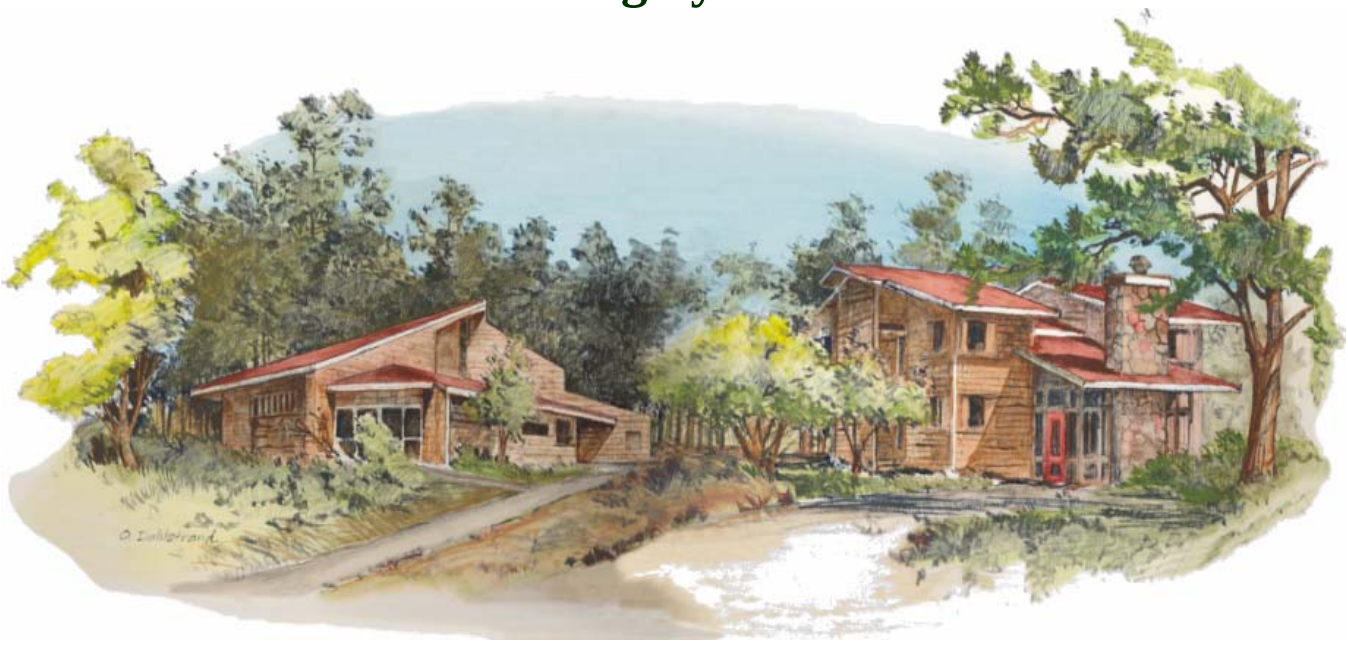
State of California . The Resources Agency . Department of Parks and Recreation

INTERMEDIATE PLUMBING SKILLS

February 25-March 2, 2007

Training Syllabus



William Penn Mott Jr. Training Center

State of California

M e m o r a n d u m

Date: February 6, 2007

To: Supervisor

From: **Department of Parks and Recreation**
William Penn Mott Jr. Training Center

Subject: Employee Attendance at Formal Training
Intermediate Plumbing Skills Group 32

An employee from your office will soon be attending the formal training program described in the attached. Please insure that the employee is fully prepared to attend the session and that the groundwork is laid for the employee's implementation of the training upon returning to work.

You can assist with capturing the full value of the training by taking the following steps:

Prior to Training

1. Make sure that specific employee needs are identified and, if necessary, called immediately to the attention of the Training Coordinator.
2. Review with the employee the reason for the employee's attendance.
3. Review objectives and agenda with the employee.
4. Discuss objectives and performance expected after the training.

Immediately Following Attendance

1. Discuss what was learned and intended uses of the training.
2. Review the employee's assessment of the training program for its impact at the workplace and review the due date of the Post-Training Evaluation form.
3. Support the employee's use of the training at the work place.

Prior to Three Months Following Training

1. Employee, after discussion with supervisor, must login to the Employee Training Management System (ETMS) to complete the Post-Training Evaluation form.
2. Supervisor evaluates the effectiveness of the training on the employee's job performance and logs in to the ETMS to complete the Training Effectiveness Assessment form.

Thank you for your assistance in seeing that the full benefit of training is realized.

Michael D. Green
Acting Department Training Officer

Attachment

cc: Participant

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Mission Statement
Training Office

The mission of the Training Office is to improve organizational and individual performance through consulting, collaboration, training and development.

MOTT TRAINING CENTER STAFF

Michael Green ..... Acting Department Training Officer
Joanne Danielson ..... Training Specialist
Chuck Combs ..... Training Specialist
Dave Galanti ..... Training Specialist
Sara Skinner ..... Training Specialist
Michelle Gardner ..... Cadet Training Officer
Connie Breakfield ..... Cadet Training Officer
Pat Bost ..... Assistant Program Coordinator
Pamela Yaeger ..... Assistant Program Coordinator
Bill Spencer ..... Assistant Program Coordinator
Edith Alhambra ..... Assistant Program Coordinator
Summer Kincaid ..... Assistant Program Coordinator
Brian Petersen ..... Program Assistant

THE MISSION

of the California Department of Parks and Recreation is to provide for the health, inspiration and education of the people of California by helping to preserve the state's extraordinary biological diversity, protecting its most valued natural and cultural resources, and creating opportunities for high quality outdoor recreation.

FORMAL TRAINING GUIDELINES

Welcome to formal training, an essential component in your career development.

Since 1969, our Department has been providing a continuously changing number of diverse training programs at its main training facility, the William Penn Mott Jr. Training Center, and other locations including Marconi Conference Center and, most recently, the Two Rivers Training Facility in Sacramento. The Department strives to enhance your learning and job performance with formal training of the highest quality.

Our Department's dedication to training is only one aspect of its commitment to you and to the public. This commitment is costly and represents an important investment in you and your career. You and the Department realize a return on that investment by your positive participation in formal training itself and post training follow-through.

The program you will be participating in is described in this training syllabus, which outlines what you can expect from this training and what is expected of you. This syllabus details what you should do before you leave for training; what to do when you arrive; what you will be doing while in training; and, importantly, what you should be able to do when you return to your work site. Specifically:

1. SYLLABUS: The syllabus is now accessible on the Employee Training Management System (ETMS). You should print a copy of the syllabus to bring with you to class. Your copy of this syllabus is an important part of your training experience and should be brought with you to training. Read it before you arrive and review it following the program along with material you received at training.

2. PRE-TRAINING ASSIGNMENTS: Your completion of pre-training assignments is essential to the success of your training. You are responsible for all reading assignments in preparation for classroom sessions. Time will be provided during working hours to accomplish any assignments, which involve either individual or group efforts and resources. (Pre-training assignments are listed in the "Training Attendance Requirements" section.)

3. TRAVEL: Arrange your travel to and from the training through your District or Office. (No reimbursement for travel expense - including per diem costs - will be approved for travel not specifically authorized in advance by the District Superintendent.) Individuals may claim reimbursement for incidental expenses incurred as outlined in DAM 0410.6. The Training Center does not have the capability to provide transportation to/from Monterey Airport.

4. HOUSING: Housing will be assigned to you on a shared-room basis and will be available from 3:00 p.m. on the date of arrival to 12:00 noon on the date of departure. The Department provides your room and board expenses at the Training Center only. No per diem allowance will be authorized for living off-grounds. This does not preclude living off-grounds at your own expense. Please advise the Department Training Officer no later than one week before your scheduled arrival if you plan to live off-grounds. No animals are permitted in Asilomar housing. In the event of an emergency, staff must know your room assignment; therefore, you may not switch rooms without staff approval. Overnight guests are not allowed in the buildings unless registered beforehand at the front desk in Asilomar's Administration Building. Quiet hour for lodge living areas is 10:00 p.m.

HOUSING CANCELLATION POLICY: If you do not need lodging or must change or cancel your reservation, you must contact the Training Center at least 72 hours prior to your date of arrival. The Training Center is committed to ensuring that the reservation that has been made for you is accurate and needed.

5. MEALS: Meals will be provided, semi-cafeteria style, from dinner on the date of arrival through lunch on the date of departure. Meals will be served at 7:15 a.m. for breakfast, 12:00 noon for lunch, and 6:00 p.m. for dinner. Hot or box lunches may be provided on some days. If you require a special diet, notify the Asilomar Chef at 831-372-8016 no later than one week before your scheduled arrival.

   In order to assist participants with limited mobility, Asilomar provides a shuttle to and from the dining hall. Please contact either Asilomar staff upon check in, or Training Center staff upon your arrival, for instructions on arranging a transport.

6. OFF-GROUNDS ACCOMMODATIONS: When authorized to stay off-grounds by the Department Training Officer, the Training Center will pickup the cost of your room and meals at the current DPR Asilomar rate. If you stay off grounds and have meals on grounds, the Training Center will authorize only what the Department pays Asilomar for lodging.

7. CLOTHING: Field uniforms as found in “Description of Required Field Uniforms”, DOM Chapter 2300, Uniform Handbooks, not including optional items, will be worn daily by all uniformed employees during formal training sessions **unless otherwise specified in the Program Attendance Checklist**. Non-uniformed employees shall wear professional business attire.

   Because we are on the conference grounds with many other groups, and the image we project as State Park employees is important not only during working hours but off duty hours as well, your informal sportswear should be appropriate.

8. ROOM SAFES: Two safes have been installed in each of the lodge rooms used by the Training Center (Live Oak, Tree Tops, and Deer Lodge). These safes are a type that allows the user to input their own combination of numbers to facilitate opening and closing. The Training Center has a master key for emergency entry. Safes are to be left in the open position when checking out of your room.

9. WEAPONS: Weapons are permitted in rooms under the following conditions. Authorized firearms and magazines stored while at the Training Center shall be in a safe condition and stored in one of the following locations: your room safe in Live Oak, Tree Tops, or Deer Lodge, one of the Training Center’s safes in the Whitehead Room or secured in your vehicle.

10 ALCOHOLIC BEVERAGES: Participants shall not possess or consume alcoholic beverages in common areas (living room) while on the Asilomar Conference Grounds unless provided and hosted by Concessionaire Delaware North.

11. SMOKING: Smoking is not permitted in the Training Center or in any lodge or guest room on the Asilomar Conference Grounds.

12. TRAINING CENTER: The Training Center is located on Asilomar Conference Grounds, part of Asilomar State Beach. The Conference Grounds are operated for our Department by a concessionaire, and all lodging and food services are provided to us by employees of the concessionaire. Constant efforts are made to maintain a sound, harmonious working relationship between the Department and concessionaire. None of us can expect preferential treatment for any reason and, as a departmental employee, you will be expected to join in our continuing effort toward an effective relationship with each Asilomar concession staff member. On occasion, non-departmental groups may be staying in the same lodges. It is imperative that you represent the Department well on and off duty.

13. REGISTRATION: When you arrive at Asilomar Conference Grounds, go directly to the front desk at the Asilomar Administration Building for your room key and dining room ticket. If you require vegetarian meals, notify the front desk representative and your meal ticket will be marked accordingly.

14. COURSE LEADERS: The formal training you will attend is developed and, for the most part, conducted by experienced State Park employees in field and staff positions. Some courses will be conducted by qualified instructors from other agencies and educational institutions. Your course leaders have proven their ability and knowledge in their profession, and provide a level of expertise difficult to match.

15. TRAINING CENTER STAFF: A Training Center staff member has been assigned responsibility for your training group as well as for your training program. That staff member usually serves as a Course Leader as well as a Coordinator. During the program, you may be asked to assist Training Center staff in the logistics of your training program (organizing field trip transportation, supervising classroom breaks, etc.). Center staff will do all within their power to make your training experience pleasant and meaningful.

16. TRAINING MATERIALS: May be made available to you at both your unit and the Training Center. Handout materials issued at your unit should be brought to training for possible use. A conference binder or notebook will be issued to you at the training session for note taking and convenience in handling materials. Copies of DAM and DOM will be available to you for self-study. Bring your own pens and pencils.

17. ATTENDANCE: Regular attendance is a critical course requirement and your participation is important to the success of this training. All absences, except those of an emergency nature, must be approved in advance by the Training Specialist.

18. COLLEGE CREDIT: Most training programs are accredited by Monterey Peninsula College for lower division credit. If you successfully complete an accredited program, you will receive either a letter grade or a credit/no-credit designation.

19. VEHICLES: All vehicles should be parked in the lots adjacent to the Training Center. Any questions regarding use of a State vehicle while at the Training Center should be discussed with your supervisor prior to your departure for training, or with your Program Coordinator while at the Training Center.

20. BICYCLES: If you bring your bicycle, store it in the bicycle shed next to the Training Center. Bicycles may not be brought into any building nor chained to lamp posts, trees, etc. The Training Center has a limited number of bicycles available for your use. Prior to your use, you are required to complete a safety inspection and sign a waiver, which is posted in the bicycle shed.

21. MAIL: Mail forwarded to you during your time at the Center should be addressed to you in care of:

    Department of Parks and Recreation
    WILLIAM PENN MOTT JR. TRAINING CENTER

22. CELL PHONES: As a courtesy to your fellow participants and course leaders ensure that your cell phone is turned off during classes. Participants should not be receiving or making cell phone calls during class time. Please limit those calls to your breaks.

23. FAX: The Training Center's FAX number is (831) 649-2824.

24. TELEPHONE: Limit phone calls during classroom hours to urgent business or emergencies. Anyone wishing to contact you by telephone during working hours should call the Center at (831) 649-2954. Calls after 5:00 p.m. or during weekends should be made to (831) 372-8016, Asilomar Conference Grounds, and the caller should tell the switchboard operator you are with a Department of Parks and Recreations training group.

25. LAUNDRY AND DRY CLEANING: May be taken care of by you at one of several local establishments. An iron is available for 24-hour checkout from the Training Center front desk.

26. RECREATION: Facilities available on grounds include a heated swimming pool, ping-pong and pool tables, and a volleyball court. The Monterey area offers horseback riding, golf, tennis, racquetball, deep sea fishing, and many historical landmarks and scenic sights to explore.

27. POST-TRAINING ASSIGNMENTS: In connection with formal training are to be completed under the direction of your supervisor. See "Program Attendance Requirements" in this syllabus.

28. COFFEE BREAK REFRESHMENTS: Will be available throughout each session at the Center. You will be asked to contribute to the "Hospitality Fund" to defray expenses. Please bring your own coffee cup.

PROGRAM ATTENDANCE CHECKLIST

To assist you in your preparation for formal training session at the William Penn Mott Jr. Training Center the following list is provided:

_____1. Read and understand the Intermediate Plumbing Skills Program Syllabus prior to your arrival at the Training Center.

_____2. Complete the enclosed pre-training assignment.

- ❑ Intermediate Plumbing Skills is a training program, which requires the participant to have a working knowledge of basic plumbing practices prior to attendance. The pre-training assignment will assist training participants to review the materials covered previously in the Basic Plumbing Skills training program.
- ❑ Read the course material contained in the workbook. At the end of the workbook, you will find a series of questions. Answer the questions in the workbook and copy your answers onto the answer sheet provided.
- ❑ Discuss the Intermediate Plumbing Skills program with your supervisor. What specific changes in your abilities and performance are expected to result from your attending this training? List these expectations along with your own under "Expectations" on the back of the "pre-training answer sheet".
- ❑ Discuss the projects you will be assigned in the next twelve months which will utilize the skills developed during the training program.
- ❑ The pre-training answer sheet will be collected during the program orientation. Completion of the pre-training assignment and bringing the correct personal safety equipment are mandatory and will count for 20% of your program grade.

_____3. Arrange your travel through your District Office.

_____4. Remember to bring the following with you to training:

- ❑ Program syllabus, study guide and all pre-training assignments.
- ❑ Personal safety equipment (eye, ear, head and hand protection).
- ❑ Coveralls or appropriate work clothing and sturdy work boots.
- ❑ Proper field uniform (review Uniform Handbook).
- ❑ Coffee cup, pens, pencils.

POST-TRAINING ASSIGNMENT

Prior to ninety days after the completion of this program, the employee and his/her supervisor should sit down and discuss the impact and assess the effectiveness this program has had on the employee. Then both the supervisor and employee should login to the Employee Training Management System (ETMS) and complete the Post-Training Evaluation form (an email will be sent to both employee and supervisor notifying them that the evaluation needs to be completed). Once you login to the ETMS, you will need to fill out the evaluation form before you will be able to do anything else.

The post-training evaluation process is intended to provide a bridge between classroom instruction and the on-the-job application of training. The information obtained through this process will assist the training participant, supervisor, and Training Center in providing a return on the investment the Department has on training.

INTERMEDIATE PLUMBING SKILLS GROUP 32 – A G E N D A
February 25-March 2, 2007

Lead Instructor: John Mackey
Assistant Program Coordinator: Bob Rice

Special Notice:
This program will be conducted at the Mott Training Center Shop Annex, 2211 Garden Road, Building C, Monterey, California. Vans are available to transport you to and from the Shop Annex and will leave the Mott Training Center promptly at 0800 daily and return by 1700.

Sunday
February 25

1500-	REGISTRATION: *Check in at the Asilomar Administration Building*.	All

Monday
February 26

0830-1000	Orientation/MPC Registration	Combs
1000-1100	Basic Plumbing Review	Mackey
1100-1200	Introduction to Blueprints	Moore
1200-1300	*Lunch*	
1300-1400	Demonstrations/Pipefitting	Mackey
1400-1430	Task Hazard/THA	Spencer
1430-1530	Shop Applications/Pipefitting	Mackey
1530-1630	Introduction to Drain, Waste and Vent Systems	Mackey

Tuesday
February 27

0830-1000	Shop Applications/DWV	Mackey
1000-1200	Water Heater Maintenance	Weingarten
1200-1300	*Lunch*	
1300-1500	Shop Applications/Water Heaters	Mackey/Weingarten
1500-1630	Introduction to Water Distribution Systems	Mackey

Wednesday
February 28

0830-1000	Shop Applications/Water Distribution	Mackey
1000-1200	Introduction to Gas Systems	Suburban Propane
1200-1300	*Lunch*	
1300-1500	Shop Applications/Gas Piping	Mackey
1500-1630	Shop Applications/Project	Mackey

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Thursday
March 1

0830-1200	Shop Applications/Project	Mackey
1200-1300	*Lunch*	
1300-1430	Shop Applications/Project	Mackey
1430-1630	Demonstrations/Repairs	Mackey

Friday
March 2

0830-1030	Shop Applications/Repairs	Mackey
1030-1130	Final Exam	Mackey
1130-1230	Program Summary and Evaluation	Combs
1230-	*Lunch and Departure*	

TRAINING PROGRAM: INTERMEDIATE PLUMBING SKILLS **36 HOURS**

PROGRAM OUTLINE	Total Hours
ORIENTATION	0.5
Program Overview and MPC Registration	
GAS SYSTEMS	5.5
System Overview and Code Requirements	
Gas Appliances	
DRAINAGE (DWV) AND SEWAGE SYSTEMS	7.0
System Overview and Code Requirements	
Demonstrations	
Applications	
WATER DISTRIBUTION SYSTEMS	15.5
System Overview and Code Requirements	
Water Heater Systems	
Demonstrations	
Applications	
ADDITIONAL PLUMBING SUBJECTS	6.0
Blueprint Reading	
Project Demolition and Clean-up	
Program Review	
EXAMINATIONS	1.0
PROGRAM EVALUATION	0.5
Total Hours	36.0

INTERMEDIATE PLUMBING SKILLS

PROGRAM ORIENTATION

Purpose: Participants will meet one another and the program coordinator and facilitator. The group will share expectations for the training program. In addition, program content will be reviewed and registration for Monterey Peninsula College completed.

Performance Objectives: By the close of the session the participant will

1. Review program content, procedure and evaluation processes.

2. Share and record expectations with group members.

3. Complete Monterey Peninsula College registration materials.

4. Adhere to all Training Center guidelines.

5. Review pre-training assignment.

DRAINAGE (DWV) AND SEWAGE SYSTEMS

Purpose: To familiarize park maintenance workers with drainage (DWV) and sewage plumbing systems which will enable them to perform routine plumbing repairs.

Performance Objectives: By the close of the session the participant will

1. Identify the basic components of drainage (DWV - drain, waste and vent) plumbing systems used in the general plumbing trades.

2. Describe the common components of sewage plumbing systems used in California State Parks and plumbing trades.

3. Define the purpose, use and function of plumbing components and systems.

4. Recognize, select, and use the correct plumbing work tools relating to drainage and sewage systems.

5. Select and install various components comprising drainage and sewage systems.

6. Diagnose basic drainage (DWV) and sewage system problems and make repairs.

WATER DISTRIBUTION SYSTEMS

Purpose: To provide park maintenance workers with the ability to maintain and make routine repairs on water distribution systems.

Performance Objectives: By the close of the session the participant will

1. Define the basic components of water distribution systems used in the plumbing trade.

2. Express the purpose, use and function of these components and distribution systems.

3. Identify the most energy efficient water heater to purchase and what heater features they should be looking for; also, how to retrofit an existing system for optimum performance and longest life.

4. Describe and use the correct plumbing work tools relating to water distribution systems.

5. Employ the skills necessary to select and install various components comprising water distribution systems.

6. Explain how to diagnose basic water distribution system problems and to make subsequent repairs.

PLUMBING TOOLS AND MATERIALS

Purpose: To provide park maintenance workers with the ability to select and use the proper plumbing tools and materials for making routine plumbing repairs, replacement or new installations on park facility plumbing systems.

Performance Objectives: By the close of the session the participant will

1. Identify the common plumbing tools and materials currently used in the plumbing trades.

2. Describe the proper types of plumbing materials for making repairs and installations.

3. Use various types of plumbing materials.

4. Explain how to maintain plumbing repair tools, related hand and power tools in proper working order.

ADDITIONAL PLUMBING SUBJECTS

Purpose: To provide park maintenance workers with an understanding of allied technical subjects such as plumbing related safety regulations, irrigation systems and blueprint comprehension.

Performance Objectives: By the close of the session the participant will

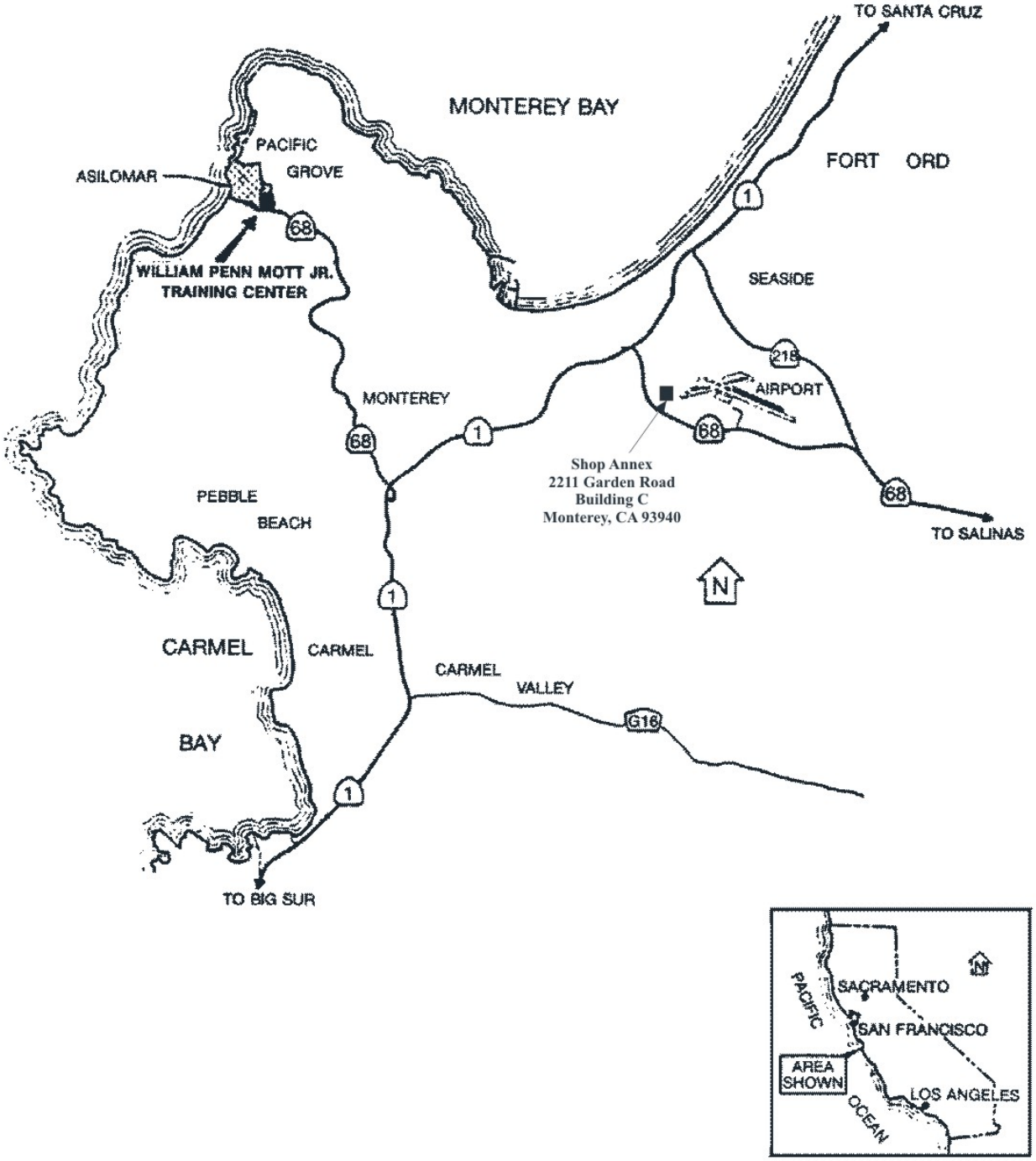
1. Identify the industrial safety regulations affecting employee safety, plumbing applications and pressurized vessels and piping.

2. Describe the basic components of common irrigation systems.

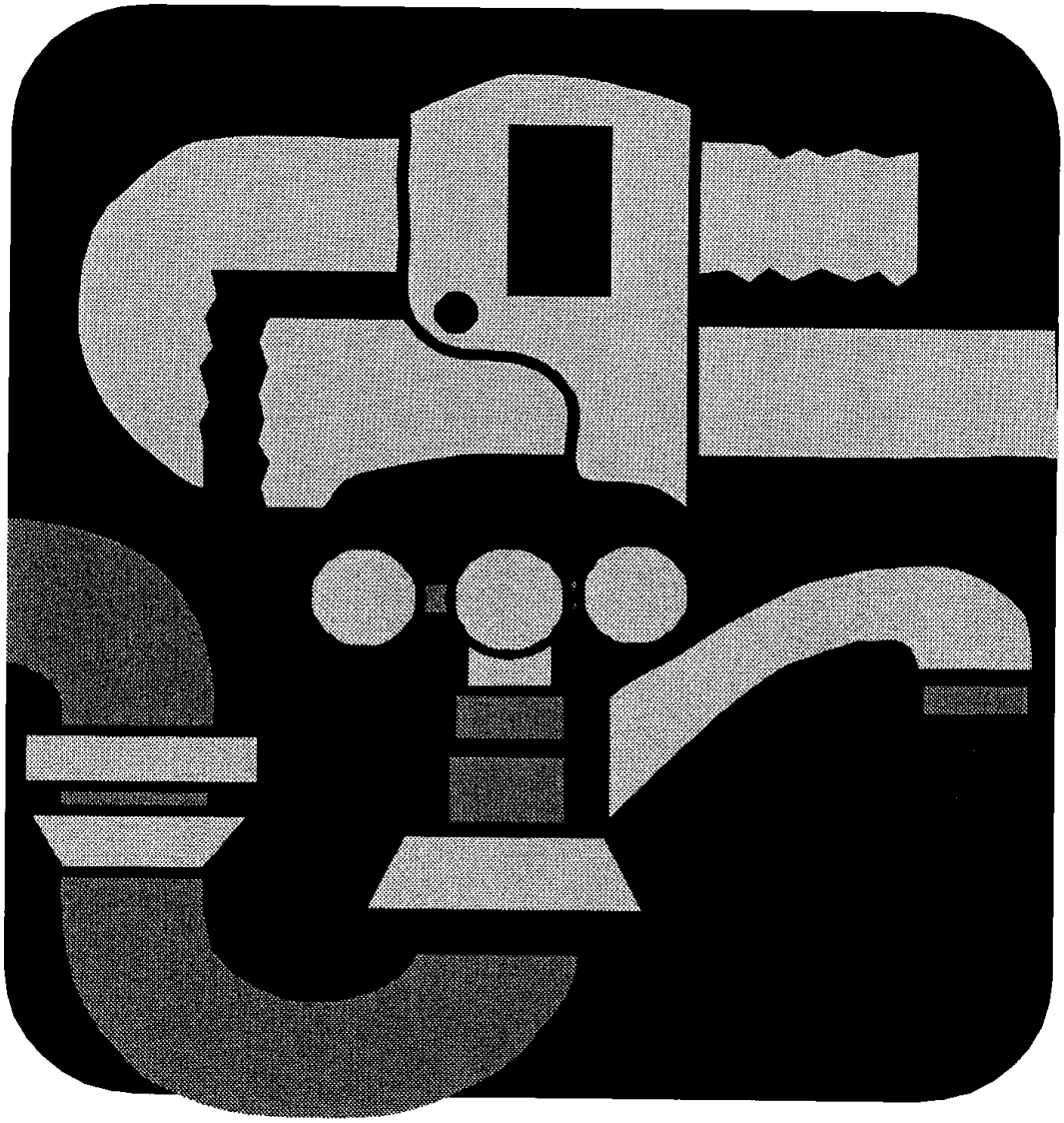
3. Explain basic plumbing blueprint comprehension.

4. Compose proper project materials lists, plumbing installation drawings and as-built drawings for various projects.

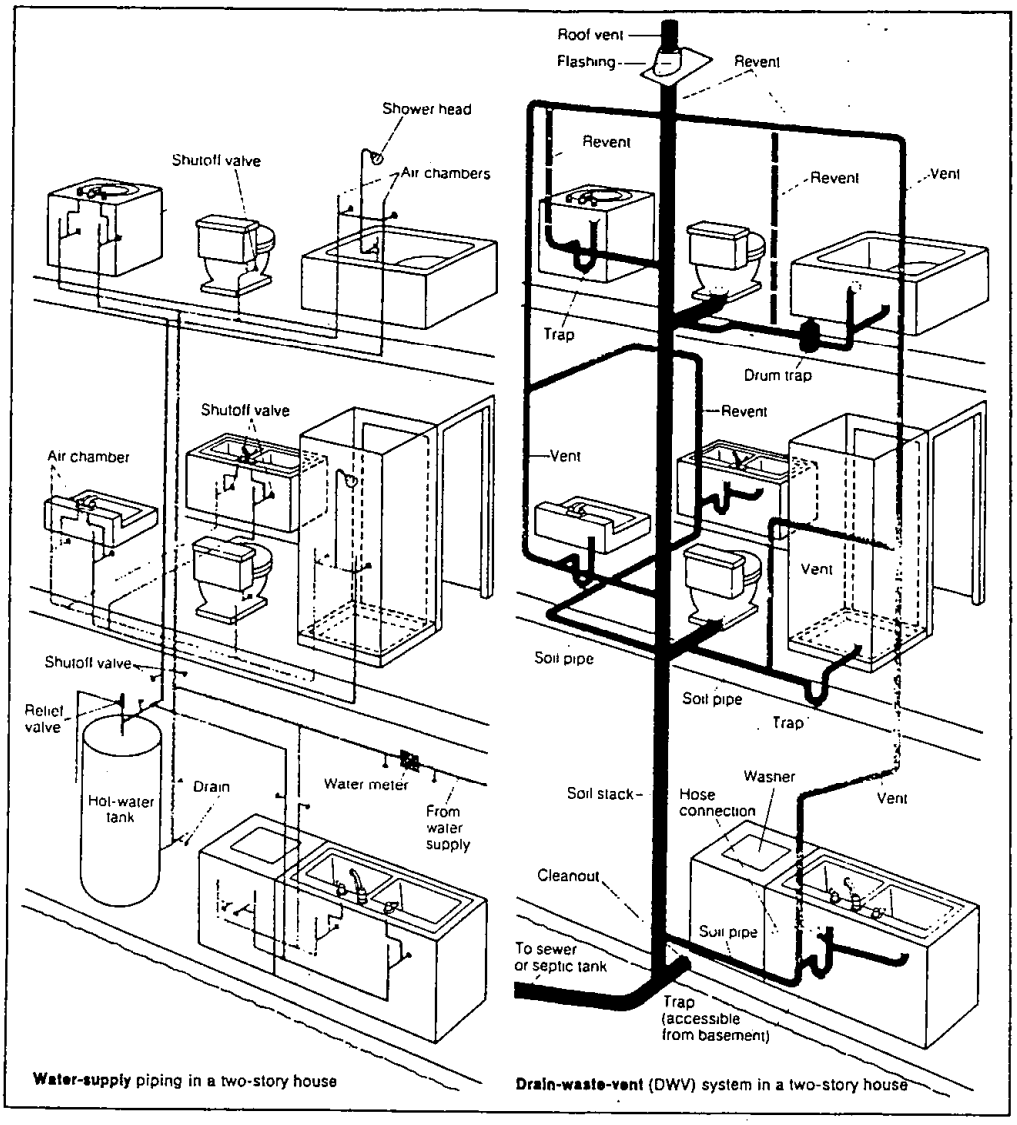
location map for
WILLIAM PENN MOTT JR. TRAINING CENTER
837 ASILOMAR BLVD.
PACIFIC GROVE, CALIFORNIA 93950



Intermediate Plumbing Skills Workbook



Home plumbing systems



Water-supply piping in a two-story house

Drain-waste-vent (DWV) system in a two-story house

THE BASIC WATER SUPPLY SYSTEM

The labyrinth of pipes, fittings, valves, and fixtures that constitutes the plumbing system in your house can be a complex puzzle. However, like most devices and systems designed by human beings, it is only bewildering to those who are unfamiliar with it. If you are interested enough in the subject to read this book and look at the drawings, you will soon see that plumbing is just a series of rather simple and logical connections of pipe, fittings, and fixtures. You may find that making repairs or even adding on to the system is quite possible for you to do all by yourself.

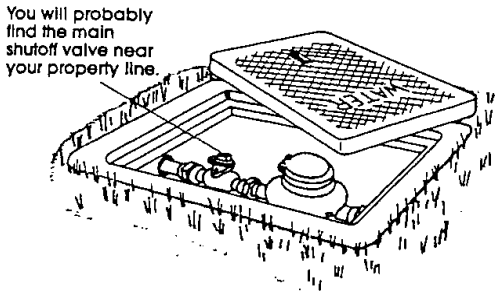
Supply Lines and Branches

It all starts with your main supply line. If you get your water from a public water works, it will probably come from the water main under the street out front, through your water meter and your main shutoff valve. In areas where the ground freezes deeply in the winter, the meter will be in the basement or crawl space. In warmer areas, it will be in a little concrete well near the curb. If you have a private water supply system, the main supply line will start at your storage tank or pump.

In any case, the supply line that enters your house should be at least ¾-inch pipe. One-inch pipe is even better if you are planning any additions or replacements. Obviously, the larger the pipe, the more water it can supply. But even more important, a larger pipe will cause less friction. When the water pressure is low, like during TV commercials when everyone uses their bathrooms at the same time, both the volume and friction factors are important to maintain a steady, even flow of water.

After the main line enters your house, it usually runs near the water heater. There it splits in two. The hot-water pipe goes through the water heater and then runs parallel to the cold-water pipe to the laundry, kitchen, and bathrooms throughout the house. At one or more convenient places in the basement or crawl space, the cold-water pipe branches to provide water to the outside faucets around the house and in the garden.

If the water entering the house must be treated in some way, the treatment units will be attached near where the water enters the house. Chemical injectors or filters will be on the main line in the basement or crawl space. Because softened water usually doesn't taste as good as hard water and because the added sodium is not considered healthy, water softeners are often placed on the branch line that goes to the water heater. This way only the hot water, used for washing and bathing, is softened. In some cases, although it makes the piping a little more intricate, unsoftened water is piped to the kitchen sink and maybe a wet bar or faucet used primarily for drinking, while softened hot and cold water is piped to the laundry and bathrooms.



To make the plumbing system more economical to install and to keep pipeline friction to a minimum, architects and house designers try to locate bathrooms, kitchens, and laundries as close together as possible on the same floors and, when they are on different floors, directly above and below one another. As you can see in the drawing on page 11, this makes for a much simpler installation and one that uses much less pipe and fewer fittings.

After the main supply line enters your house, it divides into ¾-inch hot- and cold-water pipes. The branches that feed individual fixtures may be of ½-inch pipe. These water systems may be made of galvanized iron, copper, or plastic, depending on local codes and practices and the age of the house. Building codes are very specific as to what kinds of pipe and fittings are required or allowed. Before you make any changes or additions, especially if you plan on changing from the kind of pipe already in your house, be sure to check with your building inspector.

In cold climates where pipes can freeze—and sometimes in warmer areas, too—the entire supply system is sloped to low points where drain cocks will allow the drainage of all the pipes in the system. If your system is set up this way and you are adding to it, be sure to slope your new pipes slightly toward the drain cock.

Each fixture and appliance, without exception, should have its own shutoff valves. Water softeners, filters, and other treatment devices, water heaters, dishwashers, washing machines, as well as all the sinks, tubs, and toilets should have a valve on both the hot- and cold-water pipes. If you plan on doing some or all of your own plumbing repairs and maybe some additions, installing any missing shutoff valves would be a good place to start and give you helpful practice.

Another constituent of a properly installed plumbing system is the air chamber or cushion. Air or inert gas trapped in a chamber compresses and cushions the shock when a nearby faucet or valve is turned off suddenly. Because water is not compressible it makes a loud bang and can damage pipes when it is stopped suddenly without this kind of cushion.

An air chamber is a vertical section of pipe on a supply line with a cap on top. It is usually hidden beneath cabinets or within the wall. The air in a pipe air chamber eventually dissolves in the water or leaks out around the cap, making it useless as a cushion. The cap must then be removed and a new supply of air allowed to enter.

If the cushion must be put within the wall or in another location where it is not easily serviced, consider installing a manufactured shock absorber. These are made with inert gas and a bellows so they remain permanently effective without servicing.

The Hot-Water System

A home hot-water system consists of a heater and a piping system that parallels the cold-water pipes to the faucets where hot water is desired. The heater is fueled by gas, oil, electricity, or the sun, depending on the fuel that is available in the area and the preference of the homeowner. Most heaters cannot heat water as fast as it can flow from a shower head or faucet, so they have a tank in which to store a quantity of hot water.

Home water heaters are generally available with tanks of 30- to 82-gallon capacity. The once-common 20-gallon tanks have become so unpopular that most manufacturers don't make them any more. Gas and oil-fired heaters are usually 30 to 60 gallons. Electric heaters, because they heat water more slowly and have a longer recovery time, have tanks that can hold up to 82 gallons. Some manufacturers make a *rapid-recovery* electric water heater in which the upper heating element operates independently to heat the top quarter of the tank quickly. When the top quarter is hot enough, the upper element goes off, and the lower one comes on to heat the rest of the water slowly.

The size of your water heater tank depends on how much hot water your family needs at the time of peak usage—for example, in the morning or evening when everyone takes a bath or shower. Usually the number of bedrooms in a house is used to determine the size of the water heater. For a one- or two-bedroom house, a 30-gallon tank is recommended; for three bedrooms, a 40-gallon tank, and so on. If you have several children, you may want to have a larger tank than recommended.

In some areas of the United States *demand* water heaters are available. Also called *tankless* or *instantaneous* water heaters, they are common in Japan and Europe but haven't been used in this country to any great extent since the copper shortage during World War II. These heaters have an intricate grid of copper ducts very much like an automobile radiator. When the hot water is turned on and flows through the heater, a large gas flame envelops the grid and heats the water to the desired temperature as you use it. Because this kind of heater heats water only as you use it and does not have to go on periodically to keep a whole tank of water hot, it uses up to 20 percent less fuel than a conventional tank heater. You can probably find out about availability in your area through a wholesale plumbing supply or solar equipment dealer.

Tank-type water heaters are basically simple devices. They consist of a thermostatically controlled burner or heating element that heats the water and an insulated tank to hold it until someone wants to use it. Because hot water is corrosive to metals, most quality heater tanks are glass-lined to help prevent them from rusting through.

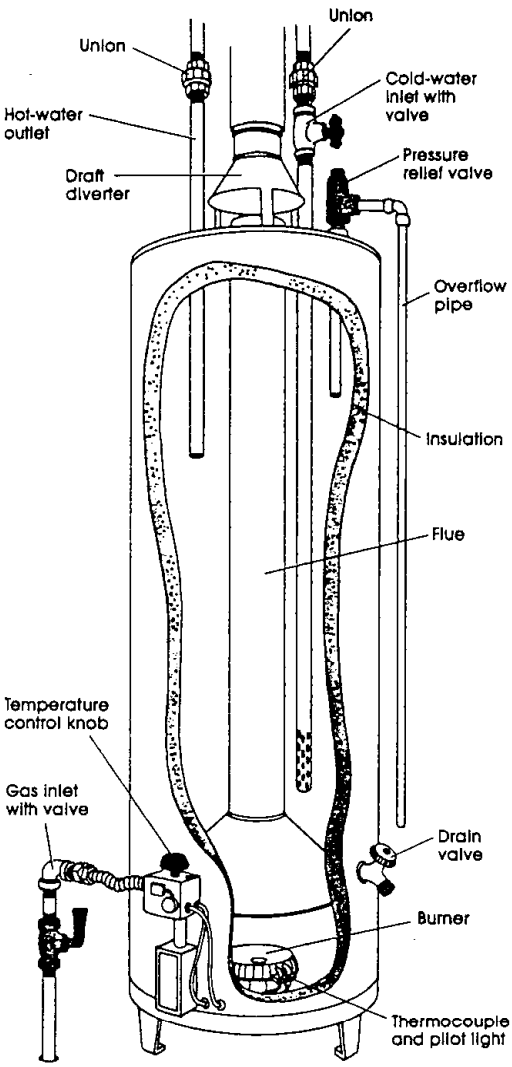
Gas-fueled heaters have a burner very similar to the one on a gas kitchen range. A pilot light lights the burner when the thermostat indicates the tank water is cooler than desired. Hot exhaust gases from the burner go through the flue in the center of the tank, where they continue to heat the water as they pass by.

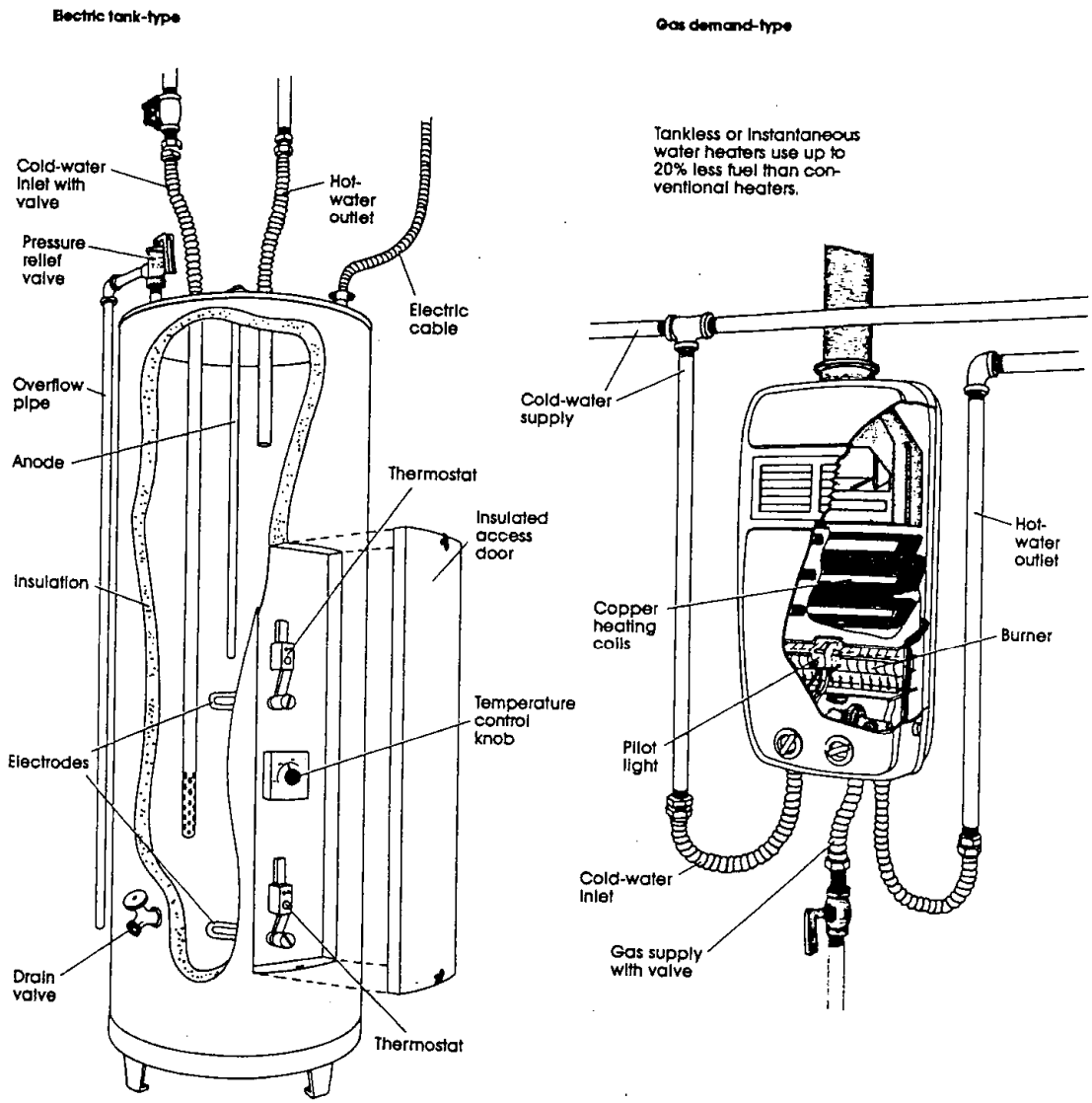
Oil-fueled heaters are less common but still in use where oil-fired furnaces are used. The water tank is suspended in the middle of the heater, and a small version of an oil-furnace blower heats the bottom and sides with hot gases before they are vented out the flue.

Electric water heaters have one or two heating elements that project through the wall of the tank into the water. Because there is no combustion, no flue is needed and no toxic gases or hot gases are emitted. An electric

Types of Water Heaters

Gas tank-type





heater, therefore, can be placed in a closet or bathroom, where the building code would not allow a gas or oil-fueled heater. All water heaters do need a drain in case of overflow and for regular maintenance draining (see page 76).

All water heater storage tanks should have a temperature/pressure relief valve. This valve will relieve the pressure and thereby prevent an explosion if the thermostat malfunctions and the temperature or pressure within the tank exceeds predetermined limits. A properly installed relief valve will have an overflow pipe attached to it that directs any escaping water or steam outside or to a floor drain.

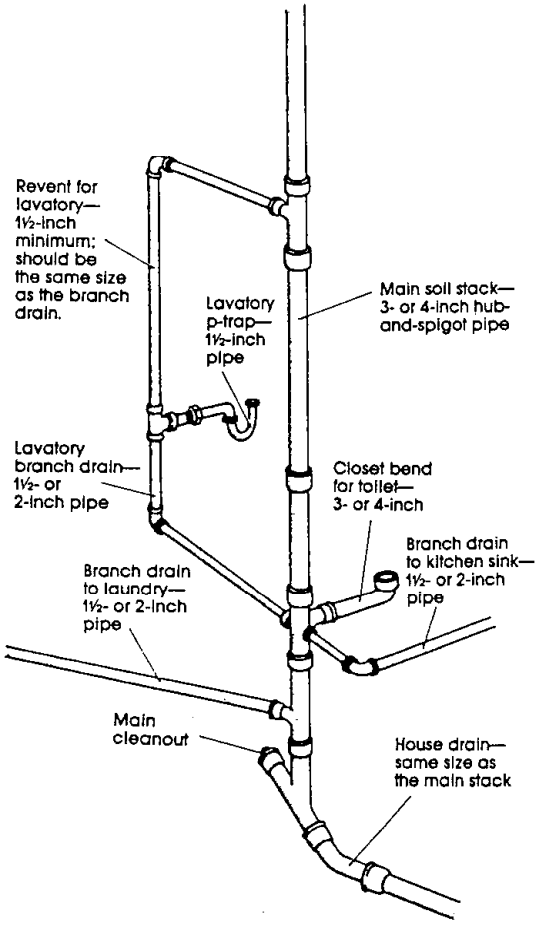
For information on passive, active, and auxiliary solar water heating systems, and what might be the best system for you, see pages 78–79.

WASTEWATER DISPOSAL

At the end of the water supply pipes in your home are fixtures or appliances where the water is used. The system that carries the used water away is the wastewater drainage system, or, as it is called in the trade, the DWV or drain-waste-vent system. Because of the nature of all the household and body wastes that are put into our used water, we need more than just drain pipes to take this water away. Our waste materials contain large amounts of bacteria, both beneficial and harmful varieties. The anaerobic bacteria, those which live in an environment without free oxygen, thrive in our digestive tracts. When these bacteria are in septic tanks, and sewer lines, they produce a foul-smelling, poisonous, and flammable mixture of gases, commonly called sewer gas. This gas must be kept out of our homes.

To prevent sewer gas, pests such as rats, and other contaminants from coming up the drain pipes into our homes, we add traps to the system. A trap is a U-shaped curve in a pipe or fitting that remains filled with water at all times. Sewer gas and other things cannot get past the water and come up through the drains. Each time you empty a sink or flush a toilet, the water in the trap is also flushed away and new water replaces it. This means, theoretically, that dirty water isn't in the trap long enough to grow large colonies of its own bacteria.

Detail of Part of the DWV System



To get rid of the sewer gas and to prevent siphoning of water out of the traps, all house drain systems have vents. Vent pipes come off the drains downstream from the traps and go up through the roof. Sewer gas passes up the vent pipes and is dispersed harmlessly into the air. When water flows down the drain, air is sucked down the vents into the pipes, equalizing the air pressure on each side of the trap. This prevents the water in the trap from being siphoned out and sewer gas from entering the house.

Also, since all drain systems are subject to clogging from time to time, they are provided with cleanouts. These are Y or T fittings with screw-on covers that give the homeowner or plumber a place to insert rods or augers for the purpose of dislodging clogs.

Drain pipes. Drain pipes differ from water supply pipes in at least two important ways. They are larger and they flow at a lower pressure, usually by gravity alone. The smallest drain pipe in the house, probably the one coming from the bathroom sink, is never smaller than 1¼-inch and 1½-inch is usually preferred by the building code. The smallest drain from a toilet is 3 inches in diameter. Metal drain pipe 2 inches or less in diameter is usually made of galvanized wrought iron, galvanized steel, or copper tubing. In larger sizes, the pipe is made of cast iron. Most building codes now allow plastic pipe for DWV systems in single-family homes, but there are usually some restrictions (see page 38).

The DWV system in a house is arranged like a tree, with the smallest branches near the top. The smallest pipes always flow into pipes the same size or larger until they all flow into the soil stack, building drain, and building sewer, which are the largest pipes in the system. The sizes of all these pipes are specified in the building code. A typical arrangement of pipes with their usual sizes and names is shown in the drawing.

If you are going to replace a section of pipe or replace an old fixture with a new one, use the same sizes of pipe, trap, and vent that were there before. If you are putting on an addition that includes a new bathroom or laundry, you should check with the code to be sure of the required pipe sizes. Unlike some specifications in the building code, pipe sizes are not minimum sizes. The theory of pipe sizing prescribes sizes that are neither too small nor too large, but just right. Pipe that is too small won't allow the proper amount of material through and may clog or unduly retard the discharge of wastewater.

Not so obviously, horizontal drain pipe that is too large is also undesirable. Larger pipe results in slower movement of the waste material through the pipe. This slower speed reduces scouring and lets heavier particles settle. The greater thermal mass of the larger pipe also causes greater cooling and solidifying of grease. All these

things contribute to the possibility of clogging. Unnecessarily large pipe also adds unnecessarily to the cost, whether the pipe is horizontal or vertical.

The proper size pipe allows for enough capacity to prevent back-ups, to promote the scouring action of swift movement, and to avoid siphoning or blow-back by allowing enough vent air. For drain pipe it is recommended that you always use the smallest size permitted by the code.

Besides making the drain pipe smaller, there is another way to increase the velocity of the waste within the pipe. That is to increase the pitch or slope of the horizontal parts of the system. Codes require that horizontal branches slope ¼ inch per foot. In practical application, this slope varies from 1/16 to ½ inch per foot, and of course the more the pitch, the faster the water will flow. If you increase the slope of a fixture drain pipe, be careful not to make the outlet from an unvented length of pipe lower than the bottom of the fixture trap it serves. If it is lower, it is likely to siphon the water from the trap (see drawing).

Vent system. Building codes require a vent system that is arranged and sized to provide the best possible pressure/suction relief for each fixture in the system. Systems that don't follow the code may have back pressure problems such as sinks that drain too slowly, toilets that need several flushes to get rid of all their contents, and blow-back through first floor fixture traps. A poor vent system can also provide too much "negative pressure" (suction), which siphons the water from traps, or "positive pressure", which forces bubbles of sewer gas through the liquid in the traps (blow-back). Either way the smell is not desirable.

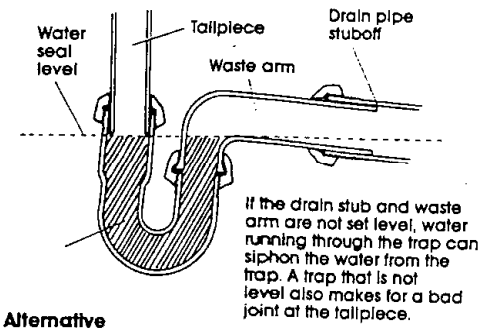
The size of vent pipe cannot be smaller than required by the code. The sizes are based on the kind of fixture, the diameter of the drain being vented, and the length of the vent pipe. For each dwelling unit, most codes require a 3-inch or 4-inch main stack extending through and above the roof. The diameter of an individual vent can never be less than 1¼ inches or less than one-half the diameter of the drain it serves, whichever is larger.

Traps. Building codes everywhere require that each fixture connected to the household drain system have a water-seal trap. Some fixtures, toilets for example, have their trap built in as an integral part of the fixture. The trap most commonly used in the home is called a P-trap because it looks like the letter "P." It is used on sinks, laundry trays, and most other fixtures that don't have built-in traps.

Building codes have many restrictions on traps because they are so important in protecting the health and welfare of the home's inhabitants. The following restrictions appear in virtually every code:

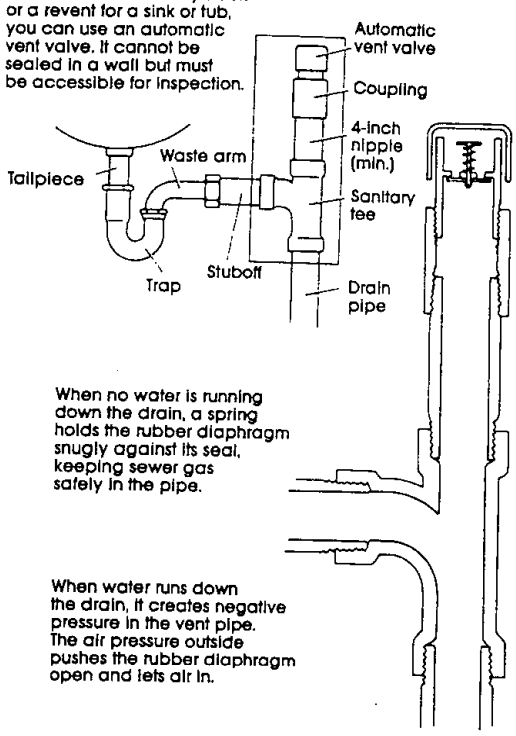
- Traps must be self-cleaning. That is, they must be smooth inside so hair, lint, and other material cannot be caught and retained.
- No trap can depend on moving parts for its seal.
- No trap outlet can be larger than the fixture drain it is serving.
- Each trap must have a water seal no less than 2 inches or more than 4 inches.

Trap Warning



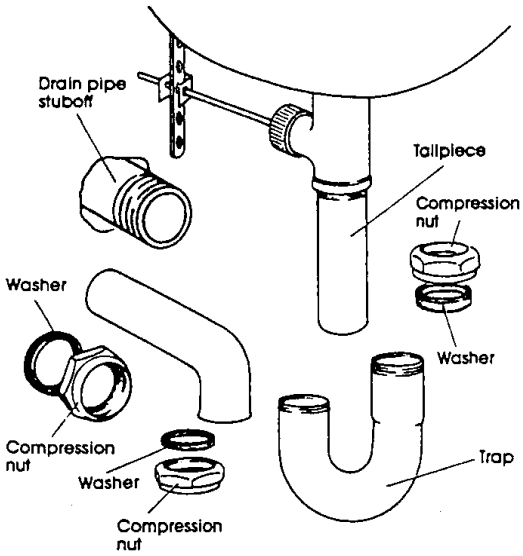
Vent Alternative

Instead of a secondary stack or a revent for a sink or tub, you can use an automatic vent valve. It cannot be sealed in a wall but must be accessible for inspection.



- All traps must be installed level in relation to their water seals to prevent siphoning.
- Each plumbing fixture must have its own trap. There are some exceptions whereby installations of sinks and laundry trays, when there are two or three units adjacent to each other, can be connected to a single trap.
- No fixture can be double trapped. A toilet with an integral trap, for instance, cannot be connected to another trap.

Typical P-Trap Assembly



Again, if you are replacing a fixture or adding fixtures similar to those already in your house, use a trap like those already in use and you will most likely be well within the requirements of the code. If you are installing a new fixture unlike anything you already have, consult a plumber or your building inspector for advice on the local requirements.

Cleanouts. All building codes now recognize the importance of accessible cleanouts and require them on all installations. The requirements regarding location, size, and minimum distance between cleanouts are spelled out very specifically. For example:

- A cleanout is required where the building sewer crosses the property line or connects to the public sewer. This cleanout allows for the cleaning of stoppages that may occur in the public sewer lateral and also is the place where tests can be performed on the entire house system.
- Some codes require and some allow a cleanout outside the house within five feet of the building.
- Accessible cleanouts are required on all horizontal drain lines and where there is a change in direction of more than 45 degreees in the building drain.
- A cleanout is required at the base of all stacks.
- All cleanouts must have at least 18 inches of clearance to allow the access of cleaning rods, snakes, and other tools.

Sometimes in one-story buildings, the local code will consider a roof vent to be a cleanout for the stack it serves. Certain requirements involving pipe sizes and changes in direction must be met for this to be the case, however. Be sure to check your local code.

Drainage from Below Sewer Level

Sometimes it is necessary to dispose of wastewater that accumulates below the main sewer line. Homeowners will occasionally want to install wash trays, an automatic washing machine, or even a whole bathroom including a sink and a toilet in a basement area. When groundwater seepage or rainwater runoff repeatedly floods a basement, facilities must be installed to automatically remove the water. Discharge of rainwater into a sanitary sewer is not permitted in some areas.

Sump pumps. Groundwater, rainwater, or gray water—water from a washing machine, bathroom sink, shower, or bathtub—can be handled very well with a sump pump. The wastewater is made to run into a concrete-lined sump pit and is then lifted into the sewer with a pump that starts automatically when water reaches a certain level in the pit.

If seepage or rainwater is flooding the basement, the sump pit should be located at the lowest point in the basement. A sump pit for a sink or washer can be anywhere that it's convenient to run a drain pipe. The size of the pit will be determined by the size and kind of pump you install.

The oldest, most common, and least expensive sump pump is the upright type. It consists of an electric motor on top of a pedestal. The base of the pedestal, containing the pump and discharge pipe, rests on the bottom of the sump pit. A ball float in the pit is connected by a rod to the motor switch. When the water in the pit reaches a predetermined level, the float flips the switch to ON. When the pump lowers the water level, the ball descends and turns the switch to OFF. The water level to turn the switch off is usually set at about 6 inches because the pump can be damaged if it empties the pit and runs dry. The pit for an upright sump pump should be 12 to 24 inches deep and 12 inches or more across; it can be either round or square.

The submersible pump is more expensive, but generally more satisfactory than the upright type. The submersible pump cannot be damaged by flooding and requires much less maintenance. It can run longer and safely take the water level lower than the upright pump. Two kinds of switch mechanisms are available on these pumps. One is the float type similar to the one described on the upright pump. These are subject to jamming if dirt or other debris accumulates in the sump pit. The more desirable type of switch is activated by water pressure. This one, too, can be set to go on and off at specific depths. The sump pit for a submersible pump should also be at least 12 inches across and from 12 to 15 inches deep.

helpful hints for residential plumbing

DRAINS:

1- All drainage plumbing pipe should fall ¼ inch in each foot of horizontal run. This will show as ¼ bubble in the window of your level.

2- The main building drain line is usually 3 inch size pipe. Where three toilets enter a line within 15 feet of each other the pipe must be 4 inch size from the point where the third toilet enters on out. Most other drain pipes must be 2 inch size. Single wash basin (lavatory) drains can be 1½ inch size pipe.

3- Pipes should be installed in a straight alignment and held so by supporting all horizontal runs every 4 feet and at the base of all vertical drops. Vertical pipes should be supported in a manner and frequency that will maintain alignment. Plumbers tape is the prime material used for supporting drain and vent pipes.

4- One primary cleanout with its riser extended to grade is usually required at the end of the building drain (within 2' outside the building foundation). A two way cleanout at this point is preferable because it usually eliminates the need for a cleanout at the upper end of the building drain. Cleanouts are usually required in all horizontal lines over 5 feet long and/or for each 135° of horizontal directional change. All kitchen sinks should have a cleanout located just below the waste tee fitting. Cleanouts are not needed above the first floor elevation. Cleanouts located under a house should be within 20 feet of an access opening with plenty of free space maintained above and behind the fitting. Except for end line cleanouts, entry to the line should be from above (wherever possible) and with the flow. Cleanout openings should be virtually as large as the pipe into which they enter.

5- Common fixture rough-ins: TOILETS- 12 inches from the center of the floor flange to the back wall studding and a minimum of 15½ inches to either side. KITCHEN SINKS- 18 inches above floor except when a food waste disposer is to be installed. The rough in should then be approximately 15 inches. LAUNDRY TRAYS- 12 to 15 inches above the floor. WASH BASINS (LAVATORIES)- 18 inches above floor. WASHER STAND PIPE- 36 inches to the top of pipe with the bottom of the p-trap bend 6 inches above the floor. TUBS AND SHOWERS- according to manufacturers specifications as they vary with the model used and are usually set at the time rough-in is made.

6- Floor drains should be primed to maintain the water barrier in the p-trap. This requires a tapped p-trap usually of cast iron.

7- A.B.S. fittings are made in all popular configurations. Drain fittings are designed with the drainage fall built into them. If they are used in venting systems they must be turned upside down. For this reason we suggest using only the proper type fittings to do the job.

8- When gluing joints refer to the section of this pamphlet, "HOW TO JOIN D.W.V. PIPE". You have about 15 seconds under normal conditions to make up and align the joint after the glue is applied. Remember that the pipe will insert further into the fitting socket once the weld is spread so DON'T CUT YOUR PIPE TOO SHORT.

helpful hints for residential plumbing

VENTING:

1- All fixtures should be vented. Vents should be placed so that the drain flow doesn't go past the vent opening. This would be considered wet venting and would usually not be approved. HOWEVER, a review by the Uniform Plumbing Code Interpretations Committee of drawings like those in the section of this pamphlet called "VERTICAL WET VENTING MAY BE APPROVED" leads us to believe that vertical wet venting as it is described in article 613 of the Uniform Plumbing Code will become increasingly acceptable. Check with your local inspection authorities for approval before planning your system in this simpler, more economical design.

2- The drainage system of a building must be vented by one or more pipes whose combined cross sectional area is at least equal to that of the largest required building drain pipe. This means that if the main building drain is a 3 inch pipe you could vent with any combination of pipes over 1½ inches in diameter that total at least 7 square inches. For instance two 2" and one 1½" pipes have a combined area of 8 sq. inches and would be adequate venting for a system which has a 3" main drain. HOWEVER, some areas require that any plumbing system into which a toilet connects must be served by at least one vent pipe with a minimum diameter of 3 inch. Common size pipes for venting sinks, tubs basins, showers, floor drains, etc. is 1½ inch pipe but when two or more of these fixture vents are tied together the pipe size should be increased as necessary. Second and third toilets are usually vented with 2 inch pipe.

3- Vents should rise vertically at not less than a 60° angle to a height at least 6" above the highest fill rim of the fixture being served before being turned to a horizontal run. No vent pipe should run horizontally over 1/3 the maximum allowable length of the vent. (SEE TABLE 4-3 of the Uniform Plumbing Code) Horizontal vent pipes should run level or slope slightly downward toward the fixtures they serve.

4- Vent pipes should NEVER be terminated in an attic but should be continued vertically through the roof to a point at least 1' above the roof and at least 1½ feet away from any vertical surface. Approved flashings should be used around vent pipes at the roof to insure that a watertight seal is made to the pipe.

5- Vent pipes should be supported to prevent sag and maintain a straight alignment in the same manner as drainage pipes.

6- A.B.S. vent fittings are available in most popular and necessary patterns. IF drainage fittings are used in a vent system they should be used UPSIDE down and with the bends turned WITH the air flow in the pipe.

7- Assembling procedures for A.B.S. vent system materials is the same as for A.B.S. drainage.(see section of this pamphlet called "HOW TO JOIN D.W.V. PIPE") Remember that the pipe will insert further into the fitting socket once the glue has been applied so don't cut your pipe too short.

INTERMEDIATE PLUMBING SKILLS STUDY QUIZ

1. The water supply line entering a residence should be at least: _____

   a. 1/2 inch inside diameter
   b. 3/4 inch inside diameter
   c. 1-1/2 inch inside diameter

2. After the main water line enters a residence it usually: _____

   a. splits near the water heater
   b. runs straight through to the outside faucets
   c. supplies all cold water fixtures, then runs to the water heater

3. If a pipe air chamber loses its air: _____

   a. remove the cap and allow air to enter the chamber
   b. replace the air chamber with a manufactured shock absorber
   c. either a or b

4. A "tankless" water heater uses: _____

   a. up to 40% less energy than the conventional water heater
   b. up to 20% less energy than the conventional water heater
   c. more energy than the conventional water heater

5. Anaerobic bacteria working in septic tanks and sewer lines produce sewer gas which is: _____

   a. poisonous
   b. flammable
   c. both poisonous and flammable

6. Sewer gas, contaminants, and pests such as rats are prevented from coming up the drains and into the building by: _____

   a. traps
   b. vents
   c. both traps and vents

7. When water flows down the drain, air is sucked into the pipes _____

through:

a. the "P" trap
b. the vent
c. both trap and vent

8. T F Two factors affecting the steady, even flow of water through a water system are line volume and line friction.

9. T F A larger diameter pipe will have greater line friction than will a smaller diameter pipe.

10. T F Branch lines feeding individual fixtures may be as small as 3/8 inches inside diameter.

11. T F In cold climates the entire water distribution system should be sloped to one or more drain cocks.

12. T F Each plumbing fixture and appliance should have it's own shutoff valve.

13. The smallest drain line allowed from a toilet is: _____

a. 2 inches
b. 3 inches
c. 4 inches

14. Using a horizontal drain pipe that is too large results in: _____

a. slower movement of waste through the pipe
b. faster movement of waste through the pipe
c. neither a nor b

15. For drain pipe it is recommended that: _____

a. the smallest size allowed by code should be used
b. the largest size allowed by code should be used

16. Code requires that horizontal drain branches slope downward: _____

a. 1/4 inch per foot of run
b. 1/2 inch per foot of run
c. 1 inch per foot of run

17. A poor vent system can provide too much: _____

a. "negative pressure" and siphon "P" traps
b. "positive pressure" and "blow-back" of gas bubbles through traps
c. both, negative and positive pressure

18. Every residential drain must have a trap. A fixture having an internal trap is: _____

a. shower
b. bathtub
c. toilet

19. Of the following, which statement is <u>not</u> true of drain traps: _____

a. traps must be smooth and self cleaning
b. traps must be installed level in relation to their water seals
c. two traps may be installed on a fixture to insure a good seal

20. Of the following, which statement is <u>not</u> true of cleanouts: _____

a. accessible cleanouts are required on all horizontal drain lines
b. a cleanout is required at the base of all stacks
c. roof vents are never considered cleanout

21. Which type of sump pump is generally the better choice? _____

a. upright
b. submersible

22. T F An air chamber should be installed in water systems to cushion shocks to the system and reduce "water hammer".

23. T F Water heaters must have a temperature/pressure relief valve.

24. T F The wastewater drainage system is called the DWV, or Drain-Waste-Vent system.

25. T F A "P" trap is a fitting that remains filled with water at all times.

26. Horizontal runs of suspended pipe should be supported: _____

a. every 2 feet
b. every 4 feet
c. every 8 feet

27. ABS drain fittings are designed with the drainage fall built into them. When using drain fittings in a venting system they: _____

a. must be used right side up
b. must be used upside down
c. must not be used

28. Of the following, which statement is <u>not</u> true of vent pipes: _____

a. they may terminate in an attic
b. should project at least 1 foot above the roof
c. may not terminate within 1 1/2 feet from any vertical surface

29. T F All residential drain systems must have vents to get rid of sewer gasses and to prevent siphoning of traps.

30. T F All drain systems are subject to clogging and must be provided with clean-outs.

31. T F Unlike some specifications in the building code, drain-waste pipe sizes are not minimum sizes.

PLUMBING SKILLS
PRE-TRAINING ANSWER SHEET

1.	_____		17.	_____	
2.	_____		18.	_____	
3.	_____		19.	_____	
4.	_____		20.	_____	
5.	_____		21.	_____	
6.	_____		22.	T	F
7.	_____		23.	T	F
8.	T	F	24.	T	F
9.	T	F	25.	T	F
10.	T	F	26.	_____	
11.	T	F	27.	_____	
12.	T	F	28.	_____	
13.	_____		29.	T	F
14.	_____		30.	T	F
15.	_____		31.	T	F
16.	_____				

INTERMEDIATE PLUMBING SKILLS - EXPECTATIONS

Supervisor

After completing this training program I expect the participant to be able to:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Participant

After completing this training program I need to be able to:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Participant Name & District (print):_____

Supervisor (print & sign):_____