsing sequence usually becomes only slightly contaminated, and may even be of better quality than the facility's incoming water supply (City of San Jose, Computer and Electronics, p. 5). Direct reject de-ionized water to other uses.

— Recover, treat, and reuse filter backwash water. Recycle water in test tanks. Recycle water used in head-polishing machinery.

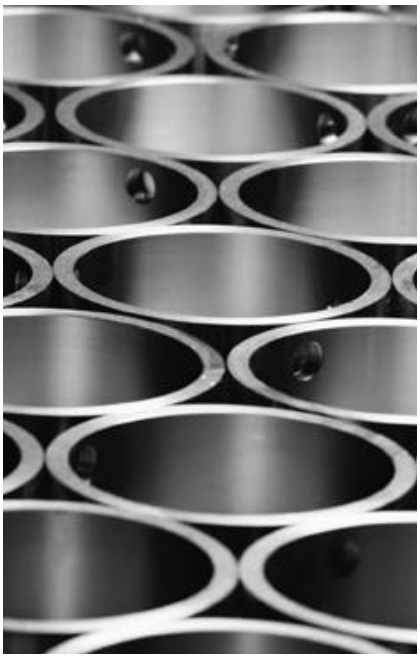
— Install ultrasonic cleaning equipment for reusable containers and degreasing.

— Instead of caustic jet spray rinses, use a burn-out oven for cleaning used engine parts. Then bombard the cleaned parts with beads and shot to remove residue. This also reduces the need for toxic waste disposal (State of California, October 1994, p. 36).

— Recycle "clean-in-place" rinse water. Use it for the next caustic wash.

PLATING AND METAL FINISHING

Many of the measures outlined in the previous section apply to plating and metal finishing as well as other industries. For plating and finishing processes, there are additional ways to reduce "drag-out," the liquids and chemicals that are carried on workpieces from one tank to another. Reducing drag-out saves water because the rinse water does not have to be replenished as often.



— To minimize drag-out, allow enough time for the workpiece to drain into the plating tank before it is moved to the rinse tanks. Drain times of 10 seconds or more have been used successfully and have cut drag-out by 67%. (University of Missouri). Also tilt or orient the workpieces so that liquids can drain more easily as they are removed from the baths and so only a small surface area comes in contact with the solution surface as the pieces are removed.

— Use wetting agents in the plating baths, which can reduce drag-out by as much as 50% by reducing surface tension. Make sure, however, that the resultant foam is compatible with waste treatment systems (ibid).

— Consider reducing the metal concentration in the plating baths. Concentrations as low as 29 ounces of chromium per gallon have been used effectively in plating shops (ibid).

— Explore increasing the plating bath temperature. Increased temperature lowers the viscosity of the plating solution so that it drains off the part more easily. Note, however, that high temperatures break down brighteners and increase carbonate buildup in cyanide solutions. The evaporation rate from the process tank will also increase. To counteract evaporation, add water from a rinse tank.

— Install air knives. Air blown on the surface of the parts as the racks are raised from the tank helps fluids drain back into the tank.

— Install drain boards between the process and rinse tanks to collect drag-out and route it back to the process tank.

— To improve the efficiency of rinsing, try agitating, lifting and lowering the tank to increase the circulation of the rinse water. Consider forcing air or water into the immersion rinse tank. Let the workpiece stay in the rinse water for a longer period of time.

— Consider evaporator/condenser systems or membrane systems for separating rinse water from plating solutions, for recycling, or for both.

— To extend the lives of the baths, inspect all parts before plating. Parts should be clean, dry, and free of rust and mill scale. Pre-wash or wipe dirty parts using old solvent.

— When the alkaline bath declines due to evaporation and drag-out loss, consider dumping only part of the bath rather than the entire amount. Then add fresh chemicals and water.

MEDICAL CARE FACILITIES

Medical care facilities, such as hospitals and nursing homes, have unique water conservation opportunities and challenges. In addition to utilizing the domestic and indoor conservation measures previously mentioned, medical care facilities should consider water conservation measures in the areas described below.

Sterilizers and Autoclaves

In many hospitals, sterilizers and autoclaves may use as much water as the cooling towers and heating system. (City of San Jose, Hospitals & Healthcare Facilities, p. 3 and p. 11). It is not unusual for medical care facilities to have five to 10 of these units available 24 hours a day. Some older models are notorious water users, running water constantly with no way to meter or control the flow. Typical continuous-flow rates range from 1.0-3.0 gpm in sterilizers and from 0.5-2.0 gpm in autoclaves (Black & Veatch, 1993, p. 33-34).

Water in sterilizers is used to produce steam, to cool the steam, and, in some cases, to draw a vacuum in the unit to speed drying of the surgical instruments, trays, and tools being cleaned. Autoclaves use ethylene oxide instead of steam as a sterilizing medium, but water is used to carry off spent ethylene oxide, and, in some cases, to create a vacuum to aid in drying.

Conservation measures include:

— Check that the flow rates being discharged do not exceed the manufacturer's recommended value. Ask if the flow can be reduced to a minimum acceptable level.

— Retrofit units with solenoid-operated valves that shut off the flow of water whenever the unit is not in operation.

— Choose new sterilizers or autoclaves that are designed to recirculate water and that allow the machine's flow to be turned off when the unit is not in use.

— Instead of using water to cool sterilizer steam, consider installing a small expansion tank to allow the steam to cool to temperatures acceptable for discharge into the sewer system. Talk to the manufacturer or service contractor to make sure this modification does not affect the sterilizer's performance.

— Alternatively, reuse cooling water and/or the steam condensate. Send this water to the boiler or cooling towers instead of down the drain. (See the Presbyterian Healthcare case study on pg. 95.)

— Use a high-quality supply of steam to maximize the water efficiency of the sterilizer.

— Shut off all units not in service.

X-Ray and Photo Processing

Film processing, including x-ray development in hospitals and other medical facilities, is commonly done with automatic machines. In general, these processors utilize a series of tanks and dryers to develop, stop, fix, harden, wash, bleach, and dry the film. Water is used principally in the rinse or wash cycle, and, in older machines, this water can run continuously. New machines are more water efficient (and reduce the amount of silver in wastewater as well).

To save water:

— Install an inexpensive flow-rate meter in the supply line to ensure that the correct flow of rinse water is being received by each processor.

— Install a control valve in the piping to each unit. Adjust water flow to the minimum rate possible. Many hospital X-ray processors use a higher flow rate than necessary to ensure acceptable quality. The average hospital unit requires about 2.0 gallons per meter (gpm) or less, but in practice the actual flow rate is typically greater than 3 or 4 gpm. (Arizona Municipal Water Users Association, 1997, p. 76). Post a list of minimum acceptable flow rates near each machine.

— Install a pressure-reducing device on any equipment that does not require high pressure.

— If the processor utilizes a solenoid valve that shuts off rinse and cooling water flows when the unit is not in use, make sure the valve is working properly. It is not uncommon for processor valves to operate incorrectly, allowing continuous water flows. Some machines without solenoid controls can be retrofitted.

— Consider recycling rinse bath effluent as make-up for the developer/fixer solution.

— Replace old equipment with water-efficient models. Look for machines equipped with a squeegee to remove excess chemicals from the film as it travels from one tank to the next. Depending on the system, a squeegee can reduce the amount of chemicals carried between tanks by up to 95 percent (ibid, p. 76). The lower the amount of chemicals carried over to the wash cycle, the less wash water is required.

Miscellaneous Medical Facility Processes

Below are several more ways to save water in medical facilities.

— Do not rely on running a stream of water through an aspirator to create a vacuum.

— Draw on the hospital's recirculating systems for cooling in place of single-pass cooling for laboratory instruments.

— In water-ring vacuum pumps, check the flow rate of the water ring seal and its control. Install a flow restrictor or replace with an oil-ring vacuum pump (See the Presbyterian Healthcare Services case study, pg.95).

— Use softened water only where it is needed. Ensure that the flow rates and cycle times are properly set during the regeneration cycle, when water is used to flush the resin and to refill the brine tank. Monitor water quality before starting the regeneration cycle to ensure that water will be used most efficiently.

OTHER PROCESSES

Here are a few conservation ideas for other kinds of processes.

Painting

— Use an electrostatic process to paint metal surfaces. This will reduce air pollution and eliminate the need for water curtains.

— Recycle water used to collect overspray paint by treating water with dissolved air flotation and a filter dewatering system to separate toxic solids.

— Replace water-wall paint-spray booths with a dry filter medium to collect overspray.

Dyeing

— Reuse water from light-colored applications for batch dyeing operations.

— Consider separating rinse drains and recycling some rinse water as dye bath make-up.

Fume Scrubbers

Wet fume scrubbers use water sprays to remove pollutants from production exhaust gases before they are released to the atmosphere. Even though most scrubbers recirculate some water, losses due to evaporation and discharge can add up; flow rates between 5 and 10 gallons per minute are common.

— Install flow meters to measure the water flowing into the scrubber for make-up water. Make sure the flow does not exceed the rate specified by the manufacturer for proper operation.

— Instead of feeding fresh water into the scrubbers, explore the possibility of using lower grade, non-potable water. (Be careful not to create any cross reactions between the chemicals in the water and those in the exhaust stream.)

— Explore treating and reusing the water normally discharged from the scrubber. Consider replacing wet scrubbers with a bag house variety (See Ponderosa Products case study, pg. 84.)

Making Use of Degraded Water

— Reuse reverse osmosis reject water for other uses. Depending on the reject water quality, uses may include process cooling, equipment cooling, fume scrubbers, photo processing, washing areas not needing ultra clean water, and irrigation.

NOTE: Because reverse osmosis filtration concentrates naturally occurring minerals into the reject water, caution should be applied in selecting an application for this mineral-laden water.

Section 7:
Case Studies in Commercial, Institutional and Industrial Water Conservation

INTEL, RIO RANCHO

Intel is the world's largest maker of computer chips and the largest private employer in the Albuquerque metropolitan area. It is also among New Mexico's top industrial water consumers, using the same amount of water per year as nine Albuquerque golf courses. Intel has aggressively pursued water conservation in response to the community's and its own concerns.

The Intel campus consists of three manufacturing plants called "fabs." Fabs 7 and 9 primarily make memory devices for cellular phones, laptop computers, and other portable electronic products. The two-building Fab 11, completed in 1995, is a state-of-the-art facility producing microprocessors or the "brains" that orchestrate data processing in personal computers. Currently all these devices are fabricated on silicon wafers, 6 or 8 inches in diameter.

In 1993, when Intel was still contemplating Fab 11, Fab 7 and 9 were using about 2.8 million gallons per day (mgd). It was estimated that the addition of Fab 11 would bring Intel's consumption up to approximately 10 mgd if no additional conservation measures were taken. With conservation however, Intel's water use since 1996 has held steady at about 4 mgd even though its chip production has increased 70 percent since 1995.

INTEL

1993: Projected Water Use (after plant expansion):
10 million gallons per day

1998: Actual Water Use:
3.86 million gallons per day

Water Savings: 61.4%

Intel once used fresh water for all its operations: fabs, air pollution scrubbers, cooling towers (which provide air conditioning), and irrigation. With conservation measures, much of the water is now recycled. (See Page 15.)

Only 15% of the water it uses is lost to evaporation, scrubbers and irrigation. The rest is pretreated and then piped directly to the City of Albuquerque's sewer system and treatment facility, where it eventually returns to the Rio Grande Basin.

Intel has reduced its manufacturing water use by:

- Increasing the efficiency of the system that purifies incoming water
- Reducing the amount of water needed in production by optimizing the existing "wet benches" that rinse wafers during their six weeks of processing and ulti mately redesigning the wet benches
- Reusing outgoing water by channeling it to cooling towers and air pollution scrubbers

Purification. Chip manufacturing is an immaculate process because even tiny amounts of impurities can degrade or ruin semiconductor devices. Therefore, the air in Intel's clean rooms is 1000 times cleaner than a hospital operating room.

Similarly, the water used to rinse the chemicals that etch and clean the chips must be ultrapure, free of the minerals that are contained in city and well water. In addition to sodium, calcium, and other minerals common to most New Mexico water, Intel also has to contend with high levels of silica in its well water. Using conventional reverse osmosis (RO) technology, Intel was able to turn every two gallons of incoming water into one gallon of ultrapure water and one gallon of concentrated "graywater," which is used for irrigation or sent to the sewer system. In other words, the filtering system with this technology was 50 percent efficient.

In 1995, engineers began adding chemicals called scale inhibitors to the water. This increased the solubility of silica, essentially increasing the graywater's capacity to hold and carry away dissolved silica so that it doesn't precipitate out or scale the membranes of the RO system. Scale inhibitors increased the filtering efficiency to 65%: Intel produced 1 gallon of ultrapure water from only 1.54 gallons, instead of 2 gallons, of incoming water. This saved 209 million gallons of water in 1996.

Intel boosted the efficiency even more by working with a consultant who pioneered a new purification process called the High Recovery Reverse Osmosis Process (HRROP). The team discovered that silica's solubility dramatically increased at high pH or alkalinity. But when the team increased the pH, the solubility of other minerals became a problem. So the researchers first softened the water to take out the other minerals and then raised the pH to keep the silica dissolved during conventional reverse osmosis. As of January 1999, a pilot program indicated that this approach will increase purification efficiency to over 85%: Every 1 gallon of ultrapure water will require only 1.176 gallons of input water (saving an additional 700,000 gallons of incoming water per day). Ironically the 0.176 gallons of rejected graywater from the $5 million system is too highly concentrated with minerals to be used for irrigation. Intel hopes to use treated effluent from the City of Rio Rancho for watering its grounds instead.

Processing. Wafers are rinsed by submersion in a tank or wet bench of ultrapure water. The tank fills and overflows continuously (to prevent the growth of bacteria), carrying away chemical residue and outgassing carbon dioxide. When Intel began looking carefully at the rinse step, it discovered that it could maintain its production quality with 75% less overflow water.

Intel also asked Sandia National Laboratories to develop a fluid dynamics computer model of flow in the tank and found that 50% of the water was not actually rinsing the wafers. So the company worked with the equipment manufacturer to design a new wet bench; by changing the shape and volume of the tank as well as the way in which water flows in and out, Intel saves half of the water previously required, as well as saving energy and chemicals. This wet bench, the first to be redesigned with conservation in mind, has been installed at other Intel sites around the globe.

Intel reduced the trickle of ultrapure water in other process steps as well as in equipment during shift changes of personnel. Further water reductions in the manufacturing process have resulted from replacing some water-based vacuum generation equipment with an air-based system.

These and other conservation efforts have not only saved water, but have also boosted production capacity by decreasing the amount of time wafers spend in rinse cycles. In some cases, conservation has also eliminated the need to purchase additional manufacturing equipment.

Facilities. Intel's North and South Energy Centers support the fabs by providing chilled water and steam for production, as well as controlling the temperature and humidity in the clean rooms and capturing pollutants before the exhaust is released to the air. Intel saves approximately 757,000 gallons of water a day by routing rinse water from some of the fabs to cooling towers and air scrubbers.

Landscaping. Intel has xeriscaped its 31 acres of grounds and upgraded its irrigation systems, resulting in an expected 60% reduction in the amount of water used to sustain its landscaping.

SANDIA NATIONAL LABORATORIES, ALBUQUERQUE

Sandia National Laboratories (SNL) is operated for the U.S. Department of Energy by the Sandia Corporation, a Lockheed Martin Company. SNL designs all non-nuclear components for the nation's nuclear weapons and conducts a wide variety of research, from the development of solar cells and computer chips to fusion. Located in six separate sites on Kirtland Air Force Base, SNL employs more than 8,000 people working in 765 buildings encompassing 5.4 million square feet.

As if the sheer size and diversity of Sandia's activities and funding weren't daunting enough, a facilities manager contemplating water conservation is also hampered by the fact that few buildings are metered. (At the time most were built, water was considered an unlimited resource.) There also are no meters measuring how much water SNL takes in as a whole; most of its water comes from wells owned and operated by Kirtland. Based on sewer flow, cooling tower evaporation rates, steam plant condensate losses and other factors, Darell Rogers, Sandia's Water Conservation Officer, estimates that Sandia used approximately 400 million gallons of water annually before any conservation measures were enacted.

SANDIA NATIONAL LABORATORIES
1995 Water Use:
400 million gallons*
1998 Water Use:
324 million gallons*
(19% reduction)
2004 Water Goal:
280 million gallons
(30% reduction)
*estimated

Microelectronics Development Laboratory (MDL).

Figure 7-1 shows Sandia's estimated water use by category. Even without a complete water audit, it was clear that the production of ultrapure water used in the microelectronics facility plus the water used for cooling and steam generation accounted for most of Sandia's consumption. Since these areas lent themselves to several easily implemented, high-return remedies, conservation measures were implemented in these areas first. Rogers says these early successes may help obtain the funding, resources and support for a more thorough audit and an institution-wide commitment to water conservation.

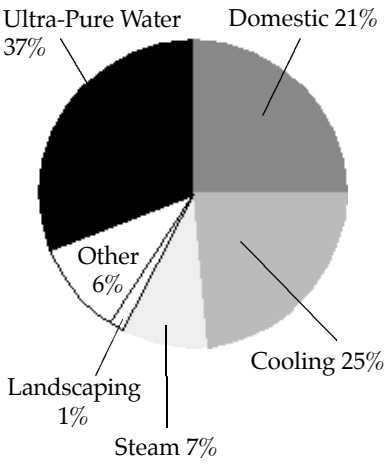
Ultra-Pure Water Production. Sandia's Microelectronics Development Laboratory uses ultrapure water to process semiconductor wafers. The facility had been consuming an estimated 128 million gallons per year. In 1996, more efficient, larger-surface-area reverse osmosis membranes were installed along with better valves for more precise control of the flow of water. Amanifold was also added to the reverse osmosis pump, which converted it to a more efficient two-stage pump. These changes reduced the lab's water use by 30-38 million gallons a year, resulting in savings of $78,000 in water and sewer costs. Moreover, because the reverse osmosis system is more efficient, it requires fewer hours of operation, resulting in an annual energy savings of $22,000. The total cost of the project was $107,113; payback was less than one year.

Reuse and Recycle Wastewater. Figure 7-2, a schematic of water flow in the Microelectronics Development Laboratory (MDL), shows several recycling opportunities. The first phase of Option 4 was completed in 1997. Sandia now pumps a portion of MDL's processing waste water to an adjacent cooling tower. The water, considered too contaminated for reuse in the plant, is treated in an acid waste neutralization system prior to entering the cooling tower. This saves 8-12 million gallons of water and $20,000 per year.

Options 1 and 3 are currently being investigated. Recycling spent rinse water from the wet benches of a semiconductor facility (a "fab") and returning it for reuse to some node of the plant ultra-pure water (UPW) system offers the greatest opportunity for water savings in semiconductor manufacturing. In addition, because spent rinse waters, by most metrics, are of much higher quality than incoming municipal water, the quality of the UPW produced is enhanced by this tactic. Unfortunately, some spent rinse waters contain contaminants, typically organics, not found in municipal waters. Worse yet, certain of these contaminants can degrade the performance of other components in the UPW system such as reverse osmosis membranes and ion exchange resins. This risk perceived to be associated with rinse water recycling continues to limit the widespread acceptance of recycling at many U.S. semiconductor manufacturing sites in spite of the conservation, costs and performance advantages that could accrue. With today's billion dollar investment in a production facility, even a small interruption in production can cost more than a year's water savings.

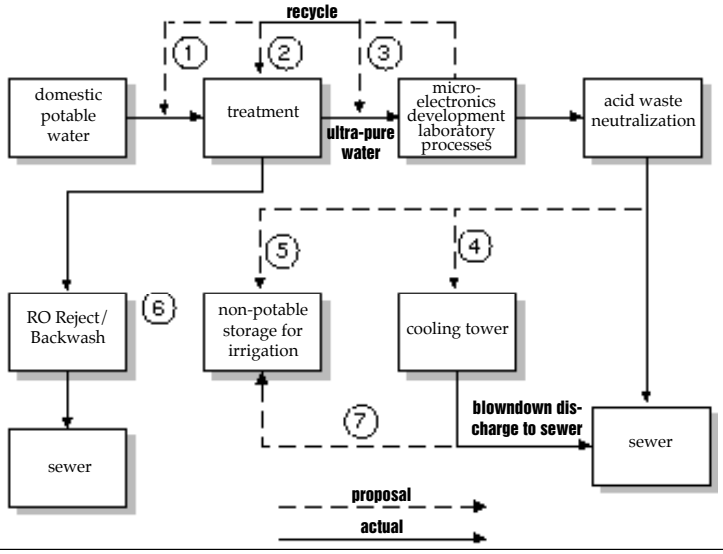
To minimize the recycling risk, SEMATECH, a consortium of chip manufacturers, funded a project at Sandia to develop and demonstrate near real-time sensors for detecting the presence of objectionable contaminants in the rinse waters collected for recycling. These fast responding sensors allow contaminated water to be diverted from the recycle loop before entering the UPW system, avoiding any of the upsets that so worry management and production staff. Incorporation of such technology, not yet completed, could reduce the MDL's water consumption by 50% and allow the US semiconductor industry to save on the order of 30 billion gallons of water per year.

Figure 7-1
1996 Water Consumption at Sandia National Laboratories



As a first step, engineers have separated the drainage systems of two kinds of discharge that occur during processing: (1) deionized water used in wafer rinse baths; and (2) various acids used to etch and clean the wafers in processing tanks. Keeping the higher quality

Figure 7-2
Water Flow Schematic at the Microelectronics Development Laboratory



rinse water apart from the acids should increase the amount of water that can be recycled. MDL is also looking into ways of recycling the acids themselves: on-site reprocessing and reuse of the acid in Wet Chemistry Process benches; collection and off-site reprocessing of the waste acid; and on-site use of the waste acid to regenerate ion exchange resins. This project, which cost $35,000 to implement, will reduce water consumption and wastewater discharge by 1-2 million gallons and save over $10,000 in operating and maintenance costs annually (thus providing full payback in 3.5 years).

Steam Plant

In continuous operation since 1949, the steam plant supplies an average of 680,000 kg/day of saturated steam for space heating and laboratory processes. Not surprisingly, it is a big water user. Through a series of projects begun in 1995, engineers have reduced water consumption by 15 to 25 million gallons a year, and have eliminated 11.5 million gallons a year of discharge into the sewer system, with a cost savings approaching $100,000 a year. The following water-saving measures have also dramatically cut energy and chemical costs:

Replacement of aging dealkylizer and improvement of synthetic resin. Before well or city water is converted to steam, it is processed through a dealkylizer to lower its pH and a water softener to remove minerals. Both systems now use a new resin, which, combined with higher dealkylizer efficiency, allows for the processing of 43% more water before the resin has to be recharged. Since recharging requires water, the new resin cuts the amount of recharge waste water by 1.2 million gallons a year. The new system also improves water quality.

Leaks repaired in the condensate return lines. The steam that condenses to water is valuable, not only because it can be used again, but also because its high temperature requires less energy to be reboiled to steam. Moreover, this water has already been treated. By repairing leaks in these lines, plant staff increased the amount of condensed steam recaptured from 52% to 68%, equivalent to 12 million gallons a year of water savings.

Reduced frequency of boiler blowdown. Minerals and treatment chemicals in water can precipitate out as scale inside a boiler. To prevent this build-up, the concentrated slurry is periodically removed in a process known as blowdown, which was producing an estimated 5.7 million gallons of wastewater a year. Greater water purity from the improved resin (see above) means that blowdowns are performed less frequently, saving about 2.7 million gallons a year.

Recycling cooling water. The plant uses cold water to cool feedwater pump bearings, fan bearings and conductivity meters (which monitor water quality). By channeling this water to the boilers instead of to the sewer, the plant now saves 6 to 10 million gallons per year.

Cooling Towers

SNL has 23 evaporative cooling towers that use an estimated 78 million gallons a year. While one can't do much about evaporation loss—that's the whole point of the process—there are ways to enhance the performance of the system. Typically, cooling towers are purged of concentrated water (blowdown) fairly often so operators don't have to worry about the towers scaling up. But this practice, with its large margin for error, uses more water than is really necessary. By closely monitoring the hardness of the water with conductivity meters, operators can more precisely determine when blowdown is needed, thereby saving 5 to 15 million gallons of water a year.

The "cycling up" (increasing the amount of input water relative to blowdown water) also saves on chemical costs since fewer blowdowns means the treatment chemicals stay in the system longer. Another beneficial byproduct: it was discovered that the water flow in the chillers was 25% below design specifications. When this is remedied, the efficiency of the chillers is expected to improve 6%, which will save $10,000 a year in energy costs.

Domestic

While bathrooms, kitchens and other domestic settings require far less water than the industrial side of SNL, they still present opportunities to conserve. ATransit Time flow meter (which uses ultra sonic waves to measure water flow) is being used to obtain a baseline for each building. Comparing water use with the number of people and activities in each building will help identify possible sources of waste and leaks (e.g., water flowing at midnight).

* More definitive water use totals will be available after meters are installed in 1999.

BORDER FOODS, DEMING

No discussion of New Mexico would be complete without chile peppers. And no survey of New Mexican businesses would be complete without Border Foods. One of the largest processors of green chiles and jalapeno peppers in the world, Border Foods roasts and processes approximately one million pounds a day and ships its Rio Luna brand of canned chiles to all 50 states and several foreign countries. And business is hot: over the last five years Border Foods has grown 300%. The company recently purchased a second plant in Las Cruces.

After peppers are delivered, they are washed. Chiles are roasted and peeled, jalapenos are de-stemmed. Then the peppers are inspected, cut or diced and acidified to prevent the growth of botulism. The seeds are removed and the peppers are heat treated to kill bacteria before they are canned or frozen. From farm cart to shopping cart, Border uses fresh water to wash raw peppers, carry away the peels, and cool the peppers after heat treatment. With the 200,000-square-foot plant running 20 hours a day, that works out to about 60 million gallons a year.

BORDER FOODS

1992 Process Water Use:
0.70 gallons/pound of product

1995 Process Water Use:
0.51 gallons/pound of product

Water Savings: 27%

By law, Border cannot reuse the peppers' wash water. But the company has reduced its process water use 27% percent by recycling at two other stages in the production line. In 1992 the staff began recycling the peel-laden water by straining out the solids and chlorinating the water before it is used again to take peels away. That brought water consumption down from about 0.70 gallons of water per pound of raw pepper in 1992 to 0.68 gallons per pound in 1993, which resulted in water savings of approximately 20,000 gallons per day.

Starting in 1994, Border also began reusing the cooling water after it was treated. Both recycling projects were expanded as the plant grew. Water use fell from 0.59 gallons per pound in 1994 to 0.51 gallons per pound in 1995. (After 1995, water use per pound went up because Border Foods increased production of its jalapeno peppers by 300%, and jalapenos are canned in brine water).

In addition, Border Foods recycles the 47 million gallons of wastewater it generates each year, using it to irrigate its nearby 100 acres of alfalfa and grass farms. The wastewater supplies all the water needed for irrigation.

PONDEROSA PRODUCTS, ALBUQUERQUE

Chances are the stereo cabine or kitchen shelves in your home are made from particleboard—the kind of particleboard produced by Ponderosa Products. The Albuquerque plant, which has 130 employees and sales of $16-20 million annually, processes 500,000 pounds of scrap wood each day in the manufacture of particleboard.

The process of making particleboard requires water consumption in these two major areas:

1. Steam is used to heat up the 20-board press to more than 300 degrees F. While inside the press, wood chips are fused with a glue-like resin to become particleboard panels.

2. Wet scrubbers are used to remove wood dust from the factory's exhaust.

Ponderosa started investigating ways to cut back on water use in 1989 when it was using approximately 63 million gallons a year. At that time James Barham, Environmental Manager, estimated that the company could save about $148,000 a year in water costs.

PONDEROSA PRODUCTS

1989 Water Use:
63 million gallons

1998 Water Use:
27.3 million gallons

Water Savings: 57%

Boilers
Barham's first project was to capture and reuse the steam condensate from the boilers. The boilers are used to make the steam required to heat up the particleboard press to more than 300 degrees F.

At first, the recovery rate was quite low, and very little condensate was recycled back into the boilers. But over the years, the project was expanded until today the recapture rate is about 50%. Ongoing efforts will attempt to increase the recapture rate even further.

Wet Scrubbers
Wet scrubbers use the most water in the plant, requiring about 330,000 gallons a day. In 1992, Ponderosa began recycling some of this water, which it was required to treat before releasing it to the sewer system. Using wire screens and other inexpensive materials from the local hardware store, the staff

devised a system to remove solids and reuse the water in the scrubbers—thus saving approximately 90,000 gallons daily.

Further water reduction came in 1995 from replacing one wet scrubber with a baghouse (which functions much like a series of vacuum cleaners that filters out dust and particles without using any water). This equipment change saved Ponderosa 15,000 to 20,000 gallons a day. The company had originally purchased this wet scrubber at a time when water was considered cheap and bountiful—a situation that Ponderosa no longer felt applied to Albuquerque's water resources.

Ponderosa's efforts have resulted in a 57% drop in annual water consumption. Admitting that a drought and the water restrictions it could bring would cause major problems for the Ponderosa plant, Barham is continually looking for further ways to reduce water consumption. He gets ideas by brainstorming with employees. Then he inspires management to make changes, not an altogether easy task. "If you show management where they can save money, then their ears perk up," he says. According to Barham, the facility's long-term goal is to have zero discharge to the city's sewer system.

COMMITTED TO RECYCLING

Water isn't the only resource being recycled at Ponderosa Products. After particleboard is manufactured, it is sanded. The waste from the sanded material is called sanderdust, which is recycled: it is burned as fuel in the boiler.

Wood waste is also generated from the trimming of each board after it is manufactured. The trimmed material is recycled and used to manufacture more boards.

Since the plant's inception in 1969, Ponderosa has used more than 4 billion pounds of wood waste that would have otherwise been burned or buried in landfills.

EL REY INN, SANTA FE

New hotels are required to install water-saving toilets, faucets, and appliances. Older hotels, however, can be faced with the expensive prospect of retrofitting in order to conserve water. Fortunately, not all water-saving programs need to be expensive or high tech. In fact, curbing water use can be as simple as placing a printed card in each room asking guests to consider using their linens and/or towels more than once. These reminders, now found in more than 200,000 hotel guest bathrooms around the world, receive serious consideration by at least 70% of guests, saving hotel owners 5% on utilities costs, according to the Green Hotels Association.

The City of Santa Fe's Water Conservation Ordinance requires that a water conservation sign be posted in every public restroom. The city also provides conservation signs and cards for use in hotel and motel guest rooms.

The 86-room El Rey Inn has been using in-room water conservation cards for more than six years, and

the staff reports that most people who stay for more than one day agree to forego having their sheets, and sometimes their towels, changed every day.

Holly Kenney, General Manager at the El Rey Inn, has also installed 1.5 gallons-per-minute showerheads as well as low-flow toilets. The performance of the low-flow toilets has been mixed, however. As a result, air-assisted versions are being installed whenever a bathroom is remodeled or repaired.

Kenney has also held a cash-prize contest for employees who submit water conservation ideas. Many of the ideas have already been implemented. Some, like catching rainwater from the roof for landscaping, may be implemented in the future. But the main purpose, according to Kenney, was to get her staff thinking about saving water—and by that criterion the contest was very successful.

EL REY INN

1995 Water Use:
1.42 million gallons

1997 Water Use:
1.19 million gallons

Water Savings: 16%

WATER CONSERVATION ASSISTANCE FOR HOTELS

The Green Hotels Association® publishes a newsletter for member hotels that includes water- and energy-saving ideas. The association's mailorder catalog offers water conservation products including toilet tank fill diverters, aerators, low-flow massaging showerheads, and other products. For more information contact: Green Hotels Association, P.O. Box 420212, Houston, TX 77242-0212; (713) 789-8889; fax (713) 789-9786; www.greenhotels.com

MARRIOTT HOTEL, ALBUQUERQUE

At the corporate level, Marriott Hotels takes energy and water conservation very seriously. Conservation is integral to Marriott's facilities management and its bottom line. The corporation strives to support its hotel engineers by providing easily accessible, up-to-date information on saving water.

The 17-story Albuquerque Marriott has aggressively clamped down on water waste. Employees have been trained in the importance of water conservation, and are briefed every day during every shift to spot and report potential problems. The hotel's dedication to water conservation has generated impressive results in the following areas:

Grounds

Much of the facility's water savings resulted from watching for leaks in the irrigation system and repairing any faulty lines or valves immediately. In 1996, the staff discovered a leak that had probably gone undetected for years. Another leak in the 18 year-old system was detected in the summer of 1998, which cost the hotel close to 1 million gallons (and may partially explain why the facility's 1998 consumption increased from the previous year).

Prior to 1997, the hotel replaced many of its high-water-use plants and trees with drought-tolerant varieties. Where appropriate, the staff eliminated sprinkler systems and converted to drip irrigation. Efficiency timing tests were performed on all outdoor irrigation zones to study how long it took for the turf to become adequately saturated. This information was used to reduce watering times.

Erik Rems, Director of Engineering for the Albuquerque Marriott, is working toward metering the landscape irrigation system separately from the hotel's interior water system so that leaks can be detected and fixed more quickly.

Guest Rooms

In 1997, water-displacement devices were placed in the existing toilets of all 411 rooms, saving 1 to 1.5 gallons per flush (approximately .5 million gallons annually). The following year, the hotel replaced the 2.5 gallons/minute sink aerators in each guest room with 1.5 gallons/minute fixtures. The new aerators are expected to save between 160,000 to 165,000 gallons a year.

MARRIOTT HOTEL

1994 Water Use:
42.19 million gallons

1998 Water Use:
26.8 million gallons

Water Savings: 36.5%

Ice Machines

More savings came from modifying the six water-cooled ice machines. Instead of running the water through the machines and then sending it down the drain, the staff reconfigured the pipes so that the water re-circulates in a closed loop, saving approximately 1 million gallons a year.

Laundry

The staff met with the hotel's laundry vendor to fine-tune all of the laundry equipment. Scales were installed to ensure that load sizes were optimum. In 1997, the hotel replaced three of its washers with new, more water efficient models. Rems plans to replace one more washer in the next few years. He is also considering recycling laundry graywater by using the last rinse water to start the next load in a new wash cycle. He expects this will save about two gallons per occupied room (approximately 230,000 gallons a year).

Kitchens

When it started its water conservation program in the mid 1990s, the Albuquerque Marriott set up a maintenance program in the kitchen, banquet and "back of the house" areas, replacing malfunctioning equipment and fixing leaks right away.

Swimming Pool

Pool equipment is regularly inspected to ensure proper operation. Rems is researching the possibility of temporarily pumping out and storing the 30,000 to 40,000 gallons of pool water when major maintenance (i.e. repainting or acid washing) is undertaken. After the job is completed the water would be pumped back into the pool. "I'd never even dream of dumping out that water," he said.

MISSISSIPPI POTASH, CARLSBAD

Mississippi Potash (MPI)—a division of Mississippi Chemical Corporation of Yazoo City, Mississippi—operates three plants in Carlsbad 24 hours a day, seven days a week, 365 days a year. The company produces potash (potassium chloride), which is used as an agricultural fertilizer and industrial-grade chemical, from carbonate minerals mined 2,000 feet below the surface. The raw ore is cut, crushed, transported by conveyor belt, hoisted up out of the mine, and transported to the mills. From July 1997 through June 1998, the company mined 5.3 million tons of raw ore and produced 922,555 tons of potash.

Milling Process

At the East Plant, raw ore is crushed and dissolved into a concentrated sodium and potassium brine solution ("leach brine") creating a slurry, and through phase chemistry, potassium chloride (KCl) salt is extracted. The sodium mineral is separated from the potassium mineral and discharged as a waste salt to the tailings pile. The tailings brine water is decanted and flows to the catch basin at a rate of 1,450 gallons per minute.

Insoluble minerals are extracted and discharged to a disposal area known as Laguna Toston at a rate of 1,000 gallons per minute, of which 600 gallons per minute is water. Discharge to Laguna Toston is lost to infiltration and/or evaporation.

Fresh water used in the plant for wash down is collected and returned to the mill. Less concentrated brine water in the catch basin is pumped back to the mill for reuse at a rate of 1,200 gallons per minute. Air pollution control equipment (wet scrubbers) utilize recycled water for removing particulate matter from the emission stream. Each of three wet scrubbers use 40-60 gallons of fresh water and 80-120 gallons of recycled water per minute.

At MPI's West Plant, the raw ore is dissolved into concentrated brine solution creating a saturated brine slurry. The slurry is conditioned with a chemical known as a "collector," and, through a flotation process, potassium chloride mineral (KCl) is extracted.

Sodium chloride salts left on the bottom of the agitation tanks are pumped off as discharge to the tails pile. As the tails brine solution flows and cools, salts precipitate naturally creating a tails pile. Decanted brine water continues to the catch basin at a rate of 300 gallons per minute. Decanted brine water in the catch basin is pumped back to the mill for reuse at a rate of eight hundred (800) gallons per minute. The air pollution control equipment (wet scrubber) utilizes recycled water for removing particulate matter from the emission stream. The wet scrubber uses 40-60 gallons of fresh water and 140-150 gallons of recycled water per minute.

MISSISSIPPI POTASH

Without recycling:
2.18 billion gallons a year

With recycling:
1.05 billion gallons a year

Water Savings: 52%

MPI's North Plant receives granular potash from the West Plant via truck. Under-sized material is compacted by pressing into a cake and run through a flake breaker. Compacted potash is screened again for size with the granular conveyed to the product storage warehouse. Wet scrubbers utilize recycled water for removing particulate matter from the emission stream. Each of the two wet scrubbers use 40-60 gallons of fresh water and 70-80 gallons of recycled water per minute.

Water Conservation

According to Jeff Campbell, Environmental Coordinator, all of Mississippi Potash's personnel are aware of the current water situation in New Mexico and are instructed to minimize water use as much as possible. All MPI plants conserve water by collecting, impounding, and recycling water. (MPI has no landscaping and utilizes low-flow toilets.)

The East Plant milling process requires 3,300 gallons per minute of water. Through collecting and recycling brine water, only 1,500 gallons per minute of fresh water is used in the plant. The use of recycled brine water saves 1,800 gallons per minute.

The West Plant milling process requires 1,100 gallons per minute of water. Through collecting and recycling brine water, only 300 gallons per minute of fresh water is pumped to the plant from the Caprock water well field. The use of recycled water nets a fresh water savings of 800 gallons per minute, or nearly 73%.

The North Plant compaction process requires 200 gallons per minute. Between 40-80 gallons of fresh water and 70-80 gallons of recycled water per minute is used for dust suppression and wet scrubber water supply. The use of recycled water saves 70-80 gallons of fresh water per minute.

Table 7-3

MISSISSIPPI POTASH WATER USE

Plant	Ogallala Aquifer Fresh Water (gpm)	Plant Process Water Demand (gpm)	Conservation Via Recycle (gpm)
East	1,500	3,300	1,800
West	300	1,100	800
North	200	0	80
Total	**2,000**	**4,150**	**2,680**

LA VIDA LLENA LIFECARE RETIREMENT COMMUNITY, ALBUQUERQUE

As the center's name suggests, residents of La Vida Llena Retirement Community enjoy "the full life," but they try to do it without wasting water. With 300 apartments and a 100-bed health care center situated on 20 acres, La Vida Llena is one of Albuquerque's largest retirement communities. Residents do not pay for water directly.

From 1994 to 1998, La Vida Llena reduced water use by 34.3 million gallons of water per year, a whopping 83% decrease. A large part of the community's water savings has come from diligently inspecting for leaks. In 1998, the staff discovered a multitude of irrigation leaks, one cooling tower leak, several boiler leaks, and a major water seepage under a kitchen floor. For months, the kitchen staff had noticed the floor was unusually warm, but it wasn't until the floor was dug up that the 15 gallon-a-minute hot water leak was discovered. Before it was fixed, this leak cost La Vida Llena thousands of gallons of water and countless dollars in wasted energy.

LA VIDA LLENA

1994 Water Use:
41.2 million gallons

1998 Water Use:
6.9 million gallons

Water Savings: 83%

La Vida Llena's water conservation program also included changes in the following areas:

Grounds
In the five years prior to 1999, La Vida Llena converted about 20 percent of its approximately 5 acres of landscaping to xeriscaping. The staff replaced inefficient, oversized sprinkler heads and adjusted watering times after saturation tests revealed they had been overwatering many areas. And, instead of addressing leaks only when someone happened to notice water flowing, La Vida Llena's grounds vendor now monitors the irrigation system for leaks on a weekly basis.

Cooling Towers
La Vida Llena was losing water in its cooling towers because no one in-house had been trained to properly apply and monitor scale inhibitors. In 1997, the community hired a contractor to manage its cooling towers more efficiently. According to Jaime Beltran, Director of Environmental Services, the cooling tower blowdown is only about 5 to 10% of what was once discharged into the sewer.

Pool and Spa
Beltran had the opposite problem with the pool and spa. The pool service company was adding chemicals indiscriminately and would often have to dump half the pool water to get the chemicals into control. When La Vida Llena cancelled its contract with that pool service company in 1997, the retirement community not only saved water but improved the pool's water quality as well. The maintenance staff installed better filters

and a high-flow-rate pump (so that water is filtered more frequently). Most importantly, the staff tests the pool chemistry continuously, adding chemicals only when needed. As a result, only 100 gallons of water is lost each week to evaporation and backwashing, compared to the thousands of gallons wasted previously.

Bathrooms

Even in the summer with the evaporative coolers running, toilets and showers use the most water. Since the fall of 1997, Beltran has been installing water-saving low-flow showerheads on a regular basis. He has also changed out about 10% of the toilets from 3.5 gallon to 1.6 gallon models. "Some residents are reluctant to go to low flow," he says. "The general perception is that they don't flush as well—although our residents have been satisfied with the performance of low-flow toilets." Moreover, unlike conventional apartments where managers can change fixtures when a tenant vacates, La Vida Llena's residents are often there for years or even decades. "They have had these toilets forever, so they don't want to change," says Beltran.

Education

With its own in-house TV station, La Vida Llena has an easy way to get the word out about reducing water use, and from time to time it discusses low-flow fixtures and other aspects of conservation. However, notes Jack Booth, Executive Director, many of the residents are very active in the Albuquerque community, and more often than not it is the residents who bring back information on water conservation to give to La Vida Llena's management.

TUSCARORA INC., LAS CRUCES

Tuscarora is one of the world's largest manufacturers of custom molded foam packaging used to cushion stereo components, computers and other equipment. The Las Cruces plant is one of 35 Tuscarora plants worldwide. The company, conscious of environmental concerns, supports recycling of expanded polystyrene packaging. And led by its Las Cruces and Juarez, Mexico plants, Tuscarora has also taken steps to reduce its water consumption.

While production at the Las Cruces plant increased 40% from 1995 to 1996, water use only rose 10%. In 1997, production increased an additional 12%. Even with the dramatic increase in plant production and a change in manufactured product from expanded polystyrene to expanded polypropylene (which requires more process water), the plant has reduced water consumption from its 1994 pre-conservation baseline rate. The company has implemented the following water conservation measures:

Recycle Cooling Water. Tuscarora uses steam from a boiler to expand foam pellets and then fuse them inside a mold. Once the desired material density is reached, water cools the material to prevent it from expanding further outside the mold. The plant had recycled this cooling water for several years, but in 1995 the staff installed new equipment that significantly increased the amount of water that can be recycled. Randy Boles, plant manager, says that with recirculation, the system consumes five times less water than the previous single pass cooling.

Install Reverse Osmosis Unit. Another source of water savings has come from replacing softeners and potentially dangerous chemicals with a reverse osmosis (RO) system that removes dissolved solids from the water destined for the boilers. The RO unit was an expensive capital outlay, but it is inexpensive to run. By decreasing the need for blowdown, the RO unit saves water and the cost of treatment chemicals, which could present problems for the treatment of the waste water. Anticipated payback period for the RO capital cost is less than five years.

Install Meter. The company also has installed a meter to measure the waste water leaving the plant. This helps to monitor the plant for leaks or other manufacturing process anomalies.

All these measures helped to reduce water use. But merely examining water use statistics can be misleading, as noted above. For example, Boles says the plant stopped processing expanded polypropylene in mid-1998, and this change alone should result in significant water savings in 1999.

"We are continually making improvements—both small and large—to reduce our water consumption," said Boles. "We learn from other Tuscarora plants and they learn from us. If any plant finds a way to save money or resources, it's spread throughout the company to different plants. I'm proud to say that the Las Cruces plant and the one in Juarez have been instrumental in changing water use company-wide."

TUSCARORA INC.

1994 Water Use:
23.4 million gallons

1998 Water Use:
20.5 million Gallons

Water Savings: 12.4%

HONEYWELL HOME & BUILDING CONTROL, ALBUQUERQUE

Honeywell is a worldwide maker of heaters, fans, humidifiers, vaporizers, electronic air cleaners, water filtration products, thermostats, and home security systems. The Albuquerque plant, with more than 250 employees in 110,000 square feet, assembles thermostats, building controls, and commercial burner and boiler controls.

In 1994, water consumption at the Albuquerque plant was 8 million gallons a year. Most of this water went to assembly operations. Specifically, water was used to clean circuit boards before electronic devices were assembled.

By requiring the circuit board manufacturer to supply cleaner boards, by changing the type of flux used, and by improving its soldering process, Honeywell eliminated the need for process water. The result was dramatic: Honeywell's 1995 water consumption dropped to 3 million gallons a year, a 63% reduction.

Every year since then, the Albuquerque plant has reduced its annual water consumption by 500,000 gallons, an additional 50% reduction. This is how:

HONEYWELL

1994 Water Use:
8,000,000 gallons

1998 Water Use:
1,419,000 gallons

Water Savings: 82%

— **Bathrooms.** As part of its remodeling projects, Honeywell replaced toilets and urinals with low-flow, automatic flush models. There have been no problems with stopped-up toilets and maintenance costs have been reduced.

— **Humidifier.** The company installed a more water-efficient temperature and humidity control system. (In the process of upgrading the humidifier, facility engineers discovered a hidden water discharge pipe and replaced it with a closed-loop system to eliminate humidifier discharge water.) The new system reduced the plant's water consumption by over 350,000 gallons a year.

—**Landscaping.** Honeywell has achieved substantial water savings by modifying its landscaping. With help from the City Albuquerque engineers and the plant's landscaping contractor, unnecessary grass was removed, the irrigation system was redesigned, and an electronic rain sensor and timer was installed. These simple upgrades enabled Honeywell to use water more efficiently and reduce its landscaping water consumption by half.

According to Dave Colton, Facility Services Manager, here's what Honeywell learned:

"The Albuquerque plant views its water conservation efforts as an extension of Honeywell's worldwide commitment to resource and energy conservation, as well as its pledge to utilize environmentally sound production practices.

"We want to send the message to others that water conservation can be done with limited resources and money. We reduced our overall water consumption 82% without spending a lot of time, brainpower or money. We found we really can make a difference."

PRESBYTERIAN HEALTHCARE SERVICES, ALBUQUERQUE

Since its establishment 90 years ago, Presbyterian Healthcare Services has experienced healthy growth. In Albuquerque alone, Presbyterian now has 24 locations and more than 60 irrigated acres of landscaping. Amidst the growth, the healthcare organization became one of the city's largest water users. Under the direction of Lonnie Burke, water conservation coordinator, Presbyterian has also been honored as one of Albuquerque's top water conservers.

In the fall of 1995, Burke began the organization's water conservation program by studying water bills and conducting a water audit. It was no easy task. Presbyterian's main hospital campus on Central Avenue had grown to comprise more than 16 city blocks, resulting in a complex tangle of plumbing and energy infrastructure—and water waste. After auditing past water use, he began to install individual meters on equipment that used large volumes of water, including cooling towers, boilers, and irrigation systems. Burke used this information to determine the efficiency of these systems and to estimate water savings and cost payback of any proposed conservation projects.

PRESBYTERIAN

1994 Water Use:
145.2 million gallons

1998 Water Use:
118.3 million gallons

Water Savings: 19%

An unanticipated benefit of the audit was the discovery that Presbyterian had been overpaying for water services. In particular, Burke found that a number of meters at the main hospital were being charged for sewer services when they were used for irrigation only, and Presbyterian was paying for two eight-inch meters when it only had one. Moreover, the city computer was charging Presbyterian for water it did not use. Facility engineers would sometimes turn off one of three main meters to the main hospital to make repairs. While the water use at the meters was zero, the computer would assume the meters were faulty and would charge the hospital what typical water usage at that meter had been in the past. According to Burke, these discoveries saved Presbyterian $42,000 annually.

New Irrigation System

Presbyterian's largest water-use reductions have come from changes in landscape irrigation practices. According to Steve Tennyson, grounds maintenance supervisor, Presbyterian's past emphasis, common in the city, was to get the grass as green as possible without regard to water use.

Tennyson and crew began paying attention to water use versus water need. They replaced inefficient sprinkler heads with better quality models that provided a more uniform spray. As they did so, it became apparent that the irrigation system had to be upgraded. The staff also installed a master valve on the 32-acre northside campus so that water stops flowing in the irrigation line when the system shuts off—thus preventing water lost to leaks. With these relatively simple efforts, Presbyterian cut its irrigation consumption by 8.1 million gallons between 1994 and 1996.

Starting in 1997, Presbyterian began installing a computerized irrigation control system at the main and northside campuses. The new system monitors water use for each zone, detects broken lines or missing sprinkler heads, and shuts down the problem zone until it is repaired. Though still not complete, the new system, coupled with other conservation measures, brought down Presbyterian's irrigation usage to 67.9 million gallons in 1998—a 25% drop from the 1994 level. According to Tennyson, one year's worth of water savings paid for the initial $31,000 cost of the system.

Tennyson took advantage of training programs offered by the City of Albuquerque and by the national Irrigation Association before reducing lawn areas and installing xeriscapes. The two-acre San Mateo facility now has only 1,600 square feet of turf. The majority of the landscaping consists of moderate- to low-water-use plants and native trees on a drip irrigation system.

Other Savings

Additional water savings have come from these changes in Presbyterian's facilities:

— **Autoclave Condensate and Cooling Water Recycling.** Autoclaves use steam to sterilize surgical instruments, trays, and other medical equipment. Burke has already saved 0.5 million gallons annually by collecting the sterilizer steam condensate previously dumped down the drain and recycling it back to the boiler. Presbyterian also plans to replace at least one autoclave with a more water-efficient version, saving 1.8 million gallons annually.

Also in the works: Burke plans to reclaim the autoclave's cooling water, which is currently discharged to the sewer. Feeding this water to the cooling towers instead will save 8 million gallons a year and will provide two-thirds of the water required by the cooling towers.

— **Pump Replacement.** Medical pumps provide suction to remove bodily fluids, and medical air pumps supply purified air for breathing. Since older models are cooled and lubricated with water, substantial water savings can be reaped by replacing them with new oil-cooled versions. Indeed, at Kaseman Hospital, part of the Presbyterian network in Albuquerque, replacing two medical pumps in 1998 saved the hospital 2.6 million gallons annually. Burke is also planning to replace six medical vacuum pumps and four medical air pumps at the main hospital. He estimates this will save 5 million gallons annually.

— **Turning Off Water.** Burke noticed that six older x-ray developers were left running continuously at night after urgent care facilities had closed, wasting up to three gallons of water per minute. Burke asked technicians to turn off the water flow at night. "Sometimes it's really simple to save water," Burke said.

— **Bathroom Retrofits.** By early 1999, Burke had replaced 21 high-water-use toilets with 1.6 gallon commodes in heavily used public washrooms. Additional low-flow toilets, faucet aerators, and low-flow showerheads will be installed. By the time the bath room retrofit project is completed, Burke estimates savings of at least 6 million gallons a year.

— **Personnel Involvement.** Burke stresses that even the most comprehensive conservation plan can be derailed if the maintenance and trades staff are left in the dark. "By installing the parts wrong, or installing the wrong parts, you can make the investment in new equipment to save water useless," he said.

"If a maintenance person incorrectly changes out a tank flapper on a 1.6 gpf toilet without installing the proper part, the toilet could end up consuming 3.5 gpf. That's why the maintenance staff needs to understand that they are an important part of the program, and they need the proper training for the program to be successful."

—Lonnie Burke

LOS ALAMOS NATIONAL LABORATORY, LOS ALAMOS

Los Alamos National Laboratory (LANL) occupies 43 square miles of land in northern New Mexico. Owned by the U.S. Department of Energy, LANL has been managed by the University of California since 1943, when the Laboratory was established as part of the Manhattan Project to create the first atomic weapons during World War II. Today the Lab conducts programs in energy, nuclear safeguards, biomedical science, environmental protection and cleanup, computational science, materials science, and other basic sciences.

The largest institution and the largest employer in the area, LANL has approximately 6,800 University of California employees plus approximately 2,800 contract personnel. Its annual budget is approximately $1.2 billion.

As shown in Figure 7-3, water use at the Lab declined somewhat in 1993 and 1995. But overall, the demand for water has been increasing in recent years. This is due primarily to increased demand for cooling as new projects come on line. Electricity-intensive programs, such as the accelerator facility (which runs high-energy physics experiments) generate tremendous amounts of heat, which must be removed. Hence, the greater the electricity usage, the greater the demand for cooling and cooling tower water. Figure 7-4 shows the breakdown of water use. Clearly, cooling tower use overshadows all other uses, consuming 58% of the 488.1 million-gallon water budget in 1997.

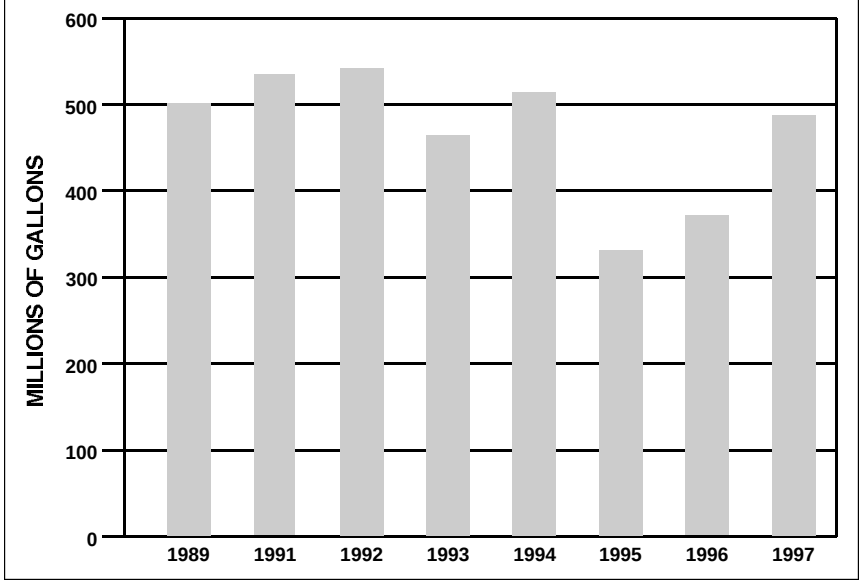
LANL

1994 Water Use:
524.8 million gallons

1997 Water Use:
488.25 million gallons

Water Savings: 7%

Figure 7-3: Water Use at Los Alamos National Laboratory



Due to limited water rights, LANL is allowed to consume a maximum of 541.6 million gallons per year. Already, however, the Lab is using about 90 percent of that amount. Any future growth will depend, in part, on aggressive conservation measures, says Jim Scott, Laboratory Associate for the Environmental Stewardship Office.

LANL has already saved 20.2 million gallons a year by reusing treated sanitary wastewater in the power plant cooling towers. Further savings may come from reducing the 88 parts per million of silica in the water sent to the cooling towers (a silica concentration slightly above that at Intel, see pg. 78). Silica precipitates out as scale, inhibiting the performance of cooling towers. Treated water will enable LANL to operate the cooling towers longer before they must be purged of scale-forming minerals.

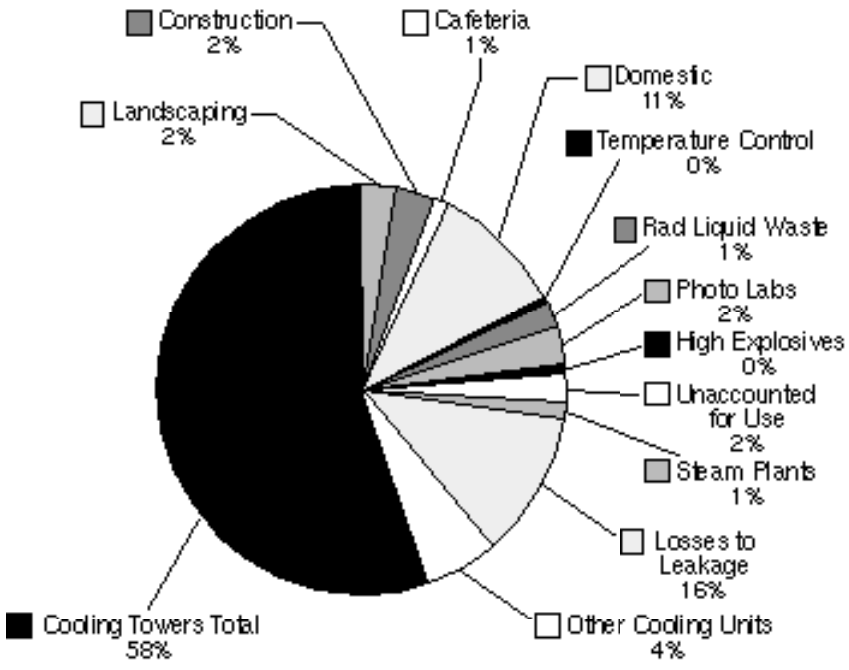
The following projects are either planned or underway:

Cooling Tower Water Efficiency Project. Los Alamos National Laboratory intends to fund pilot programs on mobile cooling towers to demonstrate various water-efficient technologies including reverse osmosis treatment. It will also explore enhanced sanitary wastewater reuse. The Lab expects water savings of about 114.0 million gallons a year from cooling tower conservation and about 94.5 million gallons a year from wastewater reuse. The project will be completed in 2002.

Leakage Repair Project. Leakage losses in the Lab's distribution system account for an estimated 16% of total usage. By identifying and repairing the leaks, the Lab will save an estimated 65.2 million to 97.8 million gallons a year. An audit to detect leaks will be completed by September 1999.

Domestic Fixtures. Low-flow fixtures will be used in all new construction. Scott estimates this will save 8.2 million gallons a year. If all existing fixtures in the laboratory were replaced, domestic water consumption would fall by 25.4 million gallons.

Figure 7-4
Los Alamos 1997 Water Usage: 1,498.39 Acre-Feet/Year (AFY)



HILLCREST PARK, ALBUQUERQUE

Built as an apartment complex in 1972 and converted to 268 condominiums in 1979, Hillcrest Park was honored with a water reduction award by the City of Albuquerque in 1998.

In 1994, with water consumption running at 24.9 million gallons annually, the homeowners' association board developed a 10-year plan to improve the property while saving water and energy. The association had an incentive to reduce water use because it pays for water and gas, while individual owners pay their own electric bills. Using association funds (collected from homeowners fees), the board took action.

Low-Flow Showerheads. In 1995, low-flow showerheads were installed, as were low-flow valves in the toilets.

Ultra-Low-Flow Toilets. Taking advantage of the City of Albuquerque's rebate program, the Hillcrest homeowners' board offered to install, free of charge, a new low-flow toilet in every homeowner bathroom. All but 10-15% of the owners took the board up on its offer, and more than 300 low-flow toilets were installed. (The cost to the homeowners' board was $45 for each toilet.) Much of the small resistance centered on worries the toilets wouldn't flush properly and stop-ups would occur. According to Hillcrest Manager Joan Justus, there are far fewer plumbing complaints with the new, ultra-low-flow toilets than there were with the older, higher-water-consumption toilets. Moreover, after the reluctant owners saw how well their neighbors' toilets worked, they wanted new toilets, too. The Hillcrest board expected the toilets to pay for themselves in three years, but, in fact, the savings were almost immediate.

HILLCREST PARK

1994 Water Use:
24.9 million gallons

1998 Water Use:
17.1 million gallons

Water Savings: 31%

Landscape Modifications. With the help of Doug Bennett in Albuquerque's Water Conservation Office, the homeowners' association revamped Hillcrest's landscaping in 1997. More than 25,000 square feet of water-thirsty bluegrass was replaced with bark, rocks, trees, and 5,000 square feet of drought-tolerant grass. The irrigation system was modified to accommodate the changes, and sprinkler heads gave way to water-efficient bubblers and misters.

"When Doug Bennett first came out for a site inspection, we discovered we were watering the street and the sidewalk," said Justus. "That's when we realized we had to do something. Now the landscape is gorgeous. In one area we have a flower bed and the water savings pays for the flowers year round."

Swimming Pool Savings. Hillcrest has also stopped draining the pool every year unless it needs resurfacing or other maintenance. And the complex makes sure the pool is well maintained with an efficient skimmer, pump, and filter system.

Why Conservation Worked

According to Justus, the water conservation efforts at Hillcrest Park were successful because the homeowners are environmentally minded and wholeheartedly supported the program. (A plaque in the Hillcrest Park office proclaims a commitment to be good stewards of the community and the world—and the homeowners back up the words with action.)

"It did take a lot of work and research by the board of directors," said Justus. "But we have saved so much money and water. The toilets paid for themselves, and the showerheads paid for themselves. We are quite proud of what we have accomplished, and we are surprised that more residential communities have not done the same things."

ETHICON ENDO-SURGERY, ALBUQUERQUE

Ethicon Endo-Surgery Inc. is a Johnson & Johnson company, which has been in Albuquerque since 1981. Employees at the 220,000-square-foot Albuquerque plant assemble, sterilize, and package advanced surgical instruments for videoscopic and traditional surgery.

In 1990, Johnson & Johnson launched its Worldwide Environmental Practices Program and Pollution Prevention Goals, setting new performance standards for each of its facilities around the world. At that time the Albuquerque plant's appearance matched that of the corporation's other sites with its signature white buildings surrounded by an expanse of verdant lawns. The lawns were so lush and extensive in fact, that golfers looking for the University of New Mexico's championship golf course next door frequently wandered into Ethicon to ask where they should go to pay their golf fees.

But as Ethicon grew aware of the need to save water, the Facilities and Environmental group was faced with a challenge: how to reduce water consumption without sacrificing the visual impact of the Johnson & Johnson park-like "look." In 1991, that lush look required 32.3 million gallons of water and five acres of Kentucky bluegrass at the Albuquerque plant. By 1998, however, Ethicon had cut the turf acreage by almost 50% and irrigation consumption was down 81% to 6.2 million gallons a year.

ETHICON

1991 Water Use:
53.3 million gallons

1998 Water Use:
27.1 million gallons

Water Savings: 49.2%

Overall, Ethicon's total water consumption fell from 53.3 million gallons in 1991 to 27.1 million gallons in 1998, a 49.2% decrease. Ethicon managed to cut back on water even though its production output more than doubled and its staff went from 700 to 900 employees.

Water conservation is part of a broader Johnson & Johnson program to save energy and reduce waste, air emissions, paper use, and pollution. Each plant is graded on how well it meets the J&J "Pollution Prevention Goals" every year. Albuquerque's Ethicon facility consistently scores well on all goals, and especially water conservation. The plant also received high marks from the City of Albuquerque, which, in 1997, gave Ethicon an award for reducing its water use.

Grounds

Ethicon retracted the grass three feet around the entire drive and parking areas and installed drought-tolerant plants that are watered only with the overspray from the lawn sprinklers. The company replaced grass with rocks in the parking lot dividers. The groundskeepers have experimented with native grasses in less visible areas to determine possible substitutes for grass in lawn areas. Finally, in 1998 Ethicon replaced a

section of lawn at the main entrance with a xeriscape garden, inviting employees to join in the designing and planting. "Initially when we took some of the grass away, we got a lot of negative comments," says Juan Cedeno, Senior Environmental Engineer. "But now associates appreciate not only the fact that xeriscaping saves water, but also the beauty native vegetation can offer to our landscapes."

Plant

Ethicon's cooling towers use about 6-8 million gallons of water a year and the boilers consume over 3 million gallons annually. In 1992, Ethicon began reusing cooling water from its vacuum pumps system as make-up water for the cooling towers and boilers. Reconfiguring the once-through cooling system saved 2.1 million gallons of water annually.

Prior to 1994, steam from Ethicon's boilers was used for humidification purposes on the production floor and in the sterilization process. In 1992, Ethicon installed equipment to recover much of the condensate that was then going down the drain and pipe it back into the boiler. Cedeno estimates the $1,000-$1,500 project saved approximately 3 million gallons of water a year. And since the recovered water has already been treated for corrosion and scaling (and it is still warm), the project saves $10,250 a year in water, energy, and chemical costs.

Ethicon also worked with its chemical vendor to develop an optimum blend of scale and corrosion inhibitors to minimize the need for blowdown, or purging of mineral-rich water from the cooling towers and boilers. Like Sandia National Laboratories, the plant also uses a conductivity meter to fine tune blowdown frequency.

In 1998, Ethicon's maintenance mechanics added meters to monitor the amount of water going into the boilers and cooling towers. Previously, water usage was watched indirectly, based on the amount of scale inhibitors and other chemicals being used. The problem with this approach is that, if there is an undetected leak somewhere, it could take a very long time to identify and locate.

Domestic

Because Ethicon makes sterile medical devices, the company is regulated by the Food and Drug Administration, which requires that employees wash their hands every time they go onto the production floor. With 900 employees, that can add up to a lot of water. Originally, Ethicon installed push-down faucets that supply water for a set amount of time. But these types of faucets can sometimes malfunction, thus wasting water. In 1996-1997, the company installed faucets with infrared sensors for automatic on-off control.

"Little things can mean a lot of water saved. Sometimes small projects can generate large savings in water conservation."

—Juan Cedeno

UNIVERSITY OF NEW MEXICO, ALBUQUERQUE

The 775-acre University of New Mexico is situated in a park-like setting where students talk in plazas, study under trees, and play Frisbee or soccer on 60 acres of cool green turf. Maintaining the garden ambience with its grass and thousands of square feet of plants and shrubs requires a lot of work. And, not surprisingly, a lot of water.

In the past five years, UNM has made a major commitment to water conservation, and the university has impressive results to show for its efforts: since 1994, overall water use is down 39%. Most of these savings have come from efforts to conserve exterior water use throughout the university grounds and at its two golf courses. Additional efforts have cut water use inside its buildings and facilities.

Grounds

"Significant water savings can be accomplished by eliminating leaks, overwatering, oversprays, and by using low-water-use plants and mulches," said Mary Vosevich, associate director of UNM's Environmental Services Division. "We also avoid high maintenance areas that offer little payback, such as curbside strips of grass."

UNM

1994 Water Use:
1,028 million gallons

1998 Water Use:
625.7 million gallons

Water Savings: 39%

To reduce landscape water use, UNM has focused on the following areas:

Grass. UNM's Kentucky bluegrass turf was installed back when little or no thought was being given to water use. As more drought-tolerant grass types became available, UNM considered changing to a new variety, but the groundskeepers soon discovered that seeding from scratch on a busy 25,000-student college campus was a losing proposition. Similarly, tests showed that drought-resistant buffalograss did not survive trampling very well. UNM settled on overseeding bluegrass with fescue, which reduced water use by an estimated 10 to 15%.

Soils. Made primarily of eroded granite, central New Mexico's highly granular soil lets a lot of water percolate through and escape out of the reach of roots. UNM now prepares its flower and groundcover soil with an Agri-soak type of material that retains moisture.

Irrigation. UNM's old irrigation system was a patchwork of independent systems controlled at more than 100 different sites. This caused considerable waste, with sprinklers turning on during the rain and broken sprinkler heads gushing water undetected for hours.

In 1994, UNM began converting the old system into a centrally controlled, computerized system that responds to environmental conditions. Each site is customized; the computer knows how much water is needed under normal conditions based on slope, shade, student traffic, and other factors. The computer

gathers data every two minutes from a weather station monitoring changes in wind, temperature, humidity, and precipitation. Then the computer make adjustments, watering less on cloudy or windy days. The computer also shuts off the water when the temperature dips below freezing. In addition, the system will automatically alert grounds management and cut off water to an area if it detects too much water flow (indicating a leak or broken head) or too little water (indicating a clogged head or line).

By the spring of 1999, UNM had converted about 20% of the campus's landscape to computer controls, including the sports field near the gym. Additional areas will gradually go on line until the system is campus wide, reducing UNM's irrigation consumption by an estimated 25 to 35%.

Vosevich acknowledged that the computerized system is a convenient tool, but to get the full benefit requires constant oversight. "It should never be used to replace the person in the field who can evaluate the condition of the plants and stick his or her hand in the ground," she said.

Landscaping. To avoid runoff into streets and parking lots, UNM has installed gravel borders immediately adjacent to parking areas. The university has converted some areas to xeric landscaping, and it has plans for a xeriscape demonstration garden to educate the public about low-water plants.

Golf Courses

UNM has two golf courses: the 240-acre South Championship Course built in 1965 and the North Course, Albuquerque's second oldest, with 9 holes on 70 acres. UNM estimates that nearly 263.8 million gallons, or 42.2% of the university's total water use in 1998, occurred at its two golf courses. Because the golf courses account for such a high percentage of water use, UNM has concentrated much of its water conservation efforts at the golf courses. These efforts have paid off: from 1994 to 1998, water used in irrigating the golf courses dropped 35.2%.

Much of that improvement came from modifying the plumbing of the original irrigation design (which sometimes flooded parts of the course) to make it more water efficient. According to Randy Hisey, course superintendent since 1997, "The secret to managing turf is to develop a healthy root system." Hisey estimates that he has doubled the root length from 1-1.5 inches to 3 inches. Deeper roots mean the turf can draw moisture from a greater volume of soil, which means it requires less water. Hisey has cut water use by:

— Instituting a better fertilization program. Hisey cut down on nitrogen and uses organic phosphorous and potassium, which he says are better for the roots and which build denser cell walls. This fertilizer makes turf more drought resistant.

— Watering more deeply to develop the root system, while cutting back on overall watering time.

— Practicing vericutting, which thins out grass like a comb, allowing for better water percolation and deeper roots.

— Increasing the aeration of the turf.

— Conducting field audits to see which areas need more or less water.

— Replacing a variety of sprinkler heads having different flow rates with heads discharging water at the same rates. This produces more uniform coverage and reduces the need for spot watering.

— Capping off sprinkler heads that were not needed.

Hisey has also recently installed a computerized system to regulate water flow. The system's centralized control makes the course easier to manage, and it takes out some of the human error. In the previous system, watering times were set for each station, regardless of how much water was flowing to the heads. Now, by taking into account variations in water pressure and flow, the computer applies the correct amount of water. Hisey says a similar system at the City of Albuquerque's Los Altos course eliminated dry and wet spots and cut water usage by 25%.

Further water savings are expected from the elimination of 40 acres of turf in the South Course. Hisey also plans to obtain a weather station, which will determine environmental conditions more accurately and more easily than the currently used evapo-transpiration (ET) monitors.

Buildings and Facilities

Outdoor water use overshadows the university's indoor use, but inside use is far from insignificant. UNM has 7 million square feet of facilities that operate virtually 24 hours a day.

The increasing use of computers, lasers, and other high-tech laboratory equipment has meant a greater demand for cooling. As a result, all new buildings are being designed with a chill water system for cooling. This closed-loop system requires no additional make-up water. In addition, low-flow faucets and toilets will be installed in all new construction (including the recent projects at Popejoy Hall, the Health Sciences Center, and UNM Bookstore).

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WATER USE AND CONSERVATION BUREAU
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Santa Fe, NM 87504-5102

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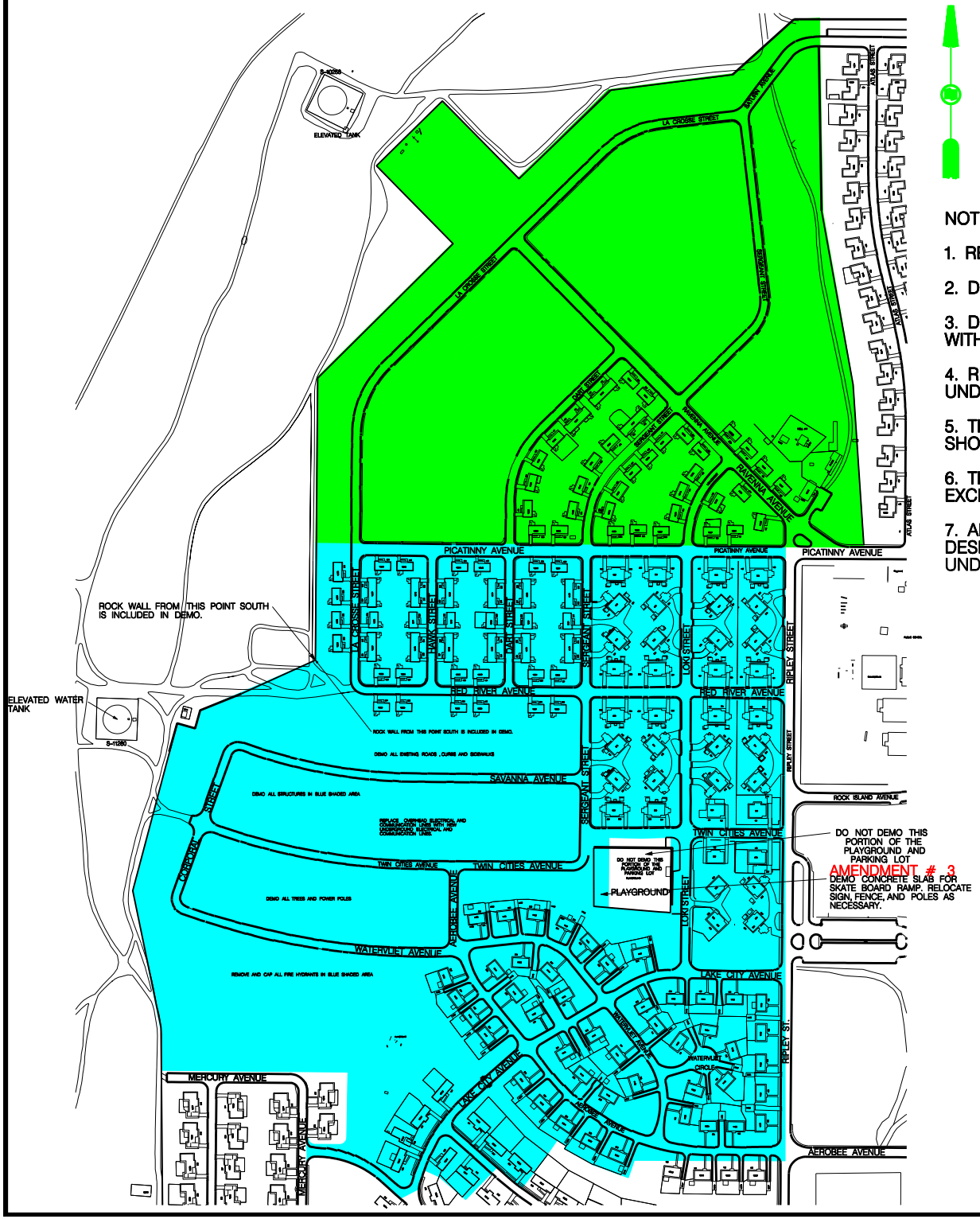

DEMOLITION PLAN

AMENDMENT # 3

FY–05 AFH PROGRAM 143 HOUSING UNITS

AMENDMENT # 3

NOTES:

1. REMOVE AND CAP ALL FIRE HYDRANTS IN THE FY05 DEMOLITION AREA.
2. DEMO ALL TREES AND POWER POLES WITHIN THIS DEMOLITION AREA.
3. DEMO ALL EXISTING HOUSE, GARAGES, ROADS, GUTTERS, AND SIDEWALKS WITHIN THE FY05 DEMOLTION AREA.
4. REPLACE OVERHEAD ELECTRICAL AND COMMUNICATION WITH NEW UNDERGROUND ELECTRICAL AND COMUNICATIONS LINES.
5. THE EXISTING ROCK WALL ON THE WEST SIDE WILL BE REMOVED AS SHOWN.
6. THE EXISTING PLAYGROUND WITHIN THE FY05 DEMO AREA WILL REMAIN EXCEPT THE PORTION TO BE RELOCATED IN THE SPECFICATIONS.
7. ALL EXISTING TRANSITE WATER LINES WILL BE REMOVED FROM THE DESIGNATED AREA AND DISPOSED OF PROPERLY. THE OTHER UNDERGROUND UTILITIES WILL BE REMOVED AS ORDINARY DEBRI.

DEMOLITION PHASES
FOR NEW CONSTRUCTION
WHITE SANDS MISSILE RANGE
ARMY FAMILY HOUSING

0 50 100 200 300'

SCALE OF FEET

SOLICITATION NO. W9126G–04–R–0042

AUGUST 24, 2004

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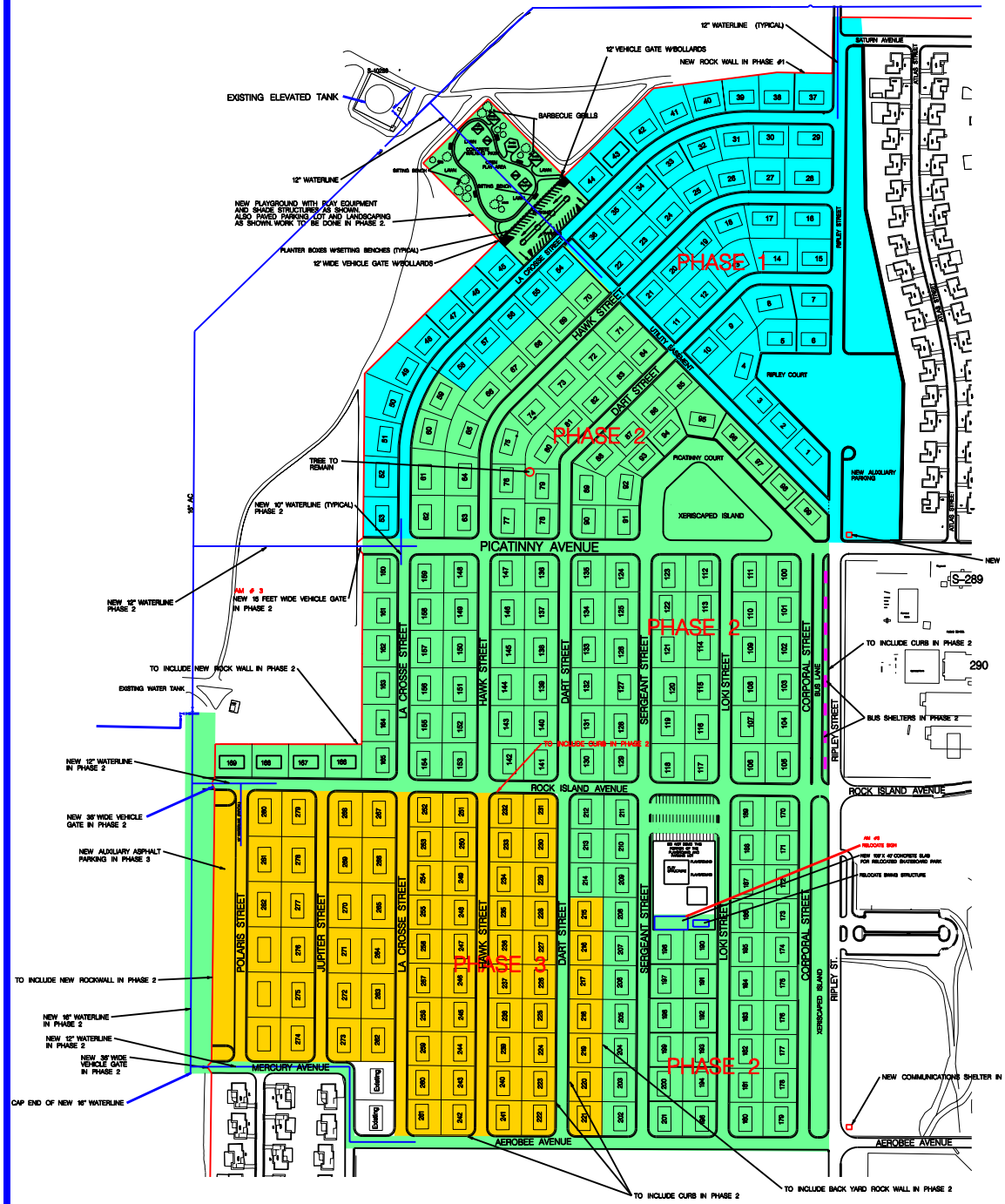

SOLICITATION NO. W9126G-04-R-0042

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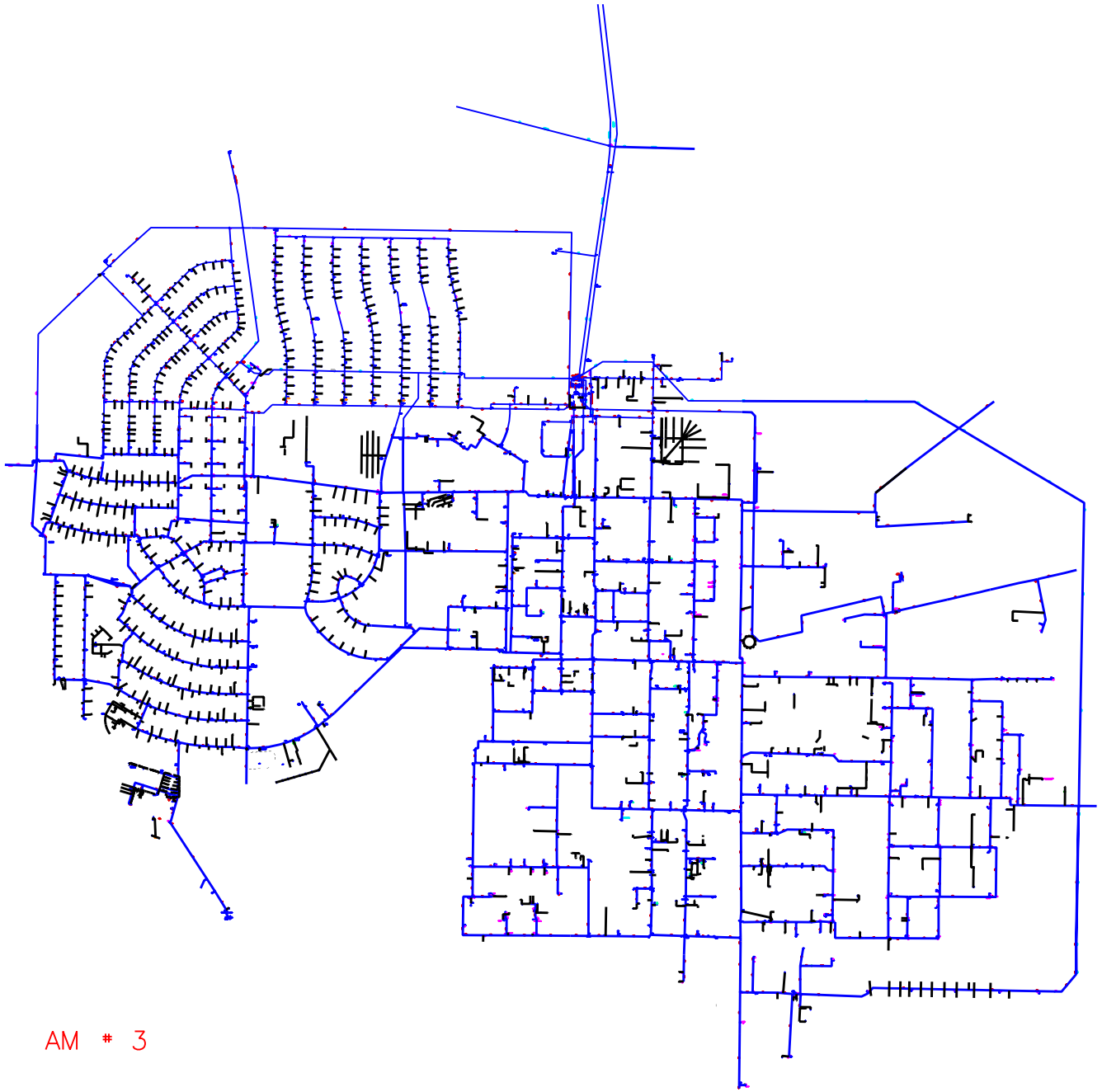

AM # 3

WHITE SANDS FAMILY HOUSING FY 05
EXISTING WATER LINES