Wyoming's Wellhead Protection (WHP) Program

Guidance Document

(Version 3.1, June 1998)

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

WATER QUALITY DIVISION

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WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY
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WATER QUALITY DIVISION
Gary Beach, Administrator

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This document can be viewed and downloaded from the World Wide Web at:

www.wrds.uwyo.edu/wrds/deq/deq.html

Early Wellhead Protection

"There shall be no man or woman dare to wash any unclean linen, wash clothes...nor rinse or make clean any kettle, pot, or pan, or any suchlike vessel ***within twenty feet of the old well or new pump****. Nor shall anyone aforesaid,* ***within less than a quarter mile of the forte****, dare to do the necessities of nature, since by these unmanly, slothful, and loathsome immodesties, the whole forte may be choked and poisoned."*

Governor Gates of Virginia
Proclamation for Jamestown, Virginia
1610

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EXECUTIVE SUMMARY

Wellhead Protection (WHP) Plan Overview:

In 1986, Amendments to the Safe Drinking Water Act (SDWA) established the Wellhead Protection (WHP) Program. Under these Amendments, each state was called upon to develop, and submit to EPA for approval, a plan that would protect ground water which supplies wells, wellfields, springs, and tunnels that provide drinking water to the general public. The basic, minimum 'elements' that states must address and include in their WHP plans are also specified in the SDWA.

On September 18, 1997 Wyoming became the 46th state to have an EPA-approved Wellhead Protection Program. This document represents Wyoming's Wellhead Protection (WHP) plan, and is intended to serve as a guideline to communities, Public Water Systems (PWSs; See Glossary), and others wishing to develop local WHP plans that will meet the minimum criteria for approval by the Wyoming Department of Environmental Quality (WDEQ) and the EPA.

Prior to developing its WHP plan, in 1991 the WDEQ sponsored public meetings throughout the state to first measure the degree of public interest and support for wellhead protection, and to gather public input on the issues and options that Wyoming should consider when developing its own plan. Questionnaires (Appendix K) completed by attendees at these meetings revealed that ***100% of those who responded indicated that '...communities should protect their public drinking water supply wells...from contamination'; 90% indicated that 'A Wellhead Protection (WHP) Program should be established in their community'***. Summary results and additional comments taken from completed questionnaires are also provided in Appendix K.

The principal objective of a WHP plan is to ***prevent*** the contamination of groundwater resources that supply PWSs. As stated in §35-11-102 (*'Policy & Purpose'*) of *Wyoming's Environmental Quality Act* (Title 35 ["Public Health & Safety"]; Chapter 11 [Environmental Quality]), the policy and purpose of the Act is *".... to enable the state to prevent, reduce and eliminate pollution ...."* and *".... to plan the development, use, reclamation, preservation and enhancement of the .... water resources of the state"*. In recognition of this purpose, WDEQ has identified the importance of providing assistance to local governments to protect drinking water supplies as an important objective in its Strategic Plan. WDEQ has identified the development of a state Wellhead Protection Plan as its primary means to meet this objective; this document is intended to provide such assistance. Responsibility for the development and administration of the state's Wellhead Protection Plan will reside within the jurisdiction of the Department of Environmental Quality's Water Quality Division (WDEQ/WQD).

Wyoming's WHP plan adopts the systematic and logical ***proactive*** approach to protecting drinking water supplies that has been established under the Safe Drinking Water Act Amendments of 1986. Communities and PWSs *may* follow this plan to develop and implement efforts that are designed to protect drinking water supplies from contamination. Potentially significant financial benefits and cost avoidances may be realized (see Appendix R) through the development and implementation of local WHP plans in accordance with the criteria set forth in this guidance. As presented in the state's plan, *there are no requirements, rules or*

regulations that impose the development or implementation of WHP plans on any PWS, either publicly and privately owned. Communities and their PWSs should weigh the benefits of developing and implementing WHP plans and proceed accordingly.

Need for Local Wellhead Protection (WHP) Programs:

Development and implementation of local WHP plans is important in Wyoming because a major portion of the state's PWSs depend upon groundwater. As illustrated in Table 1, approximately 75% of Wyoming residents rely on groundwater supplied by PWSs for all, or part, of their drinking water supplies.

Table 1
Wyoming Public Water Systems (PWSs):
Number of Systems by System Class[1]

Class of System	*Number in Class*	*Number of Sources (Wells)*	*Population Served*
'Community' PWSs	216	467	288,606
'Transient Non-Community' PWSs	336	420	49,680
'Non-Transient Non-Community' PWSs	86	129	13,215
Total PWSs	**638**	**1,016**	**351,501**

Source: Preliminary data from Wyoming Water Resource Center query of EPA PWS database (Personal Comm., Jim Oakleaf, 12-15-95).

The value of a clean, high quality groundwater supply cannot be overestimated. The enormous cost of aquifer remediation and developing alternative water supplies are only two of the many reasons why the protection of all groundwater resources developed by a PWS should be a priority. Aquifer remediation efforts described in technical literature and the news media over the past two decades have shown how difficult, if not impossible, it is to restore a contaminated drinking water supply. Clean drinking water is protective of human health and, from national media surveys, has been found to be an important factor in evaluating one's 'quality of life'.

Potential scenarios of contaminant introduction to drinking water sources are common to most PWSs, and can result from accidental spills and leaks, leaking underground storage tanks, septic systems, mining, agricultural and industrial operations, and other events and activities. The development of WHP plans includes management strategies designed to help ensure that existing groundwater resources used for public drinking water supplies will remain viable.

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[1] As classified by EPA , a **'community'** water system serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents. A **'non-community'** water system may be classified as either (1) **'transient non-community'** (does not regularly serve at least 25 of the same persons over six months per year), or (2) **'non-transient non-community'** (regularly serving at least 25 of the same persons over six months per year).

In the past several years, WDEQ/WQD has provided technical assistance and public information and education to many Wyoming communities active or interested in developing WHP plans. As depicted in Figure 1, WHP plan development and implementation is currently in progress in many communities throughout the state, including Cheyenne and Casper. Laramie and Torrington have both received EPA grants (Wellhead Protection Demonstration Projects) to develop WHP plans. These, and other on-going, projects represent a variety of aquifer conditions, land use activities, community sizes and socio-economic conditions in Wyoming. The techniques and procedures developed for each project can, and have been, used to assist other communities and PWSs in the development of their WHP plans.

Cost/Benefit of Local Wellhead Protection:

Unlike many other states, Wyoming has been extremely fortunate in that very few PWS wells have been impacted or 'lost' due to contamination. Table 2 illustrates potential financial savings which a typical Wyoming community might accrue in the event that implementation of a local Wellhead Protection plan: 1) assists a PWS in obtaining a *susceptibility monitoring waiver* from EPA, allowing it to reduce the degree of monitoring required by the Safe Drinking Water Act; 2) reduces the possibility of the need for costly treatment of a contaminated drinking water supply; and, 3) precludes the need to replace a drinking water supply well that has been lost due to contamination. More detailed information regarding potential financial benefits to both the state and communities is presented in Appendix R (*FACT SHEET 1: "Economic Benefit Potential From Implementation of a Wellhead Protection Program in Wyoming"* and *FACT SHEET 2: "Potential Economic Benefits and Cost Avoidance to Wyoming Communities (or Public Water Systems) When Wellhead Protection Plans are Implemented")*.

Table 2

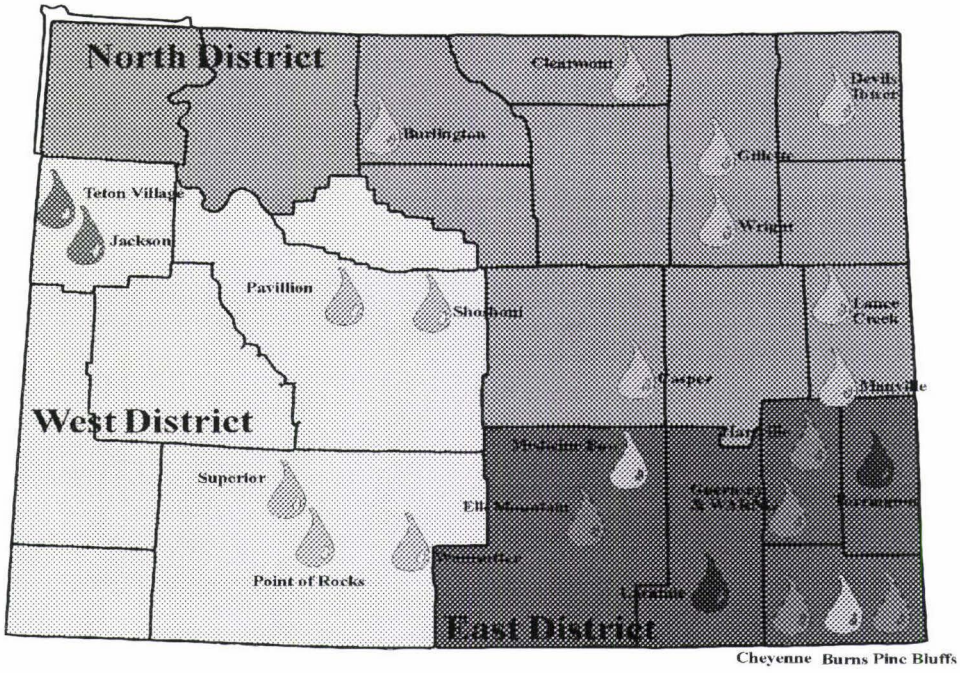
Benefit/Cost Accruing From Implementation of Local WHP Plans

Benefit (Savings)	Period	Cost	Ratio
$33K*	5 Yrs.	$5K	7:1
$506K**	Once	$5K	100:1
$650K***	Once	$5K	130:1

* Monitoring Waivers
** Treatment Plant
*** Replacement Well

Source: WDEQ

Wellhead Protection Program



LEGEND

- WHPA Delineated by PWS
- WHP Plan Development
- Project in Planning Stages

WYOMING WELLHEAD PROJECTS

(Illustrated as of 12/95)

FIGURE 1

Public Input and Participation in Development of Wyoming's WHP Plan:

The development of Wyoming's Wellhead Protection (WHP) plan stemmed from the establishment (July, 1995) and voluntary participation of a 20-member, multi-interest advisory committee. Members of the advisory committee were selected from federal and state agencies, local (city/county) governments and associations, industry, citizen interest groups and environmental interest organizations (See Acknowledgement). Major tasks of the committee involved the identification and establishment of goals, guidelines, minimum criteria, examples and reference materials deemed pertinent by the committee for inclusion in the draft plan. Results of public surveys (1991) to measure the degree of public interest and support for wellhead protection, and public input on the issues and options that Wyoming should consider when developing its own plan where provided to committee members for consideration during development of the plan.

Public participation in the development of this plan also was solicited through press releases distributed to local and statewide newspapers, informing the public of the establishment of the Wellhead Protection Advisory Committee and its role(s), and encouraging interested parties to respond with comments, ideas and suggestions to the draft elements of the state's proposed plan. The opportunity for public participation in development of the state's plan was again provided when the proposed final draft plan was released for public review and comment before Wyoming's Water Quality Advisory Board meeting in Cheyenne on May 9, 1997. The final plan was then presented to Governor Geringer for signature and submitted to EPA for approval; EPA approved Wyoming's Wellhead Protection Program on September 18, 1997.

Preview of Wyoming's Wellhead Protection Plan:

The basic premise behind the state's WHP plan is that it should allow *voluntary*, as opposed to mandatory, participation and provide reasonable flexibility in development and implementation at the local level. The development of WHP plans by communities or PWS owner/operators is often dependent upon whether the benefits derived, or potentially derived, from the development and implementation of the plan will meet community goals and objectives, and can be justified from an economic standpoint.

As detailed in this document, Wyoming's WHP plan addresses each of the 'elements' (of WHP plans) required under the SDWA Amendments, and establishes minimum criteria for WDEQ/WQD acceptance and approval of WHP plans.

Shading has been used throughout this plan to help facilitate the reader's identification of minimum standards and criteria for plans submitted to receive WDEQ and EPA acceptance.

Special consideration was given to assisting WHP plan development for the smaller 'Non-Community' PWSs which, although constituting the majority of public drinking water systems in the state, service only a small part of Wyoming's population. To facilitate the development of WHP plans for these types of systems, a condensed model 'plan' has been developed (Appendix F: "State of Wyoming Groundwater Contamination Susceptibility Assessment Survey Form") for these systems to complete and use in the belief that a simplified, streamlined approach will better suit the needs of not only these types of PWSs, but their users

as well. The University of Wyoming (with funding from EPA), the Wyoming Water Resource Center, and WDEQ/WQD have all been involved in an effort to assist some of these smaller systems by delineating WHPAs for their systems, and providing a map of the delineated WHPA to them for inclusion into their WHP plans.

PWSs wishing to use WHP plans, or parts thereof, to participate in federal incentive programs (e.g. SDWA Monitoring Waivers) must meet the minimum criteria as set forth in this document and be approved by WDEQ/WQD. Although some communities (and their respective PWSs) may have no desire to use WHP plans to enjoy such benefits, they are also encouraged to develop their plans to include all elements of this guideline, meet the minimum criteria for approval, and obtain WDEQ/WQD approval of the plan. WHP plans which are approved by WDEQ/WQD are also considered acceptable by EPA.

Just as WHP plans developed by other states are dynamic and evolving to make them more useful to their communities, it is understood that Wyoming's plan will also be subject to periodic change in hopes of improving the success of wellhead protection in Wyoming.

A listing of available reference and technical assistance documents, including order forms, is included as Appendix C.

SECTION I

INTRODUCTION

STATE WELLHEAD PROTECTION (WHP) PLAN ELEMENTS:

The 1986 Amendments to the Safe Drinking Water Act (SDWA), as presented in section 1428 of the Act, specify the basic elements to be addressed in *state Wellhead Protection (WHP) plans*, and includes the following:

(1) Define institutional roles;
(2) Establish criteria to delineate Wellhead Protection Areas (WHPAs);
(3) Identify potential contaminant sources;
(4) Develop management approaches;
(5) Formulate contingency plans;
(6) Address siting new wells;
(7) Invite public participation.

LOCAL WELLHEAD PROTECTION (WHP) PLAN ELEMENTS:

The State of Wyoming's development of a plan to meet the requirements of the SDWA Amendments is outlined below and described in greater detail in following sections of this document. In recognition of the importance and effectiveness of the Wyoming Association of Rural Water Systems (WARWS) in assisting communities and PWSs with the development of local WHP plans, this document mirrors the five steps in the WARWS WHP plan and establishes minimum standards for approval (by WDEQ/WQD) of local (e.g. community or PWS) WHP plans:

- ***Section I:*** Formation of a community planning team *(Wellhead Protection Management Committee)* that includes members of the public to initiate, lead and oversee the development and implementation of a local WHP plan.

- ***Section II:*** *Delineation* of local Wellhead Protection Areas (WHPAs).

- ***Section III:*** Identification and location of potential *Sources of Contamination.*

- ***Section IV:*** Development and implementation of a *Contaminant Source Management Plan*.

- ***Section V:*** Development of a *Contingency Plan* to ensure an alternate public water supply if contamination occurs, and a *New Well Siting Plan* for development of new wells in the event that replacement or additional supplies are needed.

This remainder of this section (Section I) of the state's plan contains a discussion of the major institutional roles and responsibilities of the many local, state and federal agencies and organizations that, to greater or lesser degrees, are typically involved with the development, implementation and funding of local WHP plans.

The following sections of this document establish the processes and criteria that define complete and acceptable (by WDEQ/WQD) Wellhead Protection (WHP) plans for 'Community' Public Water Systems (PWSs). In recognition of the unique circumstances and nature of Wyoming's 'Non-community' PWSs, these types of systems may complete and submit a condensed 'model' WHP plan (Appendix F: "State of Wyoming Groundwater Contamination Susceptibility Assessment Survey Form") together with a map (minimum 1:24,000 scale) illustrating the WHPA(s) (delineated using Arbitrary (Zone 1) and Calculated Fixed-Radius Methods (Zones 2 and 3)) for consideration of approval. 'Non-community' PWSs must follow the same requirements as 'Community' PWSs for updating WHP plans (see Section VIII).

FEDERAL, STATE and LOCAL GOVERNMENT ROLES

Effective Wellhead Protection (WHP) planning involves coordination of federal, state, and local efforts and funding sources. Information and technical support often necessary to complete local WHP plans is available from many sources. The type of information and support will vary with the organization. Some organizations specialize in developing and providing information and educational materials used to promote groundwater protection; other agencies may be able to provide technical assistance and information concerning hydrogeology (for WHPA delineations), Public Water System (PWS) well construction, local and regional water quality, contaminant sources, health effects, Best Management Practices (BMPs) or other information pertinent to WHP development.

The following agencies and organizations are potential sources of information and technical assistance available to communities and PWSs developing and implementing WHP plans:

Federal:

EPA:

- Develops and provides technical assistance documents (see *'Additional Resources'* at end of this Section) for guidance in developing individual elements of local WHP plans;

- Develops and provides computer software used to perform WHP Area (WHPA) delineations;

- Administers the Safe Drinking Water Program and awards incentives (e.g. monitoring waivers) to communities with accepted WHP plans in place;

- Approves or denies state WHP plans.

USDA Natural Resource and Conservation Service (NRCS):

- Develops and provides technical assistance on construction of agricultural waste management facilities having the potential to impact groundwater;

- Develops and provides Best Management Practices (BMPs) for numerous agricultural activities having the potential to impact groundwater;

- Cost shares with farmers and ranchers to implement measures to protect groundwater quality.

US Geological Survey (USGS):

- Develops and provides regional information on hydrogeologic conditions and groundwater quality;

- Cost shares cooperative projects with state, county and local entities to

address local hydrology issues;

- Under the National Water Quality Assessment (NAWQA) program, may assist communities with groundwater monitoring within formal (i.e. Delineated) Wellhead Protection Areas that lie within NAWQA study areas.

Bureau of Land Management (BLM) and US Forest Service (USFS):

- Administers rules and regulations governing agricultural, mining, grazing, timbering, oil and gas and mineral exploration activities on federal land.

State:

The major role of WDEQ/WQD in implementing and administering the state's WHP plan is to assist local development of *complete, technically adequate and acceptable* WHP plans by providing technical assistance and guidance on techniques and strategies available to meet the minimum acceptance criteria set forth in the state's plan. WQD also will perform completeness and technical adequacy reviews of local WHP plans submitted for acceptance, and provide recommendations and suggestions on ways to achieve acceptable plans. WQD is responsible for final approval or concurrence of local WHP plans; notice of acceptance of local WHP plans will be provided to the community and to EPA in order to facilitate the participation of local PWSs in SDWA incentive programs such as monitoring waivers.

Wyoming Department of Environmental Quality/Water Quality Division (WDEQ/WQD) will assist in:

Coordination:

- By participating on WHP management committees at the state and local levels.

- With other state and federal agencies to prioritize groundwater protection and cleanup actions within WHPAs.

- Within WHPAs, to require groundwater monitoring (utilizing the authority under W.S. §35-11-110), as needed, at future potential point source pollution facilities that are regulated by WDEQ.

- With other local, state and federal agencies in responding to oil and hazardous substance releases which enter, or threaten to enter waters of the state (including groundwater) pursuant to the '*Wyoming Oil & Hazardous Substances Pollution Contingency Plan'*, *(WDEQ, 1990).*

- With other WDEQ divisions, state and federal agencies to assist communities in providing information to develop and implement WHP plans.

  * Example: WDEQ's Land Quality Division (LQD) is involved

in an effort to develop Cumulative Hydrologic Impact Assessments (CHIAs) for several areas within the state. This information may be useful in delineating Wellhead Protection Areas.

Information Transfer:

- Information on funding sources that may be available for development and/or implementation of WHP plans, and assistance as needed in assisting applications for funding.

- Notification of spills reported to WDEQ which enter, or threaten to enter waters of the state (including groundwater).

- Notification of pollution release(s) to groundwater from WDEQ-permitted facilities within WHPAs.

- Inventory lists and related information of existing and potential pollution sources found within WHP areas.

- Inventory lists and related information of WDEQ-permitted facilities capable of causing groundwater pollution within WHPAs.

- Construction standards and specifications which are designed to protect groundwater from releases from certain potential sources such as underground storage tanks, feedlots, wastewater treatment and disposal systems, septic systems, landfills, etc.

Technology Transfer and Education:

- In conjunction with the Wyoming Water Resource Center (WWRC), digital maps and data files depicting groundwater sensitivity and vulnerability to contamination for use as planning tools by state and local agencies.

- To local communities and Indian tribes developing WHP plans, as requested.

- To Wyoming Association of Rural Water Systems (WARWS) in its efforts to promote and establish local WHP plans.

- To commercial businesses and industry on pollution prevention techniques and strategies.

In addition, WQD will:

- *Administer and enforce* its rules and regulations within WHPAs.

Wyoming Water Development Commission (WWDC):

- Provide planning assistance and funding for the development of new municipal water supplies for Wyoming communities.

- Source of information for site specific aquifer and pump test data.

Wyoming State Engineer's Office (SEO):

- Administers and apportions water supplies, including ground water, based upon water rights defined by doctrine of appropriation, priority claim, and beneficial use.

- Issues permits for the appropriation and beneficial use of ground water. All appropriators must obtain an approved SEO permit <u>before</u> drilling a well or developing a spring.

- Maintains well permit files and well construction/completion information in several formats (original documents, complete microfiche files, well database, county well inventories) available for research and use by the public.

- Provides, in SEO rules and regulations, minimum water well construction standards and abandonment/plugging procedures for wells removed from service.

- In cooperation with the USGS, develops and publishes county hydrologic and groundwater investigation reports.

- Together with WDA and WDEQ/WQD, administers responsibilities set forth in the State Pesticide Management Plan (SMP) for pesticides in ground water.

Wyoming Department of Agriculture (WDA):

- Is responsible for administering pesticide and fertilizer registration and regulating the labeling, distribution, storage, transportation use and application of pesticides.

- Through the Wyoming Environmental Pesticide Control Act, can promulgate regulations which may restrict or prohibit use of pesticides in designated areas during specified periods of time (W.S. §35-7-355).

- In consultation with WDEQ/WQD, has existing statutory authority to promulgate emergency rules; promulgate regulations relating to the time, place, manner, methods, materials and amounts and concentrations of pesticide application; and cancel or suspend registration of a pesticide.

- Together with WDEQ/WQD, administers many of the pesticide management and response activities set forth in the SMP.

- Coordinates with WDEQ/WQD on reported incidences of pesticide releases to groundwater through their inspection and enforcement activities.

Wyoming Department of Health:

- Coordinates with federal, state and local agencies in the evaluation and public notification of health threats due to contaminated water supplies.

University of Wyoming (UW):

- Has completed WHPA delineations for some 'Community' and 'Non-Community' PWSs, in part with EPA funding.

Wyoming Water Resources Center (WWRC):

- Provides information and maps relating to ground water sensitivity and aquifer vulnerability.

- Maintains groundwater and surface water quality data bases, providing information to the public upon request.

- Has completed WHPA delineations for some 'Non-Community' PWSs.

Geological Survey of Wyoming:

- Comprehensive source of geologic and hydrogeologic information used for the delineation of WHPAs.

Wyoming Oil & Gas Conservation Commission (WOGCC):

- Provides data on oil and gas wells, including location, depth, production, formation depth(s), surface casing depth, cementation, and well abandonment.

- Provides water well data from State Engineer's Office records, including location, depth, permitted yield, and depth of main water-bearing zone. Provides some details on aquifers and some chemical data. Most data is available via modem access; call for details on WOGCC free software, 'DIALWYO'.

Wyoming Emergency Management Agency (WEMA):

- The Wyoming Emergency Management Agency is responsible for the coordination and implementation of the state Emergency Management Program, including the state's Event Management Plan. During an emergency or disaster, WEMA coordinates state and federal resources to support local jurisdictions.

Local:

Conservation Districts:

- Can serve as the local contact for landowners with property(ies) lying within Wellhead Protection Areas.

- Disseminate information and educational materials concerning groundwater protection and natural resources to land users within Conservation Districts.

- Cooperate with adjacent Districts on projects overlapping District boundaries.

County Emergency Management Coordinators (CEMC):

- The County Emergency Management Coordinator (CEMC) reports to the County Commission and is directly responsible for the administration and operation of the county emergency management program, including the County Emergency Operations Plan. The coordinator is an excellent resource and will be an asset to any contingency planning committee. The name and phone number of the coordinator for each county is contained in Appendix M.

Local Emergency Planning Committee (LEPC):

- The Local Emergency Planning Committee (LEPC) has two primary roles: 1) to prepare a local hazardous materials response plan, and; 2) to manage the paperwork flow of submissions (under SARA Title III) from industry, and their disclosure in response to requests.

Cooperative Extension Service Offices:

- Develops, publishes and distributes comprehensive education and information materials related to protecting groundwater and wells from contamination, including *Wyoming Farm*A*Syst* fact sheets and worksheets used to evaluate on-farm potential contaminant sources and groundwater protection practices.

Information relating to water supply systems, planning and local authorities:

- City/County Planning Departments
- City/County Engineers
- County Health Departments
- Board of Public Utilities or Public Works; Public Works Director
- Local elected officials

Independent:

Wyoming Association of Rural Water Systems (WARWS):

- As contractors to EPA, sponsors public workshops and training sessions on groundwater protection and developing and implementing WHP plans.

- Serves as the primary point of contact between WDEQ/WQD and PWS operators in the development of WHP plans; is fundamental to distributing and communicating the state plan guidelines, requirements and criteria of acceptance to the local level.

- Provides on-site technical assistance on WHP plan development and implementation to communities; is fundamental to assisting communities in the development and successful completion of WHP plan elements.

Midwest Assistance Program (MAP):

- As contractors to EPA, assists EPA in technology transfer and providing regulatory and technical assistance to PWS operators in order to maintain compliance with SDWA requirements.

Outside Consultants:

Numerous professional firms within Wyoming have the professional credentials, qualifications and experience to provide assistance and guidance in the development of WHP plans. Dependent upon the particular need, experts are available to complete entire plans, portions thereof, or simply to coordinate and facilitate plan development as needed. Many consultants working within the environmental arena in Wyoming also have strong working knowledge of state and federal environmental programs and regulations, as well as both personal and professional contacts at all levels of government.

Local Governments (Counties and Municipalities):

County and municipal government involvement in developing and implementing WHP plans is critical to the ultimate success of any local WHP plan. County government participation, coordination and support is necessary when municipal Wellhead Protection Areas (WHPAs) extend into areas under jurisdiction of county governments. Similarly, municipal and county government participation, coordination and support is necessary when WHPAs for *'Non-community'* wells such as those for parks, schools, etc. lie within, or extend into their respective jurisdictional areas.

County officials, agencies or organizations which should be involved in developing and implementing WHP plans include:

- County Commission
- County Planning Office
- County Emergency Management Coordinator
- Owner/Operators of non-community systems (e.g State Parks, rest areas, etc.), rural water districts, mobile home parks, and subdivisions that fall outside of municipal jurisdiction.

Municipal officials, agencies or organizations which should be involved include:

- Mayor, Council, City Manager
- PWS Operators
- Board of Utilities
- City Engineer
- City Planning Department
- Local Emergency Planning Committee
- Downtown Development Authorities

WELLHEAD PROTECTION (WHP) MANAGEMENT COMMITTEES:

The main characteristic of successful local WHP Plans is recognition of the importance of public participation in both the development and implementation of the plans. Organizing a *Wellhead Protection Management Committee (WHPMC)* from local water customers and parties potentially affected by WHP plan implementation is one good approach to involve the general public. The local WHP Management Committee should represent the various interests of the community, united under the common goal of protecting drinking water supplies. The most effective way for the WHP Management Committee to accomplish this objective is to implement the WHP plan for each well, well field, spring, and tunnel comprising the drinking water sources for the PWS. One suggested approach for development of the local WHP plan is to:

- Form a WHP Management Committee and, through public meetings or hearings, ensure that interested citizens, affected parties and governing bodies are made aware of and become educated and involved in development of the WHP plan.

- Formally recognize the goals of Wellhead Protection (WHP) and the Wellhead Protection Management Committee through passage of a resolution (Figure I-1).

- Coordinate with PWS operators and WDEQ/WQD in the development of complete, comprehensive and technically sound WHP plans according to the guidelines, criteria and minimum requirements set forth in this document.

- Provide or obtain funding, if necessary, for activities to develop and complete the WHP plan.

- Implement management strategies to protect the WHPA (See Section IV).

- Submit the completed WHP plan to WDEQ/WQD for approval.

As depicted on Figure I-2, PWS personnel, local governmental representatives, health department personnel, community residents, public interest groups, potentially affected parties and commercial and industrial representatives should comprise the WHP management committee for the public drinking water supply. Because generation of a local WHP plan can be completed as a "do-it-yourself" process, the use of technical and legal consultants is optional and on an as-needed basis.

FIGURE I-1

A RESOLUTION RELATING TO WELLHEAD PROTECTION

WHEREAS, the *(City Council/County Commission)* of *(City/Town)* deems it appropriate and in the interest of the public health, safety, and welfare of the citizens to implement plans to prevent contamination of the groundwater supplies that provide potable water to the citizens of _____ ;

NOW, THEREFORE, BE IT RESOLVED BY THE *(City Council/County Commission)*: The *(City Council/County Commission)* recognizes that some residents of *(City/Town)* rely mainly on groundwater for a safe drinking water supply and that certain land uses can contaminate aquifers. It is the intent to accomplish aquifer protection, as much as possible, by developing and implementing a Wellhead Protection (WHP) Plan in accordance with Wyoming's Wellhead Protection (WHP) Plan. The Plan shall be as described within the document prepared by the Wyoming Department of Environmental Quality entitled "Wyoming's Wellhead Protection (WHP) Program; Guidance Document", and shall meet or exceed the requirements of the Wyoming Wellhead Protection (WHP) Plan.

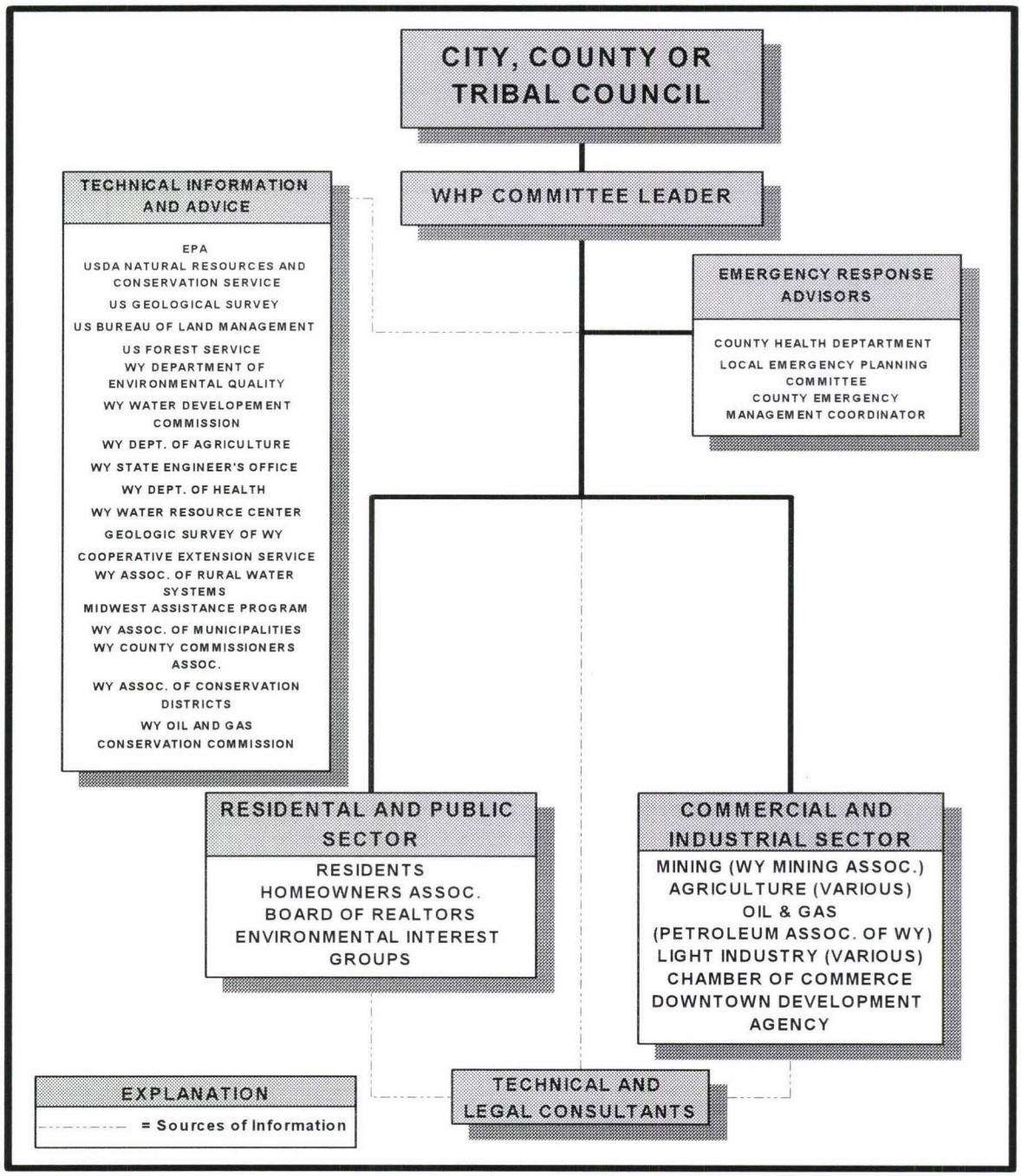
ADOPTED this _____ Day of _____, 199_.

_____

, Chairman

ATTEST:

_____



GENERAL ORGANIZATION CHART FOR WHP MANAGEMENT COMMITTEE

FIGURE I-2

A listing of the members of the Wellhead Protection Management Committee, including committee meeting schedules, resolutions, and descriptions of efforts to include public participation should be included in the Wellhead Protection (WHP) plan submitted to WDEQ/WQD.

Idealized WHP Management Committee Membership and Responsibilities

WHP planning is not static, but rather is a dynamic process requiring a multi-disciplinary team committed to protecting the groundwater source which supplies its drinking water. Because development of WHP plans is often a lengthy process and frequently requires management committee members to assume extra duty, exceptional candidates for participation are those individuals capable of committing to what may be an extended and demanding process. The following entities have been identified as important, if not vital, members of the WHP Management Committee responsible for developing and implementing the WHP plan. Suggested roles for the various participants are presented below, for illustrative purposes only.

City, County or Tribal Council/Commission: The Council supports and sponsors the establishment of the WHP Management Committee for the purpose of assessing the need for protection of the groundwater source, evaluating the effectiveness of monitoring and protection measures, and developing recommended approaches to providing adequate protection of drinking water supplies. The WHP Management Committee is appointed by the Council from local governmental agencies, the public water supplier, citizens of the community, and other individuals.

In the development of WHP plan objectives and management approaches, the Council actively solicits public involvement to ensure not only effective protection of drinking water sources, but also to ensure that the need to protect is appropriately balanced with local socio-economic and environmental considerations to achieve balance with the need for maintaining the overall health and prosperity of the community. Advice from technical and legal consultants should also be solicited while developing WHP objectives, approaches, and implementation strategies.

The Council ultimately is responsible for establishing and enacting management approaches to achieve the objectives set forth by the WHP Management Committee. The Council adopts the WHP plan for the PWS and periodically reviews, updates and amends the plan, as necessary. These local governmental agencies are responsible for development and implementation of additional management approaches adopted by the WHP Management Committee, monitoring of activities within the recharge area of the groundwater source, and enforcement of local rules and regulations designed to protect drinking water sources.

Public Water System (PWS) Operator: The PWS operator facilitates and coordinates management committee meetings for development and completion of the elements within the WHP plan. Regardless of whether the PWS supplies an industrial facility, community, mobile home park, or other type of facility, the owner is involved in completion of the Wellhead Protection Area (WHPA) delineation and Source Inventory elements, and is instrumental in the development of management approaches to be recommended to the City Council or County Commission. The operator assists and coordinates development of the Contingency Plan for emergency response measures and siting new wells, maintaining communication and coordination channels with appropriate local, state and federal agencies.

Private, Commercial and Industrial Interest Representatives: Because much, if not all, of the area within and surrounding a community's drinking water supply may be privately held, representatives of potentially affected private landowners and commercial/industrial interests should be invited and encouraged to serve on the WHP management committee. Generally, success of WHP plans depends upon the effectiveness of implementing management approaches to protect the drinking water supply from becoming contaminated. Adoption of management approaches, especially those which are, or appear to be, restrictive, prohibitive, or otherwise regulatory in nature will be more difficult if affected parties are left out of the planning process. These representatives are often an invaluable resource for supporting and sponsoring public outreach and education programs concerning groundwater and wellhead protection.

Residential Interest Representatives: Citizens of the community, water customers, and homeowners have a vested interest in protecting their public water supply and are an invaluable resource for assistance in completing the elements of WHP plans. Quite often, the time, talent, interest and commitment necessary to develop and complete a successful plan can be found within community volunteers. Their interest in participation on the management committee and related work groups should be strongly encouraged and supported.

Technical, Legal and Regulatory Advisors: Because development and implementation of WHP plans requires a knowledge and understanding of many varied disciplines and practices, WHP management committees should solicit participation from scientists, engineers, planners, technicians, attorneys and other experts within the community whenever possible. Quite often, local individuals have the best knowledge and understanding of local conditions. In the absence of local talent needed to complete specific elements of the WHP plan, committees must rely upon the external resources available to them through the agencies, organizations and private firms mentioned earlier.

Inevitably, the best WHP plans are those developed entirely by those with a vested interest in its success, for they best understand the activities which can affect and protect their water supplies.

The success of the WHP plan typically will depend upon the level of interest and support from water customers. The best way to gain public support and acceptance for an individual WHP plan is through their participation in the development of the WHP plan, including the design of management strategies and approaches geared toward protecting drinking water supplies from contamination. These management strategies and approaches are described in greater detail in Section IV, but may include any of the following:

- Contaminant Source/Activity Restrictions or Prohibitions
- Site Plan Reviews
- Design and Operating Standards
- Land Use Agreements
- Purchase of Property or Development Rights

- Public Education Programs
- Hazardous Waste Collection
- Land Use Ordinances

PUBLIC INFORMATION and EDUCATION:

Notifying the public and including them in WHP plan activities should be an integral part of the WHP plan development process. It is particularly important to educate and inform those who reside or own property or businesses within the WHPA. Owners and operators of potential and existing sources of contamination within the WHPA should be notified when WHP plan development is begun, as well as when the WHP plan is approved or modified. At a minimum, this notification should consist of publication of a map and essential plan elements in a highly visible section of the local newspaper. Specific information that should be provided to the public includes the type and location of each activity or contaminant source within the WHPA and the potential risks, if any, to the drinking water supply.

According to EPA (1990), the public typically is unaware of basic groundwater concepts, and this lack of knowledge often frustrates communication efforts. The public should be educated about the public drinking water supply system so that they can become familiar with the basic concepts and terminology relating to wellhead protection. The following fundamentals should be covered in any public education program:

- What groundwater is;
- How groundwater is distributed;
- How groundwater can become contaminated;
- Measures taken to ensure that the water supply is safe; and
- The basis for the water rate structure.

There are a number of ways to educate and inform the public concerning groundwater supply and groundwater protection. Some are more costly than others and some depend upon the extent of the community's communication resources. The following are examples of common approaches to educating and informing the public of issues relating to groundwater management and protection.

Groundwater Models: One of the most effective educational approaches toward understanding groundwater movement and contaminant migration is through the use of physical groundwater models; suppliers, including 1995 prices are listed in Appendix A.

Informational videotapes: WDEQ can provide copies of groundwater and wellhead protection videotapes based upon real-world experiences and applications for use at public meetings. These include:

"The Power to Protect" (EPA)

"Wellhead Protection Public Service Announcement" (Univ. of Wisconsin; Stevens Point)

"Wellhead Protection - DeSmet School, DeSmet, MT"

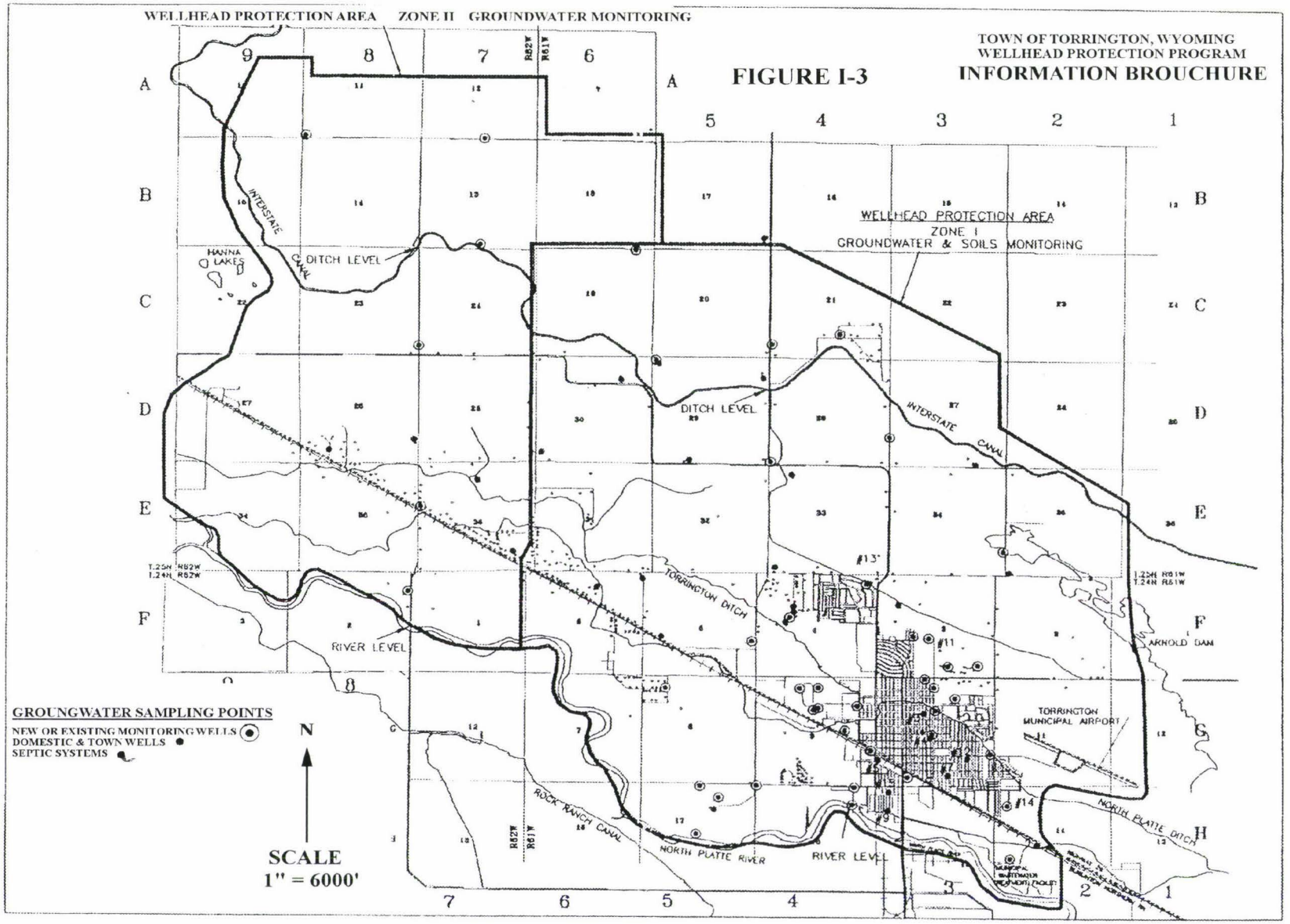
"North Dakota Groundwater Public Service Announcement"

Informational brochures to customers: This could be a separate mailing to customers, or could be included with their monthly billing statement. An example informational brochure is shown in Figure I-3. This example is particularly useful in its summarizing Torrington's WHP plan including: what is Wellhead Protection and why is it necessary; areas comprising the WHPAs; objectives of the plan; what is being done to protect local drinking water supplies from contamination, and; what citizens can do to help. The second example is shown in Figure I-4, and is a schematic of the Elk Mountain water supply system. It is useful in describing to the public how drinking water is collected and delivered to the water customer, as well as depicting vulnerabilities of the supply system. (Also see Appendix B - 'National Groundwater Protection Organizations' for a listing of organizations that provide informational and educational brochures).

Newsletters to customers: Utilities often send brief newsletters to their customers along with their monthly billing statements with different aspects of the water supply system featured. The frequency of distribution can vary, depending upon the system's resources, from monthly to even yearly.

Newspaper articles: Newspaper articles are an inexpensive and efficient way to communicate the basic elements of the water supply system and threats to water quality. In larger communities, system staff should approach the science editors of local and regional papers. The contact may be less formal in smaller communities, where local and regional papers may rely upon general reporters and donated features.

Television and radio media: Television and radio can also be used to educate the public in an inexpensive and efficient way. Contacts made with television and radio personnel may also be useful during a contamination incident. If funding permits, Public Service Announcements (PSA) could be prepared.


WELLHEAD PROTECTION AREA ZONE II GROUNDWATER MONITORING
TOWN OF TORRINGTON, WYOMING
WELLHEAD PROTECTION PROGRAM
INFORMATION BROUCHURE
FIGURE I-3
WELLHEAD PROTECTION AREA
ZONE I
GROUNDWATER & SOILS MONITORING
INTERSTATE CANAL
DITCH LEVEL
HANNA LAKES
TORRINGTON DITCH
RIVER LEVEL
ROCK RANCH CANAL
NORTH PLATTE RIVER
NORTH PLATTE DITCH
ARNOLD DAM
TORRINGTON MUNICIPAL AIRPORT
T.25N R62W
T.24N R62W
T.25N R61W
T.24N R61W
R62W
R61W
GROUNGWATER SAMPLING POINTS
NEW OR EXISTING MONITORING WELLS
DOMESTIC & TOWN WELLS
SEPTIC SYSTEMS
N
SCALE
1" = 6000'

TORRINGTON WELLHEAD PROTECTION PROGRAM (WHPP)

"The Torrington Wellhead Protection Program was developed to address the increasing nitrate levels in the ground water aquifer supplying the Town of Torrington."

What is Wellhead Protection? "Wellhead protection is by definition, protection of the area surrounding a well. So, first of all, we should explain what a "wellhead protection area (WHPA) is. A (WHPA) is defined as the surface and subsurface area surrounding a well or wellfield that supplies a public water system through which contaminants are likely to pass and eventually reach the water well or wellfield."

What are the objective of Torrington's WHPP?

- ✓ Meet drinking water quality requirements of the Safe Drinking Water Act (SDWA).
- ✓ Evaluate the hydrogeologic setting and all contaminant sources within the WHPA.
- ✓ Implement a ground water monitoring plan to provide long term ground water quality trends, establish ground water flow patterns, identify alternate wellfield sites, and attempt to correlate cultural activities and ground water quality problems.
- ✓ Evaluate the existing nitrate problem
- ✓ Implement a voluntary management plan to control all potential sources of contamination.
- ✓ Develop ordinances which can be implemented to protect the community drinking water supply.
- ✓ Develop and implement a public awareness, educational, and involvement plan for ground water protection.

What areas are included in Torrington's Wellhead Protection Program? The preliminary delineated boundaries are illustrated o the cover of this brochure. The area shown is the primary ground water recharge area for the Torrington municipal drinking water wells.

What are the potential sources of contamination? Groundwater resources are vulnerable to contamination from surface and subsurface activities I the recharge area. Contamination can come from a number of sources, including:

- ☼ agricultural sources, such as pesticides, fertilizers and livestock wastes,
- ☼ urban residential sources, such as pesticides, fertilizers, de-icing salts and improper disposal of petroleum products (yes, used oil dumped in the alley can potentially contaminate ground water) and improper disposal of commercial and household hazardous waste.
- ☼ leaking underground and above ground storage tanks (petroleum, fertilizers, etc.),
- ☼ failed septic systems and drain fields,
- ☼ improperly stored salt piles,
- ☼ improper disposal of chemicals like dry cleaning, photo processing and automotive fluids,
- ☼ municipal solid and hazardous waste landfills,
- ☼ chemical spills
- ☼ illicit dumping of industrial chemicals and wastes,
- ☼ industrial or municipal waste storage ponds,
- ☼ fertilizers, pesticide and herbicide mix, loading and cleaning areas,
- ☼ petroleum loading areas,
- ☼ improperly constructed wells.

Where does ground water nitrate contamination come from? Ground water nitrate contamination can come from several sources to include commercial fertilizers and animal waste used for supplemental nutrients on farmland, lawns and gardens, septic tank type disposal systems, leaking sewer mains, animal confinement areas, and storage and loading facilities.

Why should we be concerned about nitrates? The toxicology of nitrate has been extensively studied, (Ridder and Oehme, 1974; Shirley, 1975). Nitrate itself is essentially non-toxic to humans but it can be reduced to nitrate in the gastrointestinal tract of human infants and by the microflora of the human mouth. The nitrite presents a direct toxic hazard, and has also been suspected for many years of forming carcinogenic N-nitroso compounds (Swan, 1975). The EPA has determined that nitrate concentrations in excess of 10 ppm (parts per million) could be harmful to both infants and elderly individuals. The EPA has established 10 ppm as the maximum contaminant level (MCL). All public water systems are required bylaw to comply with this MCL.

What is being done? The following programs have been implemented or will be in the near future:

Soil Monitoring: Sample and analyze cropland and turf areas within Zone I (WHPA) to determine the amount of nitrogen remaining in the soil at end of the growing season. This data is used to determine fertilizer application rates and recommendations for the next season.
Responsible Party: Town of Torrington

Irrigation, Nutrient and Conservation Management Practices: Reduce the agriculture contribution of nitrate contamination to groundwater through accelerated technical and financial assistance with the installation of on-farm land management practices.
Responsible Party: USDA Soil Conservation Service

Non-Point Source Ground Water Sampling Program:
Samples are being collected monthly for a period of three years from the 79 points, illustrated on the cover of this brochure. The program will establish nitrate trends and provide a method for evaluating the effectiveness of management practices.
Responsible Parties: Town of Torrington, WDEQ & U.S. EPA

Future Nitrate Related Studies:

✗ *Sanitary Sewer Collection System Master Plan:*
Evaluate the existing sanitary sewer collection and trunk line system for poorly constructed, broken and leaking pipes. Develop costs and a long term plan for replacement. A recent television survey indicated numerous problems in the system. Leaking sewer pipes can contribute to nitrate contamination.

Evaluate sewer system alternatives in rural areas within the Wellhead Protection Area, i.e., community system, improved septic tank/drainfield systems, wetlands, etc..

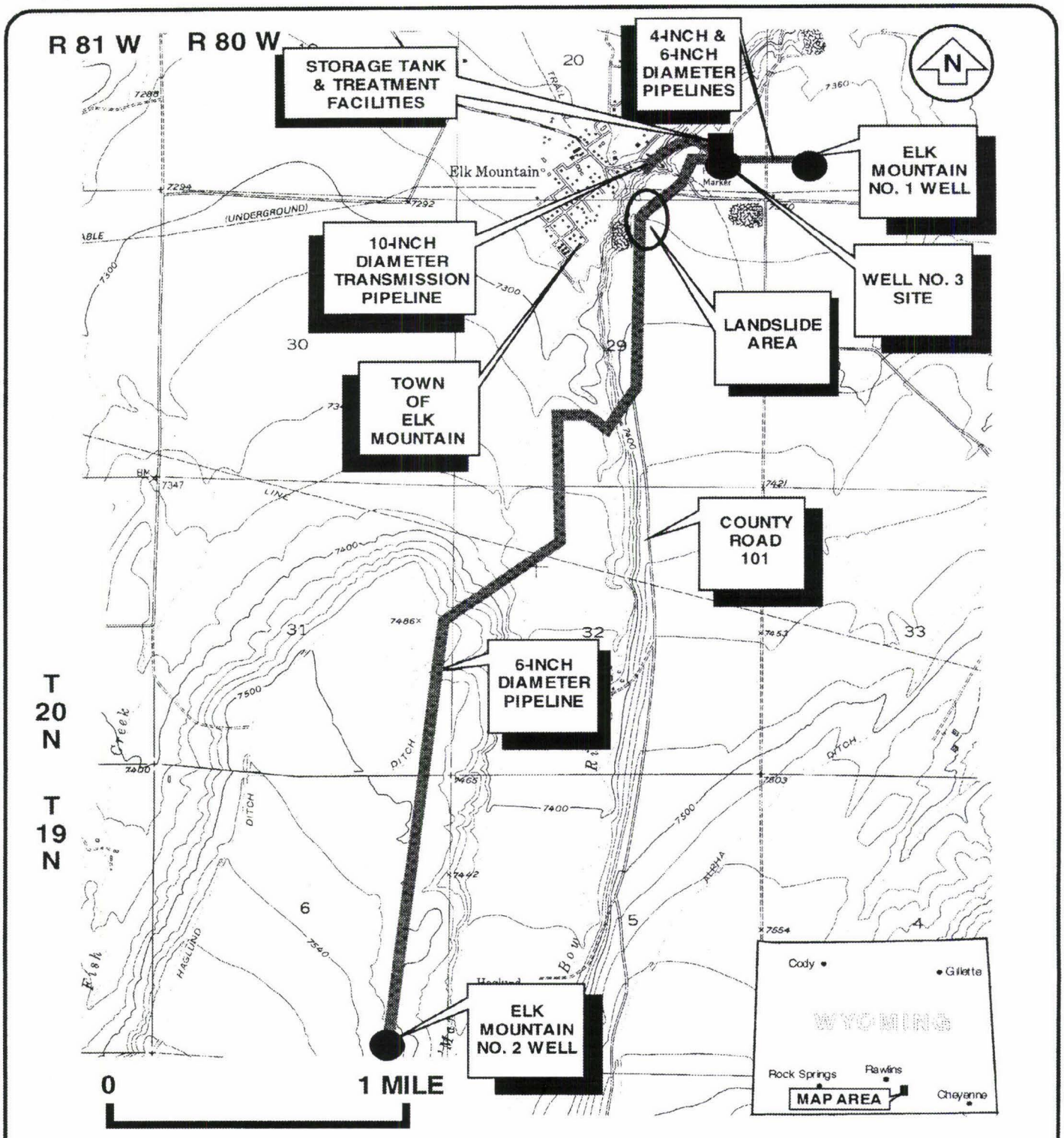
✗ *Ag and Turf Demonstration Trials:*
Plans are being developed to implement a research/demonstration project at the UW Research Station near Torrington. Principal investigators will be the University of Wyoming. The primary objectives are as follows:

- * Evaluate crop response with varying fertilizer rates, accounting for existing soil and water nitrates.
- * Evaluate timing and methods of fertilizer application.
- * Evaluate deep percolation and nitrate transport below the root zone.
- * Develop a grower's guide to implement successful BMPs.
- ✖ Alternate research
  Denitrification in shallow aquifers.
  Vadose Zone Nitrate Modeling

Program Enforcement: Participation in the program is strictly on a voluntary basis. Program success is directly related to urban and rural involvement.

What can we do as individual citizens to help? In the near future, weekly news articles will be published in the Torrington Telegram. The articles will provide information which individuals can use to help minimize pollution.
Public information meetings will be held during late fall and winter.

Remember, the Torrington community has the opportunity to solve the nitrate problem at the local level without Federal intervention. To help, get involved!



ELK MOUNTAIN WATER SYSTEM

FIGURE I-4

Presentations to civic groups: Civic groups in residential neighborhoods generally welcome presentations by utility personnel and the groups are an excellent means of establishing contact with local civic leaders, whose support may be valuable following a contamination incident.

School programs: Early education can provide a lifetime awareness of the value of a safe drinking water supply. An effort can be made to include groundwater and the water supply system as topics on local school civics or science curricula. WDEQ/WQD can provide examples of groundwater protection curricula which have been developed for use in all grade levels.

Signs in recreation areas: Because the area around a drinking water source may not be known to area residents or others traveling through the community, signs placed at strategic locations (highways, hiking trail heads, etc.) can be used effectively to educate the resident and transient population in an inexpensive manner. WDEQ is exploring the possibility of developing and distributing a 'Wellhead Protection Area' sign that can be used consistently across the state to inform pedestrians and motorists when they are entering and exiting a community WHPA.

Public Review

WDEQ\WQD suggests that each PWS retain a current copy of each WHP plan on its premises. The local WHP plan should be made available to the public upon request. In order to remain responsive to public perception of the WHP plan, the following records should be maintained by the PWS: logs of random inspections of the WHP Plan by the public and, logs of comments made by the public.

FUNDING SOURCES:

Some federal and state agencies, local planning agencies and associations may have funds available for *development* and/or *implementation* of WHP plans. Since funding sources are often unpredictable and may change, agencies and organizations should be individually contacted to determine funding availability. State agencies which have provided funding for the development of local WHP Plans include:

- WDEQ: Using EPA §319 grant monies, WDEQ's Non-Point Source (NPS) Program has supported funding for the development of local WHP plans and implementation of groundwater monitoring programs within delineated WHPAs. Final authorization of awards was dependent upon approval by both the NPS Task Force and EPA. If successful, local governments or resource management organizations must provide at least 40% of project costs. Grants are typically awarded annually; projects are generally limited to a maximum of a few years in duration.

  Recent passage (1996) of amendments to the Safe Drinking Water Act may provide an opportunity for the use of federal funds to delineate wellhead (and surface water) protection areas (Section II), potential contaminant source inventories (Section III) and vulnerability assessments within these areas. Contact WDEQ/WQD for more information on *"Source Water Protection"* and the availability of federal funding for drinking water (groundwater and surface water supplied) protection plan

development and implementation.

- WWDC: The Wyoming Water Development Commission has funded the development of Wellhead Protection (WHP) plans as part of the Level II phase for the "New Development" and "Rehabilitation" programs.

- EPA: EPA funding for WHP plans is dependent upon Congressional funding under the Clean Water Act and the Safe Drinking Water Act. Generally, these funds are passed through to the states (WDEQ/WQD) for funding local demonstration projects. In the past, both Laramie and Torrington have been recipients of EPA Wellhead Protection Demonstration Grants. Although this grant program has been terminated, new funding for *"Source Water Protection"* (including WHP) delineations (Section II), source inventories (Section III), and vulnerability assessments may be available in the future.

- USGS: Under the National Water Quality Assessment (NAWQA) program, may assist communities with groundwater monitoring within formal (i.e. Delineated) WHPAs that lie within NAWQA study areas. USGS also cost shared cooperative projects with state, county and local entities to address local hydrogeologic issues such as WHP plans.

- Local: EPA's guidance document titled "Local Financing For Wellhead Protection," (EPA 440/6-89-001) is a valuable resource and contains numerous examples of ways in which communities have locally funded the development and implementation of WHP plans.

ADDITIONAL INFORMATION AND TECHNICAL RESOURCE MATERIALS:

There is a wealth of published information, guidance and technical assistance documents available to the public pertaining to all aspects of WHP planning. Appendix B contains a list of resource groups that can provide materials for use by individuals, communities, public water suppliers and anyone interested in learning more about protecting groundwater. Appendix C contains a listing of WHP technical assistance and guidance documents and videotapes that may be ordered by using the forms provided in Appendix C. Contact information, including telephone numbers and Internet Web Site addresses are also provided in Appendix C.

SECTION II

DELINEATION OF WELLHEAD PROTECTION AREAS (WHPAs)

Introduction:

Subsection 1428(e) of the Safe Drinking Water Act Amendments of 1986 identify a *'Wellhead Protection Area',* or WHPA (pronounced wa'puh) as:

> "the surface and subsurface area surrounding a well or well field, supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or well field".[3]

As illustrated in Figures II-1 and II-2, the area of influence, or "cone of depression", of a well or well field is referred to as its *Zone of Influence (ZOI).* The 'Wellhead Protection Area' *(WHPA)* is the *entire area contributing water to the well* or well field, including all or some of the ZOI, and is commonly referred to as the *Zone of Contribution (ZOC)* to the well, or the "capture zone" of the well. Contaminants introduced at the ground's surface within this zone could reasonably be expected to reach a well.

Subsection 1428(a)(2) of the SDWA establishes the requirements for WHPA determinations:

> "for each wellhead, determine the wellhead protection area as defined in subsection (e) [above] based on all reasonably available hydrogeologic information on ground water flow, recharge and discharge and other information the state deems necessary to adequately determine the wellhead protection area..."[4]

The size and shape of the Wellhead Protection Area depends upon the hydrogeologic characteristics of the aquifer system, and the design and operational characteristics of the well(s) used to pump water from the aquifer system. The goal of Wellhead Protection Plans is to protect groundwater within the WHPA by managing the potential risk of contamination that may be posed from potential contaminant sources that are located within the *Zone of Contribution* of the well.

One of the initial objectives in development of local WHP Plans should be the identification and mapping, or *delineation*, of the area that supplies water to a well *(i.e. Zone of Contribution, or WHPA)*. The mapping process is called *delineation of the Wellhead Protection Area*, described in more detail below.

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[3] For the remainder of this Section, the term 'well' will apply to wells, infiltration galleries, radial collection wells, springs, and tunnels that serve Public Water Systems, except when noted.

[4] "Guidance for Applicants for State Wellhead Protection Program Assistance Funds Under the Safe Drinking Water Act", EPA, 440/6-87-011, June, 1987.

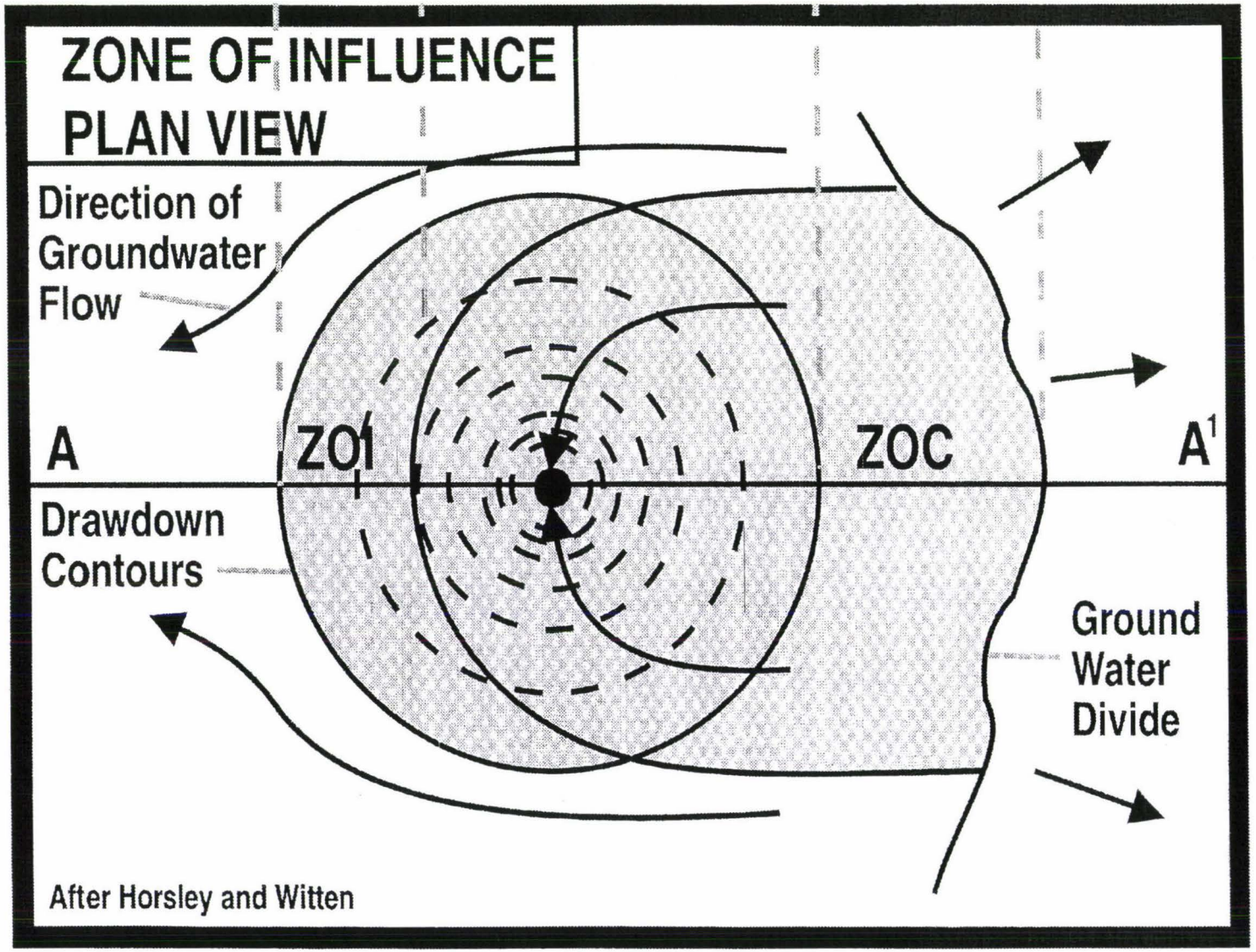
ZONE OF INFLUENCE
PLAN VIEW
Direction of
Groundwater
Flow
A
ZOI
ZOC
A1
Drawdown
Contours
Ground
Water
Divide
After Horsley and Witten

FIGURE II-1

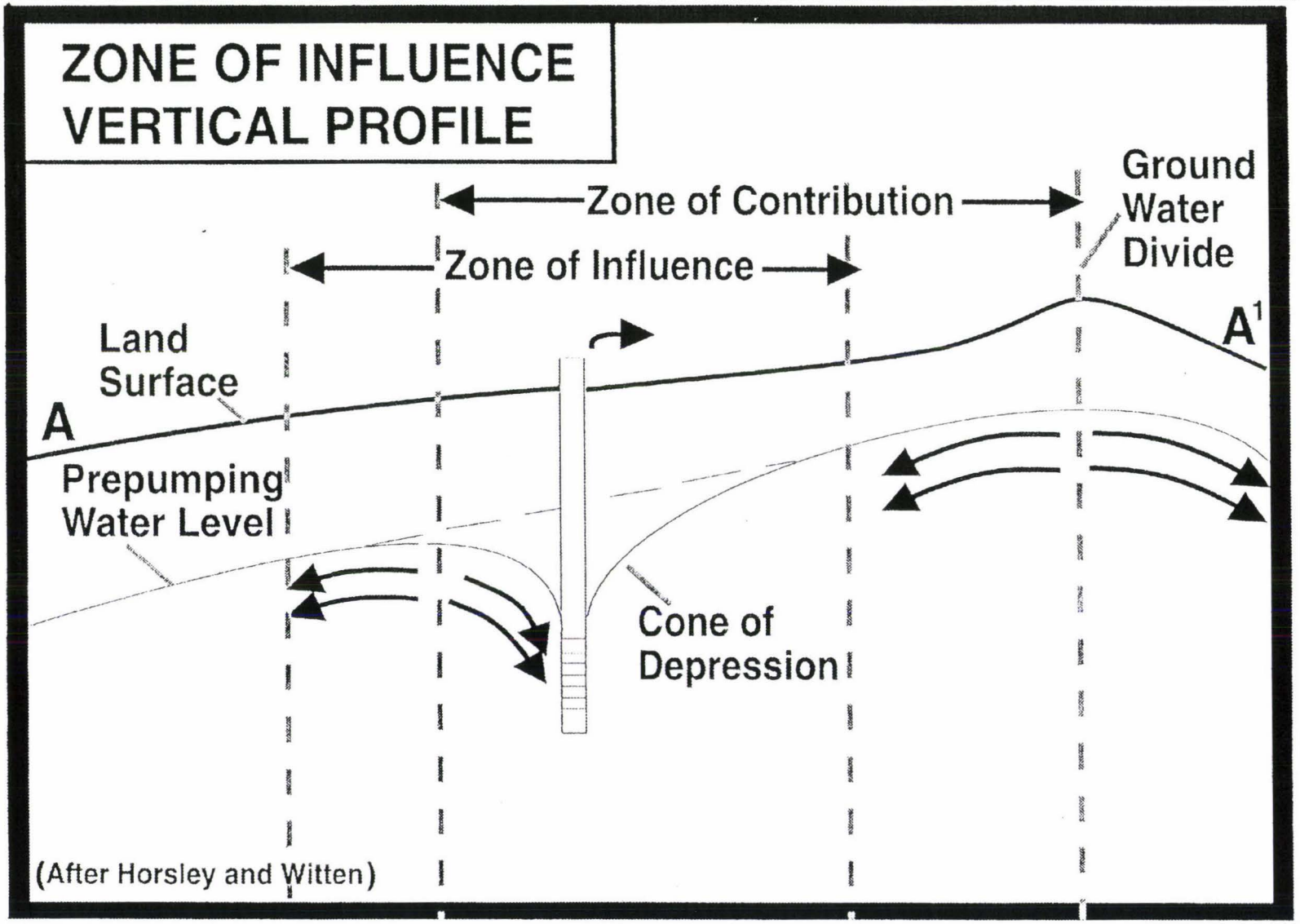
ZONE OF INFLUENCE
VERTICAL PROFILE
Zone of Contribution
Zone of Influence
Ground
Water
Divide
Land
Surface
A
A1
Prepumping
Water Level
Cone of
Depression
(After Horsley and Witten)

FIGURE II-2

Definition of Delineation 'Zones' Within the Wellhead Protection Area (WHPA):

The *method* of establishing different "zones" within a wellhead protection area has been adopted by the Wellhead Protection Advisory Committee as the approach that Wyoming PWSs will use to delineate Wellhead Protection Areas (WHPAs).

Wyoming's Wellhead Protection (WHP) Plan defines three zones within the WHPA. These include: The **'accident prevention zone'** or **'sanitary protection zone'** (Zone 1); the **'attenuation zone'** (Zone 2) and; the **'remedial action zone'** (Zone 3).

Zone 1 constitutes the **accident prevention zone** or **sanitary protection zone** and is a highly protected area around the wellhead or the collection area infrastructure around a spring or tunnel. Its purpose is to protect the annulus of the well, or the spring and tunnel collection area from the direct introduction of contaminants into the well and its immediate area from spills, surface runoff, or leakage from storage facilities or containers. Potential contaminant sources in Zone 1 should be strictly monitored, controlled or excluded to insure that contaminants are not accidentally or intentionally introduced into the aquifer at, or near the wellhead.

Zone 2, the **attenuation zone,** is established to protect a well from contact with pathogenic microorganisms (e.g. bacteria and viruses) which can emanate from a source (e.g. septic system, etc.) located close to the well, as well as to provide emergency response time to begin active cleanup and/or implementation of contingency plans should a chemical contaminant be introduced into the aquifer near the wellhead.

Zone 3 is defined as the **remedial action zone** and is designed to protect the well from chemical contaminants that may migrate to the well; it typically includes a major portion of the recharge area, or Zone of Contribution to a well. Zone 3 should be sufficiently large to provide adequate time to detect and respond to a contaminant release, including time to develop a new drinking water source or supply in the event of a release within the Zone.

WHPA Delineation Procedure Overview:

Delineation of WHPAs depends not only on the characteristics (i.e., type of media and type of flow) of the aquifer, but also on the construction and operation of the well. This section identifies minimum criteria and minimum acceptable WHPA delineation methods for the principal types of aquifers (e.g. porous, carbonate, fractured and faulted) and hydrogeologic flow conditions (i.e. porous, diffuse and conduit) that are likely to occur with Public Water Systems (PWSs) within Wyoming.

An understanding of the delineation methods, their related requirements for data and resources, and their respective strengths and limitations is essential in establishing a local WHP plan. The reader is encouraged to refer to Appendix D ("Methods for the Delineation of Wellhead Protection Areas") for more information on delineation methodologies. Appendix E ("The Aquifers and Aquifer Systems in Wyoming") provides a basic overview of the geologic and hydrogeologic settings in Wyoming.

It is important to understand that the accuracy, and therefore the validity, of any delineation of a WHPA is a function of several factors, including: *amount of information* available regarding aquifer and well characteristics; the *accuracy of the information*, and; the delineation methodology selected and applied. Delineations based upon adequate and accurate information will generally be more accurate (and defensible) than one where little information, or erroneous information on either aquifer or well characteristics is utilized. Similarly, WHPAs delineated by one of the more sophisticated delineation methodologies (e.g. Numerical Models) will generally be more accurate and defensible than those delineated by one of the simpler methods (e.g. Arbitrary Fixed Radius).

Keeping in mind that one of the fundamental purposes of delineating a WHPA is to define the 'true' area within which potential contaminant sources and land use activities are to be evaluated for management approaches (to reduce the risk of contaminating the aquifer), the accuracy of the delineated wellhead protection area is important for three primary reasons:

1) To avoid developing a WHP plan for areas which *would not have* been included within the WHPA if a more sophisticated delineation method had been applied (i.e. "overly-protective");

2) To avoid developing a WHP plan for areas which *would have* been included within the WHPA if a more sophisticated delineation method had been applied (i.e. "under-protective");

3) In the event that management approaches (especially those which are regulatory in nature) recommended by the local Wellhead Protection Management Committee are challenged, the delineation should be defensible in order to justify the area protected by those approaches.

Equally important, in the event that a community wishes to use the delineation of its WHPA as part of its justification to obtain monitoring waivers (to SDWA requirements), the delineation methodology must be reasonable and applied to appropriate hydrogeologic settings. This becomes especially important when viewed in light of the fact that reduced monitoring requirements, if obtained, eliminate a degree of certainty or verification that citizens who derive their drinking water from a PWS are being provided safe drinking water.

In evaluating the delineation methodologies to be applied within Wyoming, the Wellhead Protection Advisory Committee recognized the fact that many of Wyoming's PWSs are small systems in terms of population served, often with limited resources and technical expertise available to perform and complete the more sophisticated delineation methodologies identified in Appendix D. However, the Committee also recognized the benefits of using site specific information (i.e. aquifer/pump test data, etc.) to apply one of the more sophisticated (and generally more expensive) methodologies in order to obtain a more accurate delineation of a Wellhead Protection Area.

Process of WHPA Delineation:

The common steps to delineating WHPAs are:

1. Determine the type of aquifer media (i.e. *porous, carbonate, fractured or faulted*) and groundwater flow (i.e. *porous, diffuse or conduit*) within your aquifer.

   A. Refer to Table II-1 and *'Special Considerations'* discussion later in this Section.

2. If flow is *porous* or *diffuse*, determine if the *Calculated Fixed Radius* (CFR) method is acceptable.

   A. Refer to Part IV, Appendix G.

3. Apply appropriate Table II-2 method and criteria for your particular flow type.

   A. Refer to Table II-2 and Appendix D.

4. Transfer WHPA to map.
5. Complete *'Delineation Report'*.
6. Complete *'Susceptibility Assessment Form'* (Appendix F).

Each of these steps in described in greater detail in the remainder of this section of the document.

Aquifer Media and Groundwater Flow Types:

WHPAs will vary in size and shape. The size of the WHPA is strongly influenced by the well pumping rate, aquifer porosity, and hydraulic conductivity of the aquifer media. The size and shape of the WHPA are strongly influenced by the groundwater gradient and flow direction, the orientation and density of fractures and faults, and solution features such as karst.

Porous media aquifers have fairly *homogeneous* distributions of solid materials and interconnected pore spaces, such as sandstones and alluvium. Aquifers that are ***fractured or faulted***, comprised of solution features such as karst in ***carbonate*** formations, or other features allowing rapid fluid flux rates such as ***tunnels*** or flowing ***springs,*** often exhibit *heterogeneous* distributions of solid materials and interconnected pore spaces. These latter types of aquifer media can exhibit highly irregular and unpredictable flow characteristics which make delineation of appropriate WHPAs more difficult and less concise.

Unfractured and unfaulted porous media exhibit ***porous flow***, or groundwater movement down-gradient through the pore space of aquifer rocks. Darcy's law is operative in porous flow environments. Porous flow conditions are common within sedimentary rocks (e.g. sandstones, siltstones, etc.) comprising thick sections of many of the state's interior, inter-montaine basins (e.g. Powder River, Wind River, Green River, etc.).

Aquifers comprised of fractured or faulted media (sedimentary, igneous or metamorphic), karstified carbonate media, tunnels or springs can exhibit either ***diffuse*** or ***conduit*** flow.

Conduit flow describes groundwater movement down-gradient along a pathway comprised of interconnected fractures, faults, joints, and solution openings, resulting in a rapid response to recharge, turbulence, and highly variable chemistry, temperature, and flow rates. Darcy's law is not operative under conduit flow conditions. *Conduit* flow conditions can exist within sedimentary, igneous or metamorphic rock sequences but are most commonly associated with karst carbonate rocks and igneous and metamorphic rocks comprising the state's mountainous regions.

Diffuse flow occurs as groundwater movement through interconnected fractures, faults, joints, and bedding planes resulting in less turbulent flow, less dramatic response to recharge events, and more uniform chemistry than observed in conduit flow. *Diffuse* flow is similar to porous flow, indicating that at the scale of interest (the size of the WHPA), flow in the aquifer may be described as a porous media equivalent. This typically occurs where the fractures are dense and evenly spaced. *Diffuse* flow conditions can exist within sedimentary, igneous or metamorphic rock sequences but are most common within highly fractured sedimentary rocks situated within the state's interior basins, as opposed to mountainous regions.

Distinguishing Between *Diffuse* and *Conduit* Flow:

Diffuse flow in fractured, faulted, or karstified carbonate aquifers can sometimes be treated as a *porous* media equivalent at the WHPA scale. However, unless convincing evidence can be produced that these types of aquifers exhibit diffuse flow characteristics, *conduit* flow should be assumed.

The best criteria for determining whether fractured, faulted, or highly karstified carbonate aquifers can be treated as a porous medium (i.e. *diffuse* flow) for the purposes of delineating WHPAs include: *aquifer/pump test responses, configuration of the water-table surface, the ratio of fracture scale to problem scale, distribution of hydraulic conductivity*, and *variations in water chemistry and water quality*.

Aquifer/pump test responses:

"There are three main criteria for determining whether a fractured rock aquifer approximates a porous medium (i.e. *diffuse* flow) using an aquifer pumping test.

1. The drawdown in observation wells should increase linearly with increases in the discharge rate of the pumped well. Hickey (1984) suggests conducting a series of drawdown at 1 hour versus pumping rate for the series of tests should approximate a straight line in porous-media-equivalent settings.

2. Time-drawdown curves for observation wells located in two or more different directions from the pumped well should be similar in shape and should not show sharp inflections, which could indicate hydraulic boundaries.

3. A plotted drawdown cone from a pumping test using multiple observation wells should be either cylindrical or elliptical. Linear or very irregular cones can indicate a failure of the porous-media assumption.[5]"

Full-scale aquifer/pump tests involving several monitoring wells probably provide the most reliable measure of aquifer parameters for wellhead protection studies. Although often a preferred method of data acquisition, aquifer/pump tests in fractured-rock systems can be expensive to conduct and complex to analyze.

Configuration of the water-table surface:

"For porous-media-equivalent fractured aquifers a water-table map should show a smooth and continuous water-table surface without areas of rapidly changing or anomalous water levels. In particular, the water table should not have the "stair-step"appearance that can occur in sparsely fractured rocks with large contrasts in hydraulic conductivity between blocks and fractures. Although a "stair-step" water table clearly indicates a failure of the porous-flow assumption, a smooth water-table map does not prove a porous-media-equivalent assumption. Detection of irregularities in the water table may require more closely spaced monitoring wells than are available for most wellhead protection studies.

Ratio of fracture scale to problem scale:

"For porous-media equivalent aquifers, the observed vertical and horizontal fractures should be numerous and the scale of fracturing should be much smaller than the scale of the wellhead

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5 *Delineation of Wellhead Protection Areas in Fractured Rocks*; USEPA, pp. 16-18, June, 1991. (570/9-91009)

protection problem. As a rule of thumb, the minimum dimension of the WHPA should be at least 100 (one hundred) times the average fracture spacing. For example, at the [sic] test site, bedrock fractures are numerous and occur on a scale of a few feet or tens of feet, but the potential WHPAs ...cover several square miles.

Hydraulic conductivity distribution:

"In porous-media-equivalent settings the distribution of hydraulic conductivity, as estimated from piezometric slug tests or from specific capacity analysis (Bradbury and Rothschild, 1985), should be approximately log-normal. In aquifers where the hydraulic conductivity distribution is strongly bi-modal, the porous-media assumption is probably not valid.

Variations in water chemistry:

"Overall variations in ground-water chemistry have been shown to be useful in determining whether fractured aquifers behave as diffuse-flow (porous-media) systems or as conduit (discrete-fracture) systems. In conduit systems, variations in ground-water chemistry can be significant from place to place and through time. Water moving through conduits usually has less contact time with mineral surfaces and so can be lower in total dissolve solids and have lower mineral saturation indices than water moving through a diffuse-flow aquifer having similar mineralogy. Ground water in diffuse-flow fractured aquifers will usually have a relatively high uniform chemical compositions through time and from place to place within the aquifer. For example, Shuster and White (1971) examined water chemistry and temperature of several springs in Pennsylvania and showed that water chemistry in conduit-flow springs varied greatly with time, but the water chemistry of diffuse-flow springs did not. Municipal wells are sampled on a regular basis for such parameters as temperature, pH, hardness, turbidity and bacteria. The variation in these parameters can help determine whether a fractured-rock aquifer behaves as a porous medium. For example, ground water high in turbidity and bacteria is more often a result of conduit flow rather than diffuse flow. If a production well never has a turbidity or bacteria problem, it is probably not connected to significant conduits intersecting the land surface.[6]"

If none of the above data are available, subjective techniques can sometimes be used to estimate whether *diffuse* or *conduit* flow is present. Through the use of topographic, geologic and hydrogeologic maps, air photos, and/or published reports, basic conclusions can be made regarding the type of flow (i.e. *conduit* versus *diffuse*) is likely to be present within the aquifer.

A determination of the type of flow (i.e. ***porous, diffuse, or conduit***) that prevails within the aquifer is the first step in determining which method(s) are acceptable for delineating the Zones within the WHPA. Table II-1 illustrates a decision tree to follow in order to help determine the prevailing type of flow.

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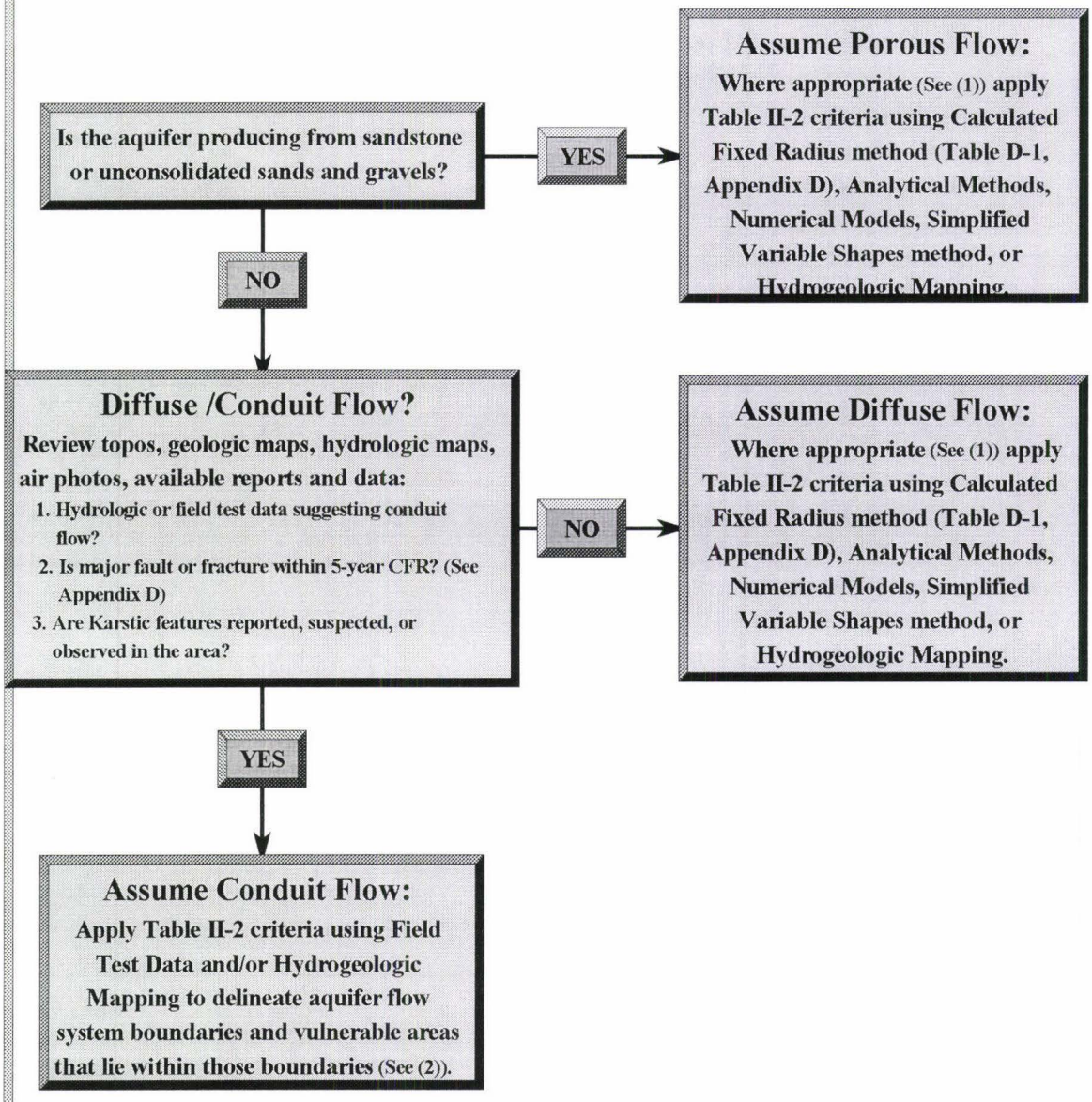
6 Ibid.

Table II-1
Groundwater Flow Type Decision Tree



(1) Refer to Part IV of Appendix G to determine if Calculated Fixed Radius method is appropriate to use.

(2) Refer to Appendix D and EPA guidance document "Delineation of Wellhead Protection Areas in Fractured Rocks" for guidelines to follow when delineating WHPAs using Field Test Data, Hydrogeologic Mapping, and Vulnerability Mapping techniques.

Accepted Delineation Criteria and Methodologies:

Wyoming's Wellhead Protection Advisory Committee accepted the following criteria and methodologies for WHPA delineations. The *criteria* adopted for the delineation of WHPAs (and the Zones which comprise the WHPA) include *'Radial Distance from Well', 'Time of Travel (TOT)'*, and *'Flow-System Boundaries'* and *'Vulnerability Mapping'* as determined from hydrogeologic mapping and/or field tests. The accepted methodologies are detailed in Appendix D, with baseline methodologies addressed below.

The most basic criterion for WHPA delineation is the radial distance from the well without regard for the ground-water flow direction. In its simplest form, the distance criterion forms the basis of the ***Arbitrary Fixed Radius*** method which delineates a WHPA by placing a circle of fixed radius around the well.

The TOT criterion bases WHPA delineations on the amount of time it takes ground-water to travel from a point source to a well. Again, without regard for the ground-water flow direction, time of travel criteria, combined with radial distance from well criteria form the basis of the ***Calculated Fixed Radius*** **(CFR)** method. The CFR method establishes a circular WHPA for *porous* and/or *diffuse* flow conditions according to site-specific data including porosity, pumping rate, and the screened/open interval of the well. Consideration of ground-water flow velocities and flow directions can also be incorporated with time of travel criteria in more advanced delineation methodologies. Appendix D provides additional information on application of the CFR delineation methodology.

The flow-system boundary criterion uses ground-water divides, surface-water bodies, or other hydrologic, physical, or geologic features to delineate a WHPA. In aquifers with conduit flow, *flow system boundaries* (e.g. groundwater divides, aquifer truncation, recharging surface waters, etc.) are established using either ***Hydrogeologic Mapping*** **or** ***Field Methods***, or a combination of both. Groundwater ***Vulnerability Mapping*** techniques delineate *'vulnerable' areas* (e.g. faults, fractures, exposed bedrock, etc.) where groundwater within the producing aquifer may be intrinsically susceptible to rapid infiltration of contaminants released at the ground surface. Hydrogeologic expertise or experience may be necessary to delineate WHPAs based on flow-system boundary criteria. Refer to EPA's guidance document *"Delineation of Wellhead Protection Areas in Fractured Rocks"* for further information regarding the delineation of WHPAs using *Field Methods*, *Hydrogeologic Mapping*, and *Vulnerability Mapping* techniques. Also see Appendix D for more details.

Minimum Baseline Methodologies and Criteria for WHPA Zones 1, 2, and 3:

The Wyoming Wellhead Protection Plan Advisory Committee adopted the use of *Fixed Radius (Arbitrary and Calculated)* and *Hydrogeologic Mapping (including Vulnerability Mapping) and/or Field Methods* methodologies **coupled with a determination of *susceptibility to contamination*** (see Appendix F: 'Susceptibility Assessment Form' and Appendix G: 'Assistance Packet - Susceptibility Assessment Form') as the minimum, or baseline, needed to meet WDEQ standards of acceptance. The adopted minimum criteria are discussed below.

Minimum Acceptable (i.e. 'Baseline') Methodologies:

At a minimum, the *Arbitrary Fixed Radius* method will be used to delineate Zone 1 of the WHPA, and the *Calculated Fixed Radius* method (porous and diffuse flow) or the *Hydrogeologic Mapping and/or Field Methods* method (conduit flow) coupled with *Vulnerability Mapping* will be used to delineate Zones 2 and 3.

Whenever practicable, the use of more sophisticated delineation methodologies (see footnote 1, Table II-2) that produce WHPAs which more accurately represent site-specific data well and aquifer conditions is encouraged. 'Community' PWSs are encouraged to *initially* delineate their WHPAs for both existing and new wells using aquifer/pump test data and results to apply either Analytical or Numerical modeling whenever practicable.

When aquifer/pump tests are performed for the installation of new wells or the rehabilitation of existing wells using state or federal funding, *Analytical Models or Numerical Models* (Appendix D) should be used instead of the *Calculated Fixed Radius* method, where applicable, to delineate the WHPA Zones.

The baseline methodologies for Zones 1, 2, and 3 are set forth below and are summarized in Table II-2; see Appendix D for details on all delineation methodologies, and the Glossary for further definition of aquifer media (i.e. porous, carbonate, fractured/faulted, springs, and tunnels) and flow types (i.e. porous, diffuse, and conduit).

Circumstances where these baseline methodologies may be inappropriate are subsequently detailed under "Special Considerations" below.

Minimum Criteria:

The minimum criteria (i.e. values for the minimum *'Radial Distance from Well'*, *'Time-of-Travel (TOT)'*, and *'Flow-System Boundaries'* for Zones 1, 2, and 3 are set forth below and are summarized in Table II-2.

TABLE II-2

ACCEPTABLE METHODS[1] AND CRITERIA FOR DELINEATION OF WELLHEAD PROTECTION AREAS (WHPA)

Protection Zones	Aquifer Media and Groundwater Flow Types		
	Porous Media	Springs, Tunnels, Carbonate or Fractured/Faulted Media	Springs, Tunnels, Carbonate or Fractured/Faulted Media
	Porous Flow Criteria	Diffuse Flow Criteria[4]	Conduit Flow Criteria
Zone 1	50 or 100 ft[2]	50 or 100 ft[2]	100 ft
Zone 2	2 year TOT radius[3]	2 year TOT radius[3][4]	Vulnerable Areas Within Flow System Boundaries[5]
Zone 3	5-year TOT radius[3]	5 year TOT radius[3][4]	Flow System Boundaries[5]

(1) In order of generally increasing complexity and sophistication, the following methods are acceptable to use to delineate Zones 2 and 3 of Wellhead Protection Areas:

* For *porous* flow type: Calculated Fixed Radius (CFR); Analytical (Flow) Models (AM); Simplified Variable Shapes (SVS); Hydrogeologic Mapping (HM); and Numerical Models. The Calculated Fixed Radius (CFR) method is the most simplistic acceptable (i.e. 'Baseline') method to delineate Zones 2 and 3 for porous flow aquifers.

* For *diffuse* flow type any of the above methods may be used to delineate Zones 2 and 3, but Hydrogeologic Mapping and/or Field Test Data must be used to establish that diffuse flow, rather than conduit flow, conditions exist. The **Calculated Fixed Radius (CFR)** method is the most simplistic acceptable (i.e. 'Baseline') method to delineate Zones 2 and 3 for diffuse flow aquifers.

* For *conduit* flow type: Hydrogeologic Mapping and/or Field Test Data, or Numerical Modeling to establish *flow system boundaries* (Zone 3) and the *vulnerable areas* (Zone 2) within the flow system boundaries. **Hydrogeologic Mapping and/or Field Test Data** methods are the most simplistic acceptable (i.e. 'Baseline') methods to delineate Zones 2 and 3 for conduit flow aquifers

These methods are further described in Appendix D of this document.

(2) Refer to *' Zone 1 - Accident Prevention Zone'* in this Section to determine which (50' or 100') applies.

(3) The **Calculated Fixed Radius (CFR)** method is the most simplistic acceptable method that might be used to delineate the 2 year and 5 year Time of Travel (TOT) radii for Zones 2 and 3. Application of the CFR method is illustrated in Table D-1 of Appendix D; actual pumping volume and well screen data for the well(s), and actual or published porosity values (for the producing aquifer) should be used when available. Under certain conditions the CFR method cannot be appropriately applied, or must be modified; refer to instructions in Part IV, Appendix G. Other methods described in (1), above may also be used to establish the TOT radius.

(4) If desired, 'diffuse' flow criteria (i.e. 2 year TOT) and the **Calculated Fixed Radius Method** may be used, but only when the presence of 'diffuse' flow conditions is supported and documented through **Hydrogeologic Mapping and/or Field Data**. A discussion of these techniques as they relate to characterization of flow as either 'diffuse' or 'conduit' (see Glossary) is provided in EPA's guidance document, *"Delineation of Wellhead Protection Areas in Fractured Rocks"*. When the use of 'diffuse' flow criteria is not preferred over the use of 'conduit' flow criteria, or when 'diffuse' flow conditions cannot be documented, the criteria and methods for 'conduit' flow conditions will be applied. Refer to Table II-1.

(5) *Flow system boundaries* (e.g. groundwater divides, geologic contacts, recharging surface waters, etc.) are first established to define Zone 3 of the WHPA using either **Hydrogeologic Mapping and/or Field Test Data**, or a combination of both. Groundwater **Vulnerability Mapping** techniques are then applied within Zone 3 to delineate *'vulnerable' areas* (e.g. faults, fractures, exposed bedrock, etc.) where groundwater within the producing aquifer may be intrinsically more susceptible to contamination; these delineated vulnerable areas comprise Zone 2 of the WHPA.

Refer to EPA's guidance document *"Delineation of Wellhead Protection Areas in Fractured Rocks"* for further information regarding the delineation of WHPAs using Field Test Data, Hydrogeologic Mapping, and Vulnerability Mapping techniques.

Zone 1:

The *Arbitrary Fixed Radius* method is the baseline method for delineating Zone 1. The boundary of Zone 1 is set at an *'arbitrary' fixed radius* of 50' *or* 100' from the well (or spring or tunnel), dependent upon factors such as well construction characteristics and proximity to potential contaminant sources:

A. A 50' radius **(minimum)** Zone 1 will be applied for those wells that:

1. Are completed (i.e. screened) across only one aquifer;

2. Are constructed according to WDEQ Water Quality Division rules and regulations (Chapter XII), or the equivalent;

3. Meet or exceed the minimum setback (isolation) distances established in WDEQ Water Quality Division rules and regulations Chapter XII;

4. Have *low* or *moderate susceptibility* as determined from the 'Susceptibility Assessment Form' (Appendix F).

B. A 100' radius **(minimum)** Zone 1 will be applied to those wells which do not meet the criteria described in A (1-4), above, *and* PWSs using springs and/or tunnels for drinking water supplies.

Zone 2:

The following criteria (and baseline methodologies) provide a **minimum** distance (based upon Time-of-Travel or 'Vulnerable' Areas) for the boundary of Zone 2:

A. A distance equivalent to a **2-year *Time of Travel* (TOT)** is used to delineate the boundary of Zone 2 for wells completed in an aquifer with *porous or diffuse flow* (see Glossary) characteristics. The ***Calculated Fixed Radius*** method is the baseline methodology for aquifer media exhibiting *porous* or *diffuse* flow.

NOTE: Under certain circumstances the *Calculated Fixed Radius* (CFR) method may not be appropriate and PWSs may be required to apply alternative criteria and/or methods to delineate the WHPA. Part VI of the 'Susceptibility Assessment Form' (Appendix F) provides assistance in determining if the CFR is appropriate for delineating WHPA Zones 2 and 3 for *porous* or *diffuse* flow. The following section titled ***Special Considerations*** describes additional conditions and situations where the CFR method is not appropriate for delineating WHPAs. If you need assistance in determining an acceptable delineation method, consult with WDEQ/WQD.

B. For wells completed in a *karst, faulted* (*fault 'rubble zone'*) or *fractured* aquifers where flow may be characterized wholly, *or in part*, as *conduit* flow, and for PWSs which rely upon springs and/or tunnels for drinking water supplies, Zone 2 is defined by the location (i.e. delineation) of **'vulnerable' areas** within the boundaries of the flow system supplying the well (spring or tunnel). ***Vulnerability Mapping and/or Field Methods*** are

the baseline methods.

Zone 3:

The following criteria (and baseline methodologies) provide a **minimum** distance (based upon *Time-of-Travel* or *Flow-System Boundaries*) for the boundary of Zone 3:

A. A distance equivalent to a **5-year *Time of Travel* (TOT)** is used to delineate the boundary of Zone 3 for wells completed in an aquifer with *porous or diffuse flow* (see Glossary) characteristics. The ***Calculated Fixed Radius*** method is the baseline methodology.

NOTE: Under certain circumstances the *Calculated Fixed Radius* (CFR) method may not be appropriate and PWSs may be required to apply alternative criteria and/or methods to delineate the WHPA. Part VI of the 'Susceptibility Assessment Form' (Appendix F) provides assistance in determining if the CFR is appropriate for delineating WHPA Zones 2 and 3 for *porous* or *diffuse* flow. The following section titled ***Special Considerations*** describes additional conditions and situations where the CFR method is not appropriate for delineating WHPAs. If you need assistance in determining an acceptable delineation method, consult with WDEQ/WQD.

B. For wells completed in a *carbonate, faulted* (*fault 'rubble zone'*) or *fractured* aquifers where flow may be characterized wholly, or in part, as *conduit* flow, and for PWSs which rely upon springs and/or tunnels for drinking water supplies, Zone 3 is defined by the ***flow-system boundaries*** of the flow system supplying the well (spring or tunnel) as determined from ***Hydrogeologic Mapping and/or Field Methods.***

SPECIAL CONSIDERATIONS:

Delineation *methods* and *criteria* applicable to unique systems such as (1) springs and tunnels; (2) limestone wells; (3) wells and springs in crystalline and metamorphic rocks; (4) **'Buffer Zones'** for recharge areas lying outside of WHPAs; (5) delineating WHPAs for multiple wells in a well field; (6) confined aquifers; (7) ground water/surface water interaction areas, and; (8) wells completed in multiple aquifers are provided as follows:

(1) Springs and Tunnels:

Springs:

According to Jensen and others (1995), more than 100 PWSs in Wyoming use springs; these springs serve as the primary drinking water supplies for more than 10 percent of the state's population. Due to the complexity of conduit flow systems which frequently supply water to springs, the analytical and numerical methods commonly used to delineate protection zones for water supply wells generally do not apply. Hydrogeologic mapping or field tests should be used to identify geologic and hydrologic controls on groundwater flow to springs and to locate flow boundaries. This information should be used to specify "spring head" protection zones based on flow boundaries at sites where the zone of contribution to the spring is practicable to protect. Jensen and others (1995) indicate that hydrogeologic mapping, as applied to delineating protection areas for springs, refers predominantly to geologic, hydrologic, geochemical, and geophysical techniques for characterizing subsurface features using the surface expression and geophysical or geochemical signatures of such features. These techniques include fracture-trace analysis, analysis of land surface topography, geologic mapping, potentiometric surface mapping, geophysical surveys, tracer studies, stable and radioactive isotope studies, and geochemical characterization.

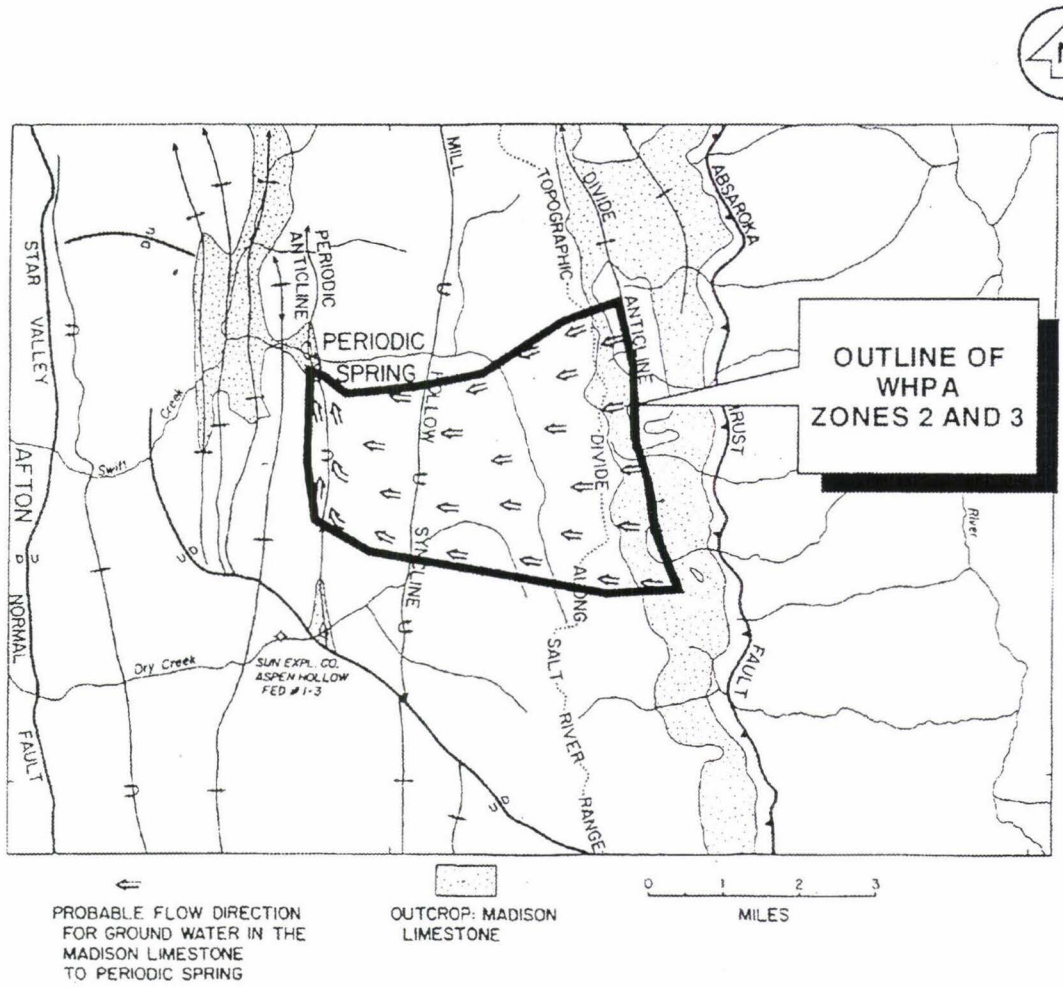
Information from such studies forms the basis for the conceptual model of groundwater flow to the spring. Depending on site conditions, groundwater flow boundaries and pathways may be identified and mapped in detail. In some cases, techniques used for surface watershed management, such as the program underway by the Town of Pinedale, may be appropriate. An example of WHPA delineation for the Periodic Spring serving the Town of Afton in the Overthrust Belt in southwestern Wyoming is depicted on Figure II-3. Note the estimated WHPA is irregular in shape and covers an area encompassing a few square miles. Given the knowledge of the spring hydraulics and local structural geology, as summarized by Huntoon and Coogan (1987), the protection zones could plausibly be reduced to the immediate area around the spring and the recharge area. Jensen and others (1995) provide case studies of the use of hydrogeologic mapping for delineating protection zones around springs in two different hydrogeologic settings in Utah.

Tunnels:

Some PWSs in Wyoming are located close to old mine workings which eventually may be considered as drinking water supplies. A good example of this situation is the Town of Hartville which is located close to the old Sunrise iron ore mine. As with springs, analytical and numerical methods commonly used to delineate WHPAs for water supply wells generally are not applicable for tunnels. Hydrogeologic mapping or field tests should be used to identify

geologic and hydrologic controls on groundwater flow to tunnels and to locate flow boundaries. This information should be used to specify "tunnelhead" protection zones based on flow boundaries at sites where the zone of contribution to the tunnel is practicable to protect. Hydrogeologic mapping, as applied to delineating protection areas for tunnels, refers predominantly to geologic, hydrologic, geochemical, and geophysical techniques for characterizing subsurface features using the surface expression and geophysical or geochemical signatures of such features. These techniques include fracture-trace analysis, analysis of land surface topography, geologic mapping, potentiometric surface mapping, geophysical surveys, tracer studies, stable and radioactive isotope studies, and geochemical characterization.

Information from such studies forms the basis for the conceptual model of groundwater flow to the tunnel. Depending on site conditions, groundwater flow boundaries and pathways may be identified and mapped in detail. As with springs, techniques used for surface watershed management such as the program underway by the Town of Pinedale may be appropriate.



Map showing the location of Periodic Spring which serves as the principal water supply for the Town of Afton, Wyoming. Groundwater circulation within Madiosn Limestone Aquifer shown by arrows. The northern and southern extent of the recharge area along the Divide Anticline for Periodic Spring should be considered a minimum contributing area which would constitute Zones 2 and 3 of the WHPA. Modified from Huntoon and Coogan, 1987

WYOMING WHP PROGRAM
TOWN OF AFTON
EXAMPLE OF WHPA DELINEATION FOR PERIODIC SPRING
FIGURE II-3

(2) Limestone Wells:

Wells tapping the limestones in Wyoming are some of the largest producing wells in the Rocky Mountain region. For example, the Town of Worland reportedly uses a well which flows nearly 14,000 gallons per minute (gpm); the City of Gillette has several wells with yields ranging from 500 to 1,000 gpm. Borehole videotaping of many limestone wells located throughout the state reveals that groundwater flow into the wells occurs through pipe-like conduits (caves), along bedding planes, and fractures enlarged by solution; all of these features constitute karst conditions. The single most distinguishing feature of karst aquifers when contrasted with other aquifer types is that the voids in a soluble aquifer are predominantly created by the flow regime. Thus, the permeability structure in a soluble aquifer is (1) a consequence of the circulation system imposed on the aquifer, and (2) organized to facilitate the circulation of fluids in the down gradient direction. The permeability structure in a karst aquifer is not an independent, inherited static attribute of the rock. *The rule of thumb for determining if you are dealing with a karst aquifer is: if carbonate rocks are present, assume you are dealing with karst even if no karst morphologic features are obvious.*

Two major types of groundwater flow occur in karst aquifers: conduit flow which refers to groundwater flow through tubes; and diffuse flow, which refers to groundwater flow through integrated pores. Groundwater flow in conduits and fractures of karst aquifers differs radically from diffuse or porous flow in other aquifers. Conduit flow is generally much faster; flow rates for circulation of water through the subsurface approaches open channel surface water velocities. For example, dye tracing techniques in the Bighorn Mountains demonstrate that typical flow velocities in caves gave rise to off-range transit times of 2 to 12 days. From the perspective of WHPA delineation, a primary focus for groundwater protection are the source areas for the surface streams higher in the upland serving as the recharge area.

Exploring for and developing groundwater from karst aquifers in Wyoming can be some of the most formidable challenges facing even the most experienced groundwater scientists and engineers. The tasks of protecting wells tapping karst aquifers are obviously complicated by the extreme heterogeneities in the permeability architecture within these aquifers. As a consequence, PWSs relying on wells tapping these types of aquifers are encouraged to seek the professional advice of water professionals experienced with working in karst hydrogeologic settings.

(3) Wells and Springs Developed in Crystalline and Metamorphic Rocks:

Some PWSs use springs and wells tapping fractures in the crystalline and metamorphic rocks composing the core of Wyoming mountain ranges. Good examples include some of the ski areas located throughout the state, as well as unincorporated communities such as Ryan Park near Saratoga, Vista West near Sundance, and the Hartville area. Because these rocks store water in fractures, the hydrogeologic setting is typically unconfined. Methods and criteria appropriate to the hydrogeologic setting should be used to delineate the WHPA for the well tapping these rocks. For example, the WHPA delineation for the crystalline rock well serving the Ryan Park area in the Snowy Range in southeastern Wyoming is depicted on Figure II-4. Note the elliptical pattern of the WHPA; this was derived by (1) hydrogeologic mapping of the hydrologic boundaries (i.e. flow-system boundaries) of the fractured rock aquifer, (2) extended aquifer/pump testing of the aquifer which provided hydrologic information suggesting the rocks

were extensively fractured and reacted hydraulically as if the aquifer was a porous media equivalent, and (3) use of an analytical model to calculate the extent of the hydraulic cone of depression, with modifications based on the known hydrologic irregularities in the permeability distribution in the fractured rocks. One of the more interesting aspects of this WHPA delineation is that the simulated area of influence by the well corresponds with the known hydrogeologic boundaries, indicating the delineated WHPA reasonably represents the Zone of Contribution (ZOC) to the well under study. Further definition of 'vulnerable' areas (i.e. Zone 2) within the ZOC can be completed through hydrogeologic mapping or field tests.

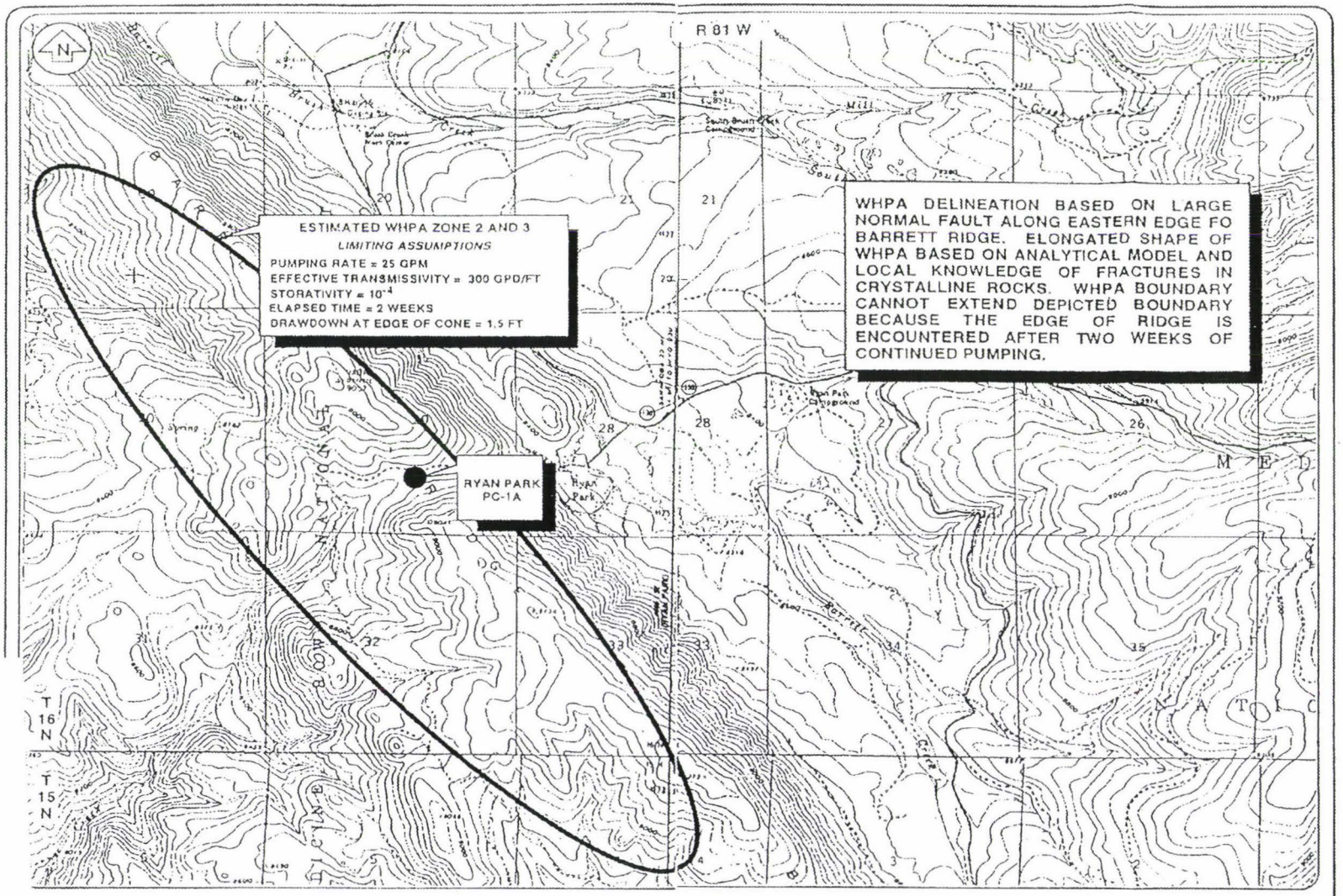
(4) Recharge areas lying outside of Zones 1,2 and 3:

A Zone 3 WHPA delineated by CFR may not encompass the entire ZOC for a well in an area with a significant hydraulic gradient. Other methods of WHPA delineation that utilize a TOT calculation may have similar limitations. In some circumstances, such as when a vulnerable recharge area is located upgradient from a WHPA, the WHPA can be expanded in an upgradient direction in order to provide added protection. This expanded area can extend outward to include the entire ZOC.

This expanded area affords important protection to recharge areas beyond the WHPA boundaries, and can provide information on potential contaminant sources outside Zone 3 which have the potential for releasing contaminants into the wellhead protection area. Analysis may show the need for contingency plans to respond to uncontrolled surface discharges that may travel overland to enter a stream located in or adjacent to the WHPA. It may also identify other non-contiguous critical aquifer recharge areas requiring some from of protection.

(5) Delineation of WHPAs for Multiple Wells in a Well field:

If the WHPAs of different wells overlap, the WHPA *of the well field* should be defined by combining (i.e. "nesting" or "clustering"; see Figure II-5) the individual WHPAs in areas where there is overlap. Where computer modeling approaches are used (e.g. WHPA, WhAEM, etc.) to delineate the WHPAs, interference of the wells on one another must be incorporated into the modeling.



WY0MING WHP PROGRAM
EXAMPLE OF WHPA ZONE DELINEATION IN CRYSTALLINE ROCKS FOR WELL IN SNOWY RANGE
FIGURE II-4

OVERLAPPING WELLHEAD PROTECTION AREAS

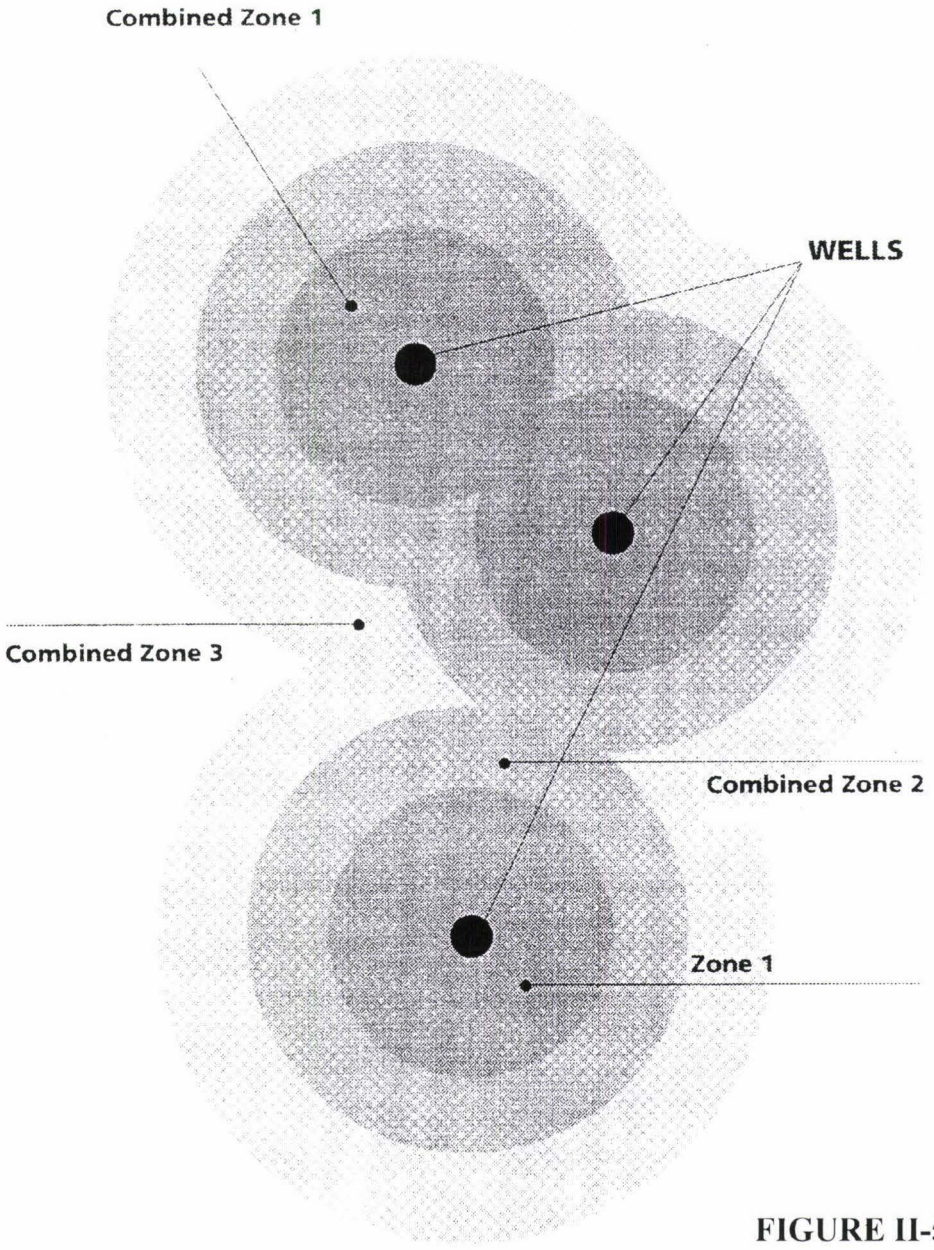


FIGURE II-5

(6) Confined Aquifers

The delineation approach for confined aquifers is the same as that for unconfined or semi-confined aquifers; refer to Tables II-1 and II-2. Confined aquifer conditions generally are less susceptible to contamination and often can justify reduced source management approaches that may be less prescriptive in nature. Recharge areas for confined aquifers should still be considered for inclusion in the protection plan.

(7) Groundwater/Surface Water Interaction Areas:

Groundwater and surface waters may be hydraulically connected. Wells located near rivers may draw a significant portion of their total withdrawal from the surface source. This is particularly true when the wells are hydraulically connected by fractures or in Ranney lateral collectors. A connection between a well and a surface source may be identified by examining water temperature fluctuation, or fluctuations in water chemistry of the well water which reflect changes in the surface water, or by Microscopic Particulate Analyses (MPAs). Another method of identifying hydrologic continuity is by the correlation of water levels and impacts of pumping on adjacent water levels both in surface waters and other wells.

If surface waters are discharging to groundwater, or a well is drawing water from surface supplies into its capture zone, that groundwater supply may be considered as Ground Water Under the Direct Influence (GWUDI) of surface water. Where this condition exists, the PWS is strongly encouraged to develop and implement a plan to prevent surface water contaminants from entering the well via groundwater. A groundwater source classified as a GWUDI may be subject to additional protection measures (e.g. surface watershed control plans), such as those being developed by the Town of Pinedale. Most groundwaters experience some degree of hydraulic continuity with surface waters, however the majority of groundwater-based PWSs are not GWUDIs.

Wells in direct hydraulic continuity with surface water must factor this condition into their delineation effort. Depending on the degree of connection, the surface source (river, lake) often serves as a hydrologic boundary, resulting in a smaller WHPA. Situations such as these usually require professional geologic/hydrogeologic assistance in delineation of the WHPA.

(8) Wells Completed in Multiple Aquifers:

Delineation criteria, thresholds and methodology(ies) for wells completed in multiple aquifers prior to promulgation of rules and regulations requiring sealing between aquifers [WDEQ/WQD Chapter XII, 1985] will be considered by WDEQ/WQD on a case by case basis.

WHPA DELINEATION REPORT:

WHP plans must contain a *'WHPA Delineation Report'* for each well supplying groundwater used for drinking water. PWSs supplied by multiple wells completed within the same aquifer can summarize the information in one *Delineation Report.*

NOTE: 'Non-community' PWSs (see Glossary) do not need to develop and provide a copy of the **WHPA DELINEATION REPORT** described below. In lieu of the **WHPA DELINEATION REPORT**, they may complete a *'Susceptibility Assessment Form'* (Appendix F) as their WHP Plan (including a map illustrating the WHPA(s) for each source) in order to have their WHP plan reviewed for approval. 'Non-community' PWSs must follow the same requirements as 'Community' PWSs for updating WHP plans (see Section VIII).

The Wyoming Water Resource Center and the University of Wyoming have assisted WDEQ/WQD in delineating WHPAs for many 'Non-Community' PWSs to adopt and incorporate into the Susceptibility Assessment Form, if they choose. Contact the WDEQ/WQD for further information.

The required contents of the Delineation Report are set forth as follows:

Geologic Data:

A summary description of the geology and hydrogeology of the aquifer and overlying geologic formations within the. This should include geologic formation name(s), stratigraphic section, lithologic descriptions, and description of structural and geomorphic settings including faults, fractures and solution cavities (size, abundance, spacing, orientations and location(s). Fractures, faults and solution cavities should be identified from existing maps, reports, air photos, satellite imagery, surface outcrops, field tests or drill holes.

Aquifer Data:

A summary description of the aquifer media type (i.e. porous, carbonate, fractured or faulted); degree of confinement (i.e. confined/semi-confined/unconfined); and, type of flow (i.e. porous, diffuse or conduit) - cite sources of information used to document media type, degree of confinement and flow type. Also include the depth, thickness, horizontal and vertical extent of the aquifer, the location of its recharge area, its horizontal and vertical hydraulic conductivity, transmissivity, storativity (storage coefficient), porosity, hydraulic gradient, and saturated thickness - cite sources of information used to document each of these.

If the groundwater source is a well, hydraulic conductivity and transmissivity data should be obtained from an appropriate aquifer/pump test. If a previously performed aquifer/pump test has been performed, is available and includes the data listed below, it may be used instead. Hydraulic data derived from hydrologic reports, or from areal or regional numerical modeling efforts also may be used.

If an aquifer test was conducted using a *single well*, the report must include the following information:

- static (i.e. non-pumping) water level;
- constant pump rate or stepped rates and durations at which the test was conducted;
- time-drawdown data and curve.*

  * NOTE: If a time-drawdown curve does not develop using existing pumping equipment, it is not necessary to equip the well with a higher capacity pump, however, an aquifer test should be performed (with a temporary pump of sufficient capacity to stress the aquifer) when the well is deepened, renovated, or the pump is pulled from the well for maintenance.

- total drawdown of the well during the test; and,
- length of time the well was pumped.

An aquifer test using more than one well is encouraged because the data collected is generally more accurate. Therefore, if the aquifer test is conducted using *multiple wells*, the report should include the following for any well used as an observation well, in addition to the information required for a single well test (above):

- location, total depth, screened interval and elevation of each observation well;
- distance and direction of each observation well from the pumping (i.e. 'Test') well;
- well radius, casing type, screen type and size, and method of construction for each observation well;
- static (i.e., pre-pumping) water level in each observation well;
- time-drawdown or distance-drawdown data and curve for each observation well; and,
- total drawdown for each observation well.

Well Data:

The well drillers log, elevation of the wellhead, well radius, total depth of the well, depth and length of the screened interval(s), well screen type, casing type, method of well construction, and the maximum projected pumping rate of the well.

Pump Data:

The model, type, make, series, rating, date of installation, etc.

WHPA Delineation Information:

The information used to delineate each of the WHPA zones, including: all applicable hydraulic and groundwater data, equations, calculations, modeling input parameters, information sources/references, maps and reports used to delineate the boundaries of WHPA Zones 1, 2 and 3.

Map Showing Boundaries of the WHPA Zones:

A map, drawn on a U.S. Geological Survey 7.5 minute series topographic map (1:24,000 scale), showing the location of the groundwater source of drinking water (e.g., well), the boundaries of WHPA Zones 1, 2 and 3, and recharge areas which fall outside the boundaries of the WHPA. A regional map will be needed when the recharge area lies well away from the WHPA.

In addition, the WHP plan should include a written description of the distances which define the delineated boundaries of Zone 2 and Zone 3. These written descriptions should include the maximum distances up gradient from the well (or collection area for a spring or tunnel), the maximum distances down gradient from the well, and the maximum widths of each protection zone.

Current Zoning and County Plan Map:

A map illustrating and clearly distinguishing between the various types of city/county zoning classifications and land use categories within the WHPA.

Confined Aquifer Conditions:

Confined aquifer conditions generally are less susceptible to contamination and often can justify less stringent source management approaches (see Section IV of this document). In order to demonstrate that confining conditions exist, the following information must be included, and cited, in the *Delineation Report*:

- geologic description of the confining layer, including: thickness; depth; lithology; formation name or stratigraphic section; lateral extent; hydraulic conductivity.
- elevation (Mean Sea Level) of the base of the confining layer (in the well bore);
- static water level elevation of the well (Mean Sea Level);
- description and map of the aquifer's recharge area, including: distance, direction, geographic/geologic description of the recharge area.

'Susceptibility Assessment Form' (Appendix F):

A completed *'Susceptibility Assessment Form'* (Appendix F) also must be included with the *Delineation Report* for each 'Community' and 'Non-Community' PWS 'source' (i.e. well, spring, tunnel etc.) included in the WHP Plan.

Sources of Information:

Appendix E *(The Aquifers and Aquifer Systems in Wyoming)* contains general discussions of Wyoming geology and hydrogeology. Sources and contacts for additional information (including WHPA and W*h*AEM software and user guides) available for use in completing WHPA delineations and *Delineation Reports* are provided in Appendix C.

NOTE: For the purposes of delineating Wellhead Protection Areas for *Source Water Assessments*, Wyoming may adopt any policy of another EPA-approved State Wellhead Protection Program or create a new policy consistent with the methods in the EPA's *"Guidelines for Delineation of Wellhead Protection Areas"*.

SECTION III

INVENTORY OF KNOWN AND POTENTIAL CONTAMINANT SOURCES
(Within the Wellhead Protection Area)

Introduction:

Subsection 1428(a)(3) of the Safe Drinking Water Act (SDWA) requires that state Wellhead Protection (WHP) plans will:

> "identify within each wellhead protection area all potential anthropogenic sources of contaminants which may have any adverse effect on the health of persons."

An anthropogenic source is any activity, performed by or caused by human actions, that is, or potentially can be a source of contamination to groundwater, including human actions affecting natural contaminants. The releases can be either from *point* sources, such as leaking tanks or impoundments, or from *non-point* sources, such as the application of agricultural chemicals or releases from areas containing septic tank/leachfield systems. Finally, a contaminant is interpreted in the WHP Plan as an organic, inorganic, radiological or microbiological substance that is regulated under Federal, State or local environmental programs, and any other substance that the State determines appropriate[5].

Federal environmental laws and hazardous material regulations generally include the Resource Conservation and Recovery Act (RCRA), Comprehensive Environmental Response Compensation and Liability Act (CERCLA or "Superfund"), Safe Drinking Water Act (SDWA), Clean Water Act (CWA), Toxic Substances Control Act (TSCA), and Federal, Insecticide, Fungicide and Rodenticide Act (FIFRA). Although these regulations have imposed controls on a wide range of industries and hazardous material treatment, storage and disposal practices, they have tended to focus only on the larger manufacturing industries which manage the majority of hazardous wastes and hazardous materials in this country. Other smaller industries and businesses are not as stringently controlled (if controlled at all) either because the Federal statutes focus on industries that manage wastes or materials above a threshold amount or because the materials managed by the smaller industries are not considered "hazardous." Nonetheless, EPA and many States have discovered that these materials and wastes that are not generally regarded or regulated as "hazardous" commonly contaminate ground-water supplies. In certain hydrogeologic settings, even very small amounts of a hazardous substance can contaminate large areas of ground water; both community and private supply wells have been contaminated by light industries.

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[5] "Guidance for Applicants for State Wellhead Protection Program Assistance Funds Under the Safe Drinking Water Act", EPA, 440/6-87-011, June, 1987.

CATEGORIES OF 'SOURCES' HAVING THE POTENTIAL TO CONTAMINATE DRINKING WATER SUPPLIES

Based upon the knowledge and expertise of the state's Wellhead Protection Advisory Committee, together with information from WDEQ inventories of regulated sites and contaminated sites in Wyoming and existing lists from EPA and other states, categories of sources (activities) having the potential to contaminate groundwater have been identified (see Table III-1: "Potential Sources of Ground-Water Contamination"). As illustrated in the Table, categories have been grouped according to the type of activity (i.e. residential, agriculture, municipal, commercial or industrial) with which the source is commonly associated. The type(s) of contaminant(s) commonly associated with the various types of sources also are provided in the Table.

*In the discussion which follows, **'existing'** sources are those which are known to have caused, or threaten to cause groundwater contamination; WDEQ may have information pertaining to 'existing' sources. **'Potential'** sources are those which may or may not have caused groundwater contamination, but have the potential to do so; WDEQ may, or may not have knowledge and/or information available relating to 'potential' sources.*

Table III-1 is used in conjunction with Form III-1 (*Source Identification Form*; Appendix H) to inventory and collect pertinent information for all potential and existing sources that fall within the boundaries of the Wellhead Protection Area (delineated in accordance with the procedures and criteria described in Section II of this document).

A more complete description of the 'Source Inventory' process follows Table III-1.

TABLE III-1
POTENTIAL SOURCES OF GROUND-WATER CONTAMINATION

SOURCE	HEALTH, ENVIRONMENTAL, OR AESTHETIC CONTAMINANT[1,2,3]
NATURALLY OCCURRING SOURCES	
Rocks and soils (0001)	Aesthetic Contaminants: Iron and iron bacteria; manganese; calcium and magnesium (hardness) Health and Environmental Contaminants: Arsenic; asbestos; metals; chlorides (fluorides, sulfates); sulfate-reducing bacteria; other microorganisms
Water (0002)	Excessive sodium; bacteria; viruses; low pH (acid) water
Decaying organic matter, Bacteria (0003)	
Geological radioactive gas (0004)	Radionuclides (radon, etc.)
Natural hydrogeological events and formations (0005)	Salt-water/brackish water intrusion (or intrusion of other poor quality water); contamination by a variety of substances through sink-hole infiltration in limestone terrains
AGRICULTURAL SOURCES (K)[5]	
Animal feedlots (0006) and burial areas (0007)	Livestock sewage wastes; nitrates; phosphates; chloride; chemical sprays and dips for controlling insect, bacterial, viral, and fungal pests on livestock; coliform[6] and noncoliform bacteria; viruses
Manure spreading areas (0008) and storage pits (0009)	Livestock sewage wastes; nitrates
Livestock waste disposal areas (0010)	Livestock sewage wastes; nitrates
Crop areas and irrigation sites (0011)	Pesticides;[7] fertilizers;[8] gasoline and motor oils from chemical applicators
Chemical storage areas and containers (0012)	Pesticide[7] and fertilizer[8] residues
Farm machinery areas (0013)	Automotive wastes;[9] welding wastes
Agricultural drainage wells (0014) and canals (0015)	Pesticides;[7] fertilizers;[8] bacteria; salt water (in areas where the fresh-saltwater interface lies at shallow depths and where the water table is lowered by channelization, pumping, or other causes)
RESIDENTIAL SOURCES (D)	
Common household maintenance and hobbies (0016)	Common Household Products:[10] Household cleaners; oven cleaners; drain cleaners; toilet cleaners; disinfectants; metal polishes; jewelry cleaners; shoe polishes; synthetic detergents; bleach; laundry soil and stain removers; spot removers and dry cleaning fluid; solvents; lye or caustic soda; household pesticides;[11]; photochemicals; printing ink; other common products; Wall and Furniture Treatments: Paints; varnishes; stains; dyes; wood preservatives (creosote); paint and lacquer thinners; paint and varnish removers and deglossers; paint brush cleaners; floor and furniture strippers; Mechanical Repair and Other Maintenance Products: Automotive wastes;[9] waste oil; diesel fuel; kerosene; #2 heating oil; grease; degreasers for driveways and garages; metal degreasers; asphalt and roofing tar; tar removers; lubricants; rustproofers; car wash detergents; car waxes and polishes; rock salt; refrigerants
Lawns and gardens (0017)	Fertilizers;[7] herbicides and other pesticides used for lawn and garden maintenance[12]
Swimming pools (0018)	Swimming pool maintenance chemicals[13]
Septic systems (0019), cesspools (0020), and sewer lines (0021)	Septage; coliform and noncoliform bacteria;[6] viruses; nitrates; heavy metals; synthetic detergents; cooking and motor oils; bleach; pesticides;[11, 12] paints; paint thinner; photographic chemicals; swimming pool chemicals;[11] septic tank/cesspool cleaner chemicals;[14] elevated levels of chloride, sulfate, calcium, magnesium, potassium, and phosphate
Underground storage tanks (0022)	Home heating oil
Apartments and condominiums (0023)	Swimming pool maintenance chemicals;[13] pesticides for lawn and garden maintenance and cockroach, termite, ant, rodent, and other pest control;[11,12] wastes from on-site sewage treatment plants; household hazardous wastes[10]

SOURCE	HEALTH, ENVIRONMENTAL, OR AESTHETIC CONTAMINANT[1,2,3]
GOVERNMENT SOURCES (E)	
Schools (0024) and government offices and grounds (0025)	Solvents; pesticides;[11,12] acids; alkalis; waste oils; machinery/vehicle servicing wastes; gasoline and heating oil from storage tanks; general building wastes[15]
Park lands (0026)	Fertilizers;[8] herbicides;[12] insecticides[11]
Public and residential areas infested with mosquitoes, gypsy moths, ticks, ants, or other pests (0027)	Pesticides[7,11]
Highways, road maintenance depots, and deicing operations (0028)	Herbicides in highway rights-of-way;[7,12] road salt (sodium and calcium chloride); road salt anticaking additives (ferric ferrocyanide, sodium ferrocyanide); road salt anticorrosives (phosphate and chromate); automotive wastes[9]
Municipal sewage treatment plants and sewer lines (0029)	Municipal wastewater; sludge;[16] treatment chemicals[17]
Storage, treatment, and disposal ponds, lagoons, and other surface impoundments (0030)	Sewage wastewater; nitrates; other liquid wastes; microbiological contaminants
Land areas applied with wastewater or wastewater byproducts (0031)	Organic matter; nitrate; inorganic salts; heavy metals; coliform and noncoliform bacteria;[6] viruses; nitrates; sludge;[16] nonhazardous wastes[18]
Storm water drains and basins (0032)	Urban runoff; gasoline; oil; other petroleum products; road salt; microbiological contaminants
Combined sewer overflows (municipal sewers and stormwater drains) (0033)	Municipal wastewater; sludge;16 treatment chemicals;[17] urban runoff; gasoline; oil; other petroleum products; road salt; microbial contaminants
Recycling/reduction facilities (0034)	Residential and commercial solid waste residues
Municipal waste landfills (0035)	Leachate; organic and inorganic chemical contaminants; wastes from households[10] and businesses;[15] nitrates; oils; metals
Open dumping and burning sites (0036), closed dumps (0037)	Organic and inorganic chemicals; metals; oils; wastes from households[10] and businesses[15]
Municipal incinerators (0038)	Heavy metals; hydrocarbons; formaldehyde; methane; ethane; ethylene; acetylene; sulfur and nitrogen compounds
Water supply wells, monitoring wells, older wells, domestic and livestock wells (0039), unsealed and abandoned wells (0040), and test hole/wells (0041)	Surface runoff; effluents from barnyards, feedlots, septic tanks, or cesspools; gasoline; used motor oil; road salt
Sumps and dry wells (0042)	Storm water runoff; spilled liquids; used oil; antifreeze; gasoline; other petroleum products; road salt; pesticides;[7] and a wide variety of other substances
Drainage wells (0043)	Pesticides;[11,12] bacteria
Well pumping that causes interaquifer leakage, induced filtration, landward migration of sea water in coastal areas; etc. (0044)	Saltwater; excessively mineralized water
Artificial ground-water recharge (0045)	Storm water runoff; excess irrigation water; stream flow; cooling water; treated sewage effluent; other substances that may contain contaminants, such as nitrates, metals, detergents, synthetic organic compounds, bacteria, and viruses

SOURCE	HEALTH, ENVIRONMENTAL, OR AESTHETIC CONTAMINANT[1,2,3]
COMMERCIAL SOURCES (C)	
Airports (0046), abandoned airfields (0047)	Jet fuels; deicers; diesel fuel; chlorinated solvents; automotive wastes;[9] heating oil; building wastes[15]
Auto repair shops (0048)	Waste oils; solvents; acids; paints; automotive wastes;[9] miscellaneous cutting oils
Barber and beauty shops (0049)	Perm solutions; dyes; miscellaneous chemicals contained in hair rinses
Boat yards and marinas (0050)	Diesel fuels; oil; septage from boat waste disposal areas; wood preservative and treatment chemicals; paints; waxes; varnishes; automotive wastes[9]
Bowling alleys (0051)	Epoxy; urethane-based floor finish
Car dealerships (especially those with service depts.) (0052)	Automotive wastes;[9] waste oils; solvents; miscellaneous wastes
Car washes (0053)	Soaps; detergents; waxes; miscellaneous chemicals
Camp grounds (0054)	Septage; gasoline; diesel fuel from boats; pesticides for controlling mosquitoes, ants, ticks, gypsy moths, and other pests;7,11 household hazardous wastes from recreational vehicles (RVs)[10]
Carpet stores (0055)	Glues and other adhesives; fuel from storage tanks if forklifts are used
Cemeteries (0056)	Leachate; lawn and garden maintenance chemicals[12]
Construction trade areas and materials (plumbing, heating and air conditioning, painting, paper hanging, decorating, drywall and plastering, acoustical insulation, carpentry, flooring, roofing and sheet metal, wrecking and demolition, etc.) (0057)	Solvents; asbestos; paints; glues and other adhesives; waste insulation; lacquers; tars; sealants; epoxy waste; miscellaneous chemical wastes
Country clubs (0058)	Fertilizers;[8] herbicides;[7,12] pesticides for controlling mosquitoes, ticks, ants, gypsy moths, and other pests;[11] swimming pools chemicals;[13] automotive wastes
Dry cleaners (0059)	Solvents (perchloroethylene, petroleum solvents, Freon); spotting chemicals (trichloroethane, methylchloroform, ammonia, peroxides, hydrochloric acid, rust removers, amyl acetate)
Funeral services and crematories (0060)	Formaldehyde; wetting agents; fumigants; solvents
Furniture repair and finishing shops (0061)	Paints; solvents; degreasing and solvent recovery sludges
Gasoline services stations (0062)	Oils; solvents; miscellaneous wastes
Golf courses (0058)	Fertilizers;[8] herbicides;[7,12] pesticides for controlling mosquitoes, ticks, ants, gypsy moths, and other pests
Hardware/lumber/parts stores (0063)	Hazardous chemical products in inventories; heating oil and fork lift fuel from storage tanks; wood-staining and treating products such as creosote
Heating oil companies, underground/above ground storage tanks (0064)	Heating oil; wastes from truck maintenance areas[9]
Horticultural practices, garden nurseries, florists (0065)	Herbicides, insecticides, fungicides, and other pesticides[12]
Jewelry/metal plating shops (0066)	Sodium and hydrogen cyanide; metallic salts; hydrochloric acid; sulfuric acid; chromic acid
Laundromats (0067)	Detergents; bleaches; fabric dyes
Medical institutions (0068)	X-ray developers and fixers;[19] infectious wastes; radiological wastes; biological wastes; disinfectants; asbestos; beryllium; dental acids; miscellaneous chemicals
Office buildings and office complexes (0069)	Building wastes;[15] lawn and garden maintenance chemicals;[12] gasoline; motor oil
Paint stores (0070)	Paints; paint thinners; lacquers; varnishes; other wood treatments
Pharmacies (0071)	Spilled and returned products
Photography shops, photo processing laboratories (0072)	Biosludges; silver sludges; cyanides; miscellaneous sludge
Print shops (0073)	Solvents; inks; dyes; oils; photographic chemicals

SOURCE	HEALTH, ENVIRONMENTAL, OR AESTHETIC CONTAMINANT[1,2,3]
Railroad tracks and yards (0074)	Diesel fuel; herbicides for rights-of-way; creosote for preserving wood ties
Research laboratories (0075)	X-ray developers and fixers;19 infectious wastes; radiological wastes; biological wastes; disinfectants; asbestos; beryllium; solvents; infectious materials; drugs; disinfectants (quaternary ammonia, hexachlorophene, peroxides, chlornexade; bleach); miscellaneous chemicals
Scrap and junk yards (0076)	Any wastes from businesses[15] and households;[10] oils
Sports and hobby shops (0077)	Gunpowder and ammunition; rocket engine fuel; model airplane glue
Aboveground and underground storage tanks (0078)	Heating oil; diesel fuel; gasoline; other petroleum products; other commercially used chemicals
Transportation services for passenger transit (local and interurban) (0079)	Waste oil; solvents; gasoline and diesel fuel from vehicles and storage tanks; fuel oil; other automotive wastes[9]
Veterinary services (0080)	Solvents; infectious materials; vaccines; drugs; disinfectants (quaternary ammonia, hexachlorophene, peroxides, chlornexade, bleach); x-ray developers and fixers[19]
INDUSTRIAL SOURCES (B)	
Material stockpiles (coal, metallic ores, phosphates, gypsum) (0081)	Acid drainage; other hazardous and nonhazardous wastes[18]
Waste tailing ponds (commonly for the disposal of mining wastes) (0082)	Acids; metals; dissolved solids; radioactive ores; other hazardous and nonhazardous wastes[17]
Transport and transfer stations (trucking terminals and rail yards) (0083)	Fuel tanks; repair shop wastes;[9] other hazardous and nonhazardous wastes[17]
Aboveground and underground storage tanks and containers (0084)	Heating oil; diesel and gasoline fuel; other petroleum products; hazardous and nonhazardous materials and wastes[18]
Storage, treatment, and disposal ponds, lagoons, and other surface impoundments (0085)	Hazardous and nonhazardous liquid wastes;[18] septage; sludge[16]
Chemical landfills (0086)	Leachate; hazardous and nonhazardous wastes;[18] nitrates
Radioactive waste disposal sites (0087)	Radioactive wastes from medical facilities, power plants, and defense operations; radionuclides (uranium, plutonium)
Unattended wet and dry excavation sites (unregulated dumps) (0088)	A wide range of substances; solid and liquid wastes; oil-field brines; spent acids from steel mill operations; snow removal piles containing large amounts of salt
Operating and abandoned production and exploratory wells (for gas, oil, coal, geothermal, and heat recovery); test hole wells; monitoring and excavation wells (0089)	Metals; acids; minerals; sulfides; other sulfides; other hazardous and nonhazardous chemicals[18]
Dry wells (0090)	Saline water from wells pumped to keep them dry
Injection wells (0091)	Highly toxic wastes; hazardous and nonhazardous industrial wastes;[18] oil-field brines
Well drilling operations (0092)	Brines associated with oil and gas operations

SOURCE	HEALTH, ENVIRONMENTAL, OR AESTHETIC CONTAMINANT[1,2,3]
INDUSTRIAL PROCESSES (B) (PRESENTLY OPERATED OR TORN-DOWN FACILITIES)[20]	
Asphalt plants (0093)	Petroleum derivatives
Communications equipment manufacturers (0094)	Nitric, hydrochloric, and sulfuric acid wastes; heavy metal sludges; copper-contaminated etchant (e.g., ammonium persulfate); cutting oil and degreasing solvent (trichloroethane, Freon, or trichloroethylene); waste oils; corrosive soldering flux; paint sludge; waste plating solution
Electric and electronic equipment manufacturers and storage facilities (0095)	Cyanides; metal sludges; caustics (chromic acid); solvents; oils; alkalis; acids; paints and paint sludges; calcium fluoride sludges; methylene chloride; perchloroethylene; trichloroethane; acetone; methanol; toluene; PCBs
Electroplaters (0096)	Boric, hydrochloric, hydrofluoric, and sulfuric acids; sodium and potassium hydroxide; chromic acid; sodium and hydrogen cyanide; metallic salts
Foundries and metal fabricators (0097)	Paint wastes; acids; heavy metals; metal sludges; plating wastes; oils; solvents; explosive wastes
Furniture and fixtures manufacturers (0098)	Paints; solvents; degreasing sludges; solvent recovery sludges
Machine and metalworking shops (0100)	Solvents; metals; miscellaneous organics; sludges; oily metal shavings; lubricant and cutting oils; degreasers (TCE); metal marking fluids; mold-release agents
Mining operations (surface and underground) (0101)	Mine spoils or tailings that often contain metals; acids; highly corrosive mineralized waters; metal sulfides
Unsealed abandoned mines used as waste pits (0102)	Metals; acids; minerals; sulfides; other hazardous and nonhazardous chemicals[18]
Paper mills (0103)	Metals; acids; minerals; sulfides; other hazardous and nonhazardous chemicals;[18] organic sludges; sodium hydroxide; chlorine; hypochlorite; chlorine dioxide; hydrogen peroxide
Petroleum production and storage companies, secondary recovery of petroleum (0104)	Hydrocarbons; oil-field brines (highly mineralized salt solutions)
Industrial pipeline (0105)	Corrosive fluids; hydrocarbons; other hazardous and nonhazardous materials and wastes[18]
Photo processing laboratories (0106)	Cyanides; biosludges; silver sludges; miscellaneous sludges
Plastics materials and synthetics producers (0107)	Solvents; oils; miscellaneous organics and inorganics (phenols, resins); paint wastes; cyanides; acids; alkalis; wastewater treatment sludges; cellulose esters; surfactant; glycols; phenols; formaldehyde; peroxides; etc.
Primary metal industries (blast furnaces, steel works, and rolling mills) (0108)	Heavy metal wastewater treatment sludge; picking liquor; waste oil; ammonia scrubber liquor; acid tar sludge; alkaline cleaners; degreasing solvents; slat; metal dust
Publishers, printers, and allied industries (0109)	Solvents; inks; dyes; oils; miscellaneous organics; photographic chemicals
Public utilities (phone, electric power, gas) (0110)	PCBs from transformers and capacitors; oils; solvents; sludges; acid solution; metal plating solutions (chromium, nickel, cadmium); herbicides from utility rights-of-way
Sawmills and planers (0111) and gluing wastes	Treated wood residue (copper quinolate, mercury, sodium bazide); tanner gas; paint sludges; solvents; creosote; coating
Stone, clay, and glass manufacturers (0112)	Solvents; oils and grease; alkalis; acetic wastes; asbestos; heavy metal sludges; phenolic solids or sludges; metal-finishing sludge
Welders (0113)	Oxygen, acetylene
Wood preserving facilities (0114)	Wood preservatives; creosote

[1]In general, ground-water contamination stems from the **misuse and improper disposal** of liquid and solid wastes; the **illegal dumping or abandonment** of household, commercial, or industrial chemicals; the **accidental spilling** of chemicals from trucks, railways, aircraft, handling facilities, and storage tanks; or the **improper siting, design, construction, operation, or maintenance** of agricultural, residential, municipal, commercial, and industrial drinking water wells and liquid and solid waste disposal facilities. Contaminants also can stem from **atmospheric pollutants**, such as airborne sulfur and nitrogen compounds, which are created by smoke, flue dust, aerosols, and automobile emissions, fall as acid rain, and percolate through the soil. When the sources listed on this table are used and managed properly, ground-water contamination is not likely to occur.

[2]Contaminants can reach ground water from activities occurring on the land surface, such as industrial waste storage; from sources below the land surface but above the water table, such as septic systems; from structures beneath the water table, such as wells; or from contaminated recharge water.

[3]This table lists most common wastes, but not all potential wastes. For example, it is not possible to list all potential contaminants contained in storm water runoff or research laboratory wastes.

[4]Contaminant *Source* Code Number for Form III-1 (*Source Identification Form*).

[5]Facility *Type* Code Number for Form III-1 (*Source Identification Form*).

[6]Coliform bacteria can indicate the presence of pathogenic (disease-causing) microorganisms that may be transmitted in human feces. Diseases such as typhoid fever, hepatitis, diarrhea, and dysentery can result from sewage contamination of water supplies.

[7]Pesticides include herbicides, insecticides, rodenticides, fungicides, and avicides; many are highly toxic and quite mobile in the subsurface. An EPA survey found that the most common pesticides found in drinking water wells were DCPA (dacthal) and atrazine (EPA, 1990b), which EPA classifies as **moderately toxic** (class 3) and **slightly toxic** (class 4) materials, respectively (Meister Publishing Company, 1991).

[8]The EPA National Pesticides Survey (EPA, 1991) found that the use of fertilizers correlates to nitrate contamination of ground-water supplies.

[9]Automotive wastes can include gasoline; antifreeze; automatic transmission fluid; battery acid; engine and radiator flushes; engine and metal degreasers; hydraulic (brake) fluid; and motor oils.

[10]Toxic or hazardous components of common household products are noted on the attached table (EPA 1990c).

[11]Common household pesticides for controlling pests such as ants, termites, bees, wasps, flies, cockroaches, silverfish, mites, ticks, fleas, worms, rats, and mice can contain active ingredients including naphthalene, phosphorus, xylene, chloroform, heavy metals, chlorinated hydrocarbons, arsenic, strychnine, kerosene, nitrosamines, and dioxin.

[12]Common pesticides used for lawn and garden maintenance (i.e., weed killers, and mite, grub, and aphid controls) include such chemicals as 2,4-D; chlorpyrifos; diazinon; benomyl; captan; dicofol; and methoxychlor.

[13]Swimming pool chemicals can contain free and combined chlorine; bromine; iodine; mercury-based, copper-based, and quaternary algaecides; cyanuric acid; calcium or sodium hypochlorite; muriatic acid; sodium carbonate.

[14]Septic tank/cesspool cleaners include synthetic organic chemicals such as 1,1,1 trichloroethane, tetrachloroethylene, carbon tetrachloride, and methylene chloride.

[15]Common wastes from public and commercial buildings include automotive wastes (see above definition); rock salt; and residues from cleaning products that may contain chemicals such as xylenols, glycol esters, isopropanol, 1,1,1-trichloroethane, sulfonates, chlorinated phenols, and cresols.

[16]Municipal wastewater treatment sludge can contain organic matter; nitrates; inorganic salts; heavy metals; coliform and noncoliform bacteria (see above definition); and viruses.

[17]Municipal wastewater treatment chemicals include calcium oxide; alum; activated alum, carbon, and silica; polymers; ion exchange resins; sodium hydroxide; chlorine; ozone; and corrosion inhibitors.

[18]The Resource Conservation and Recovery Act (RCRA) defines a hazardous waste as a solid waste that may cause an increase in mortality or serious illness or pose a substantial threat to human health and the environment when improperly treated, stored, transported, disposed of, or otherwise managed. A waste is hazardous if it exhibits characteristics of ignitability, corrosivity, reactivity, and/or toxicity. Not covered by RCRA regulations are domestic sewage; irrigation waters or industrial discharges allowed by the Clean Water Act; certain nuclear and mining wastes; household wastes; agricultural wastes (excluding some pesticides); and small quantity hazardous wastes (i.e., less than 220 pounds per month) discharged from businesses.

[19]X-ray developers and fixers may contain reclaimable silver, glutaldehyde, hydroquinone, phenedone, potassium bromide, sodium sulfite, sodium carbonate, thiosulfates, and potassium alum.

[20]This table lists potential ground-water contaminants from many common industries, but it does not address all industries.

PROCEDURES FOR INVENTORYING EXISTING AND POTENTIAL SOURCES OF CONTAMINATION:

The objective of completing a Source Inventory is to identify all potential and existing sources of contamination that may threaten public drinking water supply wells. Development of the Source Inventory may occur prior to (using an estimate of WHPA boundaries), during (provisions must be made to adjust (finalize) the inventory when WHPA boundaries are fixed), or upon completion of delineation of the WHPA (see Section II), but must be completed before Management Approaches (Section IV) are developed and implemented.

Initial development of the Source Inventory should proceed from WHPAs of the well serving the most number of residents to the WHPA of the well serving the least. This prioritization approach should be further refined based upon the susceptibility of each well to potential contamination as determined from the county *Groundwater Sensitivity* map[6], an excellent tool that illustrates where groundwater is most susceptible to contamination from a release at, or near, the ground's surface.

The process of developing and completing the inventory may be assigned to PWS operators, city/county employees, local citizen volunteer groups, consultants, or others, in meeting the state's objective of providing a flexible, 'do-it-yourself' approach to wellhead protection. In many communities, local volunteer groups (e.g. Retired Senior Citizens, Scouts, 4-H'ers, etc.) have become enthusiastic participants and an invaluable resource in developing and completing source inventories. Identifying and inventorying past, present and proposed contaminant sources within WHPAs involves a process of:

I. Obtaining a base map on which to plot existing and potential sources.
II. Obtaining available information on existing and potential sources:
    1. Access and record existing data
    2. Target likely sources for further study
    3. Access unknown sources
    4. Verify accuracy and reliability of the information gathered
III. Describing sources within the WHPA:
    1. Complete *Source Identification* forms (Form III-1; Appendix H) for each existing and potential source of contamination identified within the WHPA.
IV. Developing the *Source Inventory list* from completed *Source Identification* forms.
V. Prioritizing sources within the WHPA for management purposes.
VI. Transferring source location and information to WHPA delineation maps.
VII. Updating, Refining and Expanding Source Inventory information.

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6 As of June, 1997 maps for the following counties will have been completed: Washakie, Park, Goshen, Fremont, Lincoln, Laramie, Natrona, Sweetwater, Uinta and Campbell. Maps for the remaining counties (Big Horn, Sheridan, Platte, Johnson, Crook, Weston, Teton, Albany, Converse, Hot Springs, Carbon, Sublette and Niobrara) will be available in 1999. Maps will be available at main county libraries, city/county planning offices and local Conservation District offices.

Source Inventories should be developed following the process set forth below. Wellhead Protection (WHP) Plans must identify which of the specific approaches described below were used to complete the community's Source Inventory.

I. Obtain a base map on which to plot existing and potential sources:

The first step in beginning the Source Inventory is to obtain a 'working' base map for use in identifying areas to include in the inventory and for locating existing and potential sources for which information is available. Acceptable working base maps may be topographic maps, city maps or WHPA delineation maps of a scale small enough to allow sources to be easily and accurately located and illustrated. Ultimately, potential and existing sources must be plotted on a *'Source Overlay'* map of the WHPA, as discussed below.

II. Obtain available information on existing and potential sources:

Figure III-1 illustrates a recommended approach to collecting information on potential sources.

1. Access and record existing data:

A substantial amount of inventory data base material and other information on known existing sources of contamination is available from local, state and federal agencies for use in developing and completing source inventories. Table III-2 presents a listing of many of the local, state and federal agencies that may have useful databases and related information for completing source inventories.

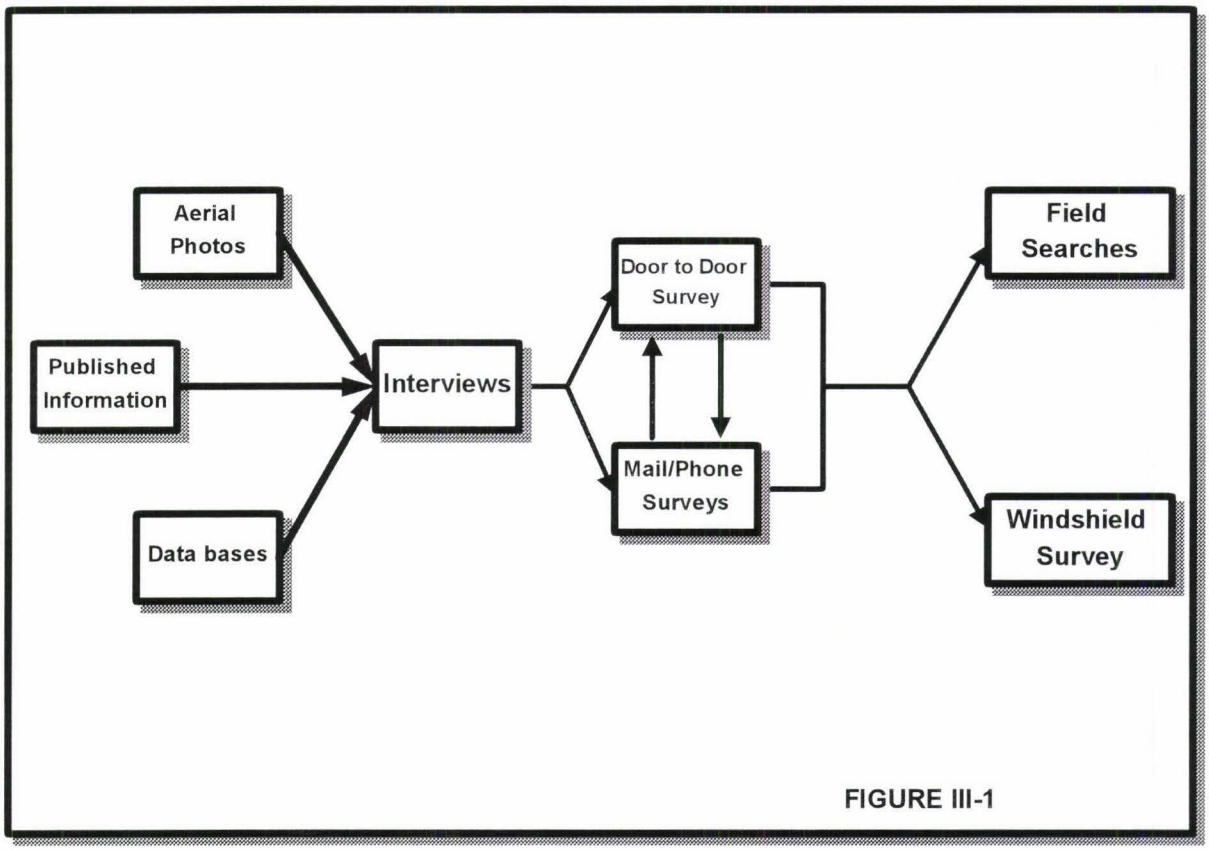
Aerial Photos
Published Information
Data bases
Interviews
Door to Door Survey
Mail/Phone Surveys
Field Searches
Windshield Survey

FIGURE III-1

Table III-2

STATE & LOCAL INFORMATION SOURCES

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY (WDEQ) 122 W 25TH STREET, 4W CHEYENNE, WY 82002	
AGENCY	**INFORMATION AVAILABLE**
Water Quality Division (WQD) District Offices Cheyenne: 307-777-7781 Lander: 307-332-3144 Sheridan: 307-672-6457	* NPL/CERCLA/FUD Sites (DSMOA Program) * Emergency Spills, Leaks, Complaint Investigations * Leaking Underground and Above Ground Storage Tanks * Surface Water Discharge Permits (NPDES) * Storm Water Pollution Prevention Plans & Permits * Sewage Treatment Plants & Wastewater Permits * Industrial Wastewater Treatment Plants * Animal Waste Management Facilities (over 1000 animal units) * Injection Wells (Classes I, II, III, IV & V) * Groundwater Monitoring Systems * Private Septic System Rules and Permits * Pesticide Monitoring in Groundwater * Wellhead Protection Planning * Groundwater Quality Information * Groundwater Pollution Investigations * Groundwater Sensitivity (Pollution Potential) and Aquifer Vulnerability Maps * Public Water System (PWS) Construction Permits * Non-Point Source Pollution Control Program * Subdivision Permit Reviews
Solid and Hazardous Waste Division (SHWD) District Offices Cheyenne: 307-777-7752 Lander: 307-332-6924 Casper: 307-473-3750	* Hazardous Material Treatment, Storage and Disposal Facilities * RCRA Permits/Hazardous Waste Facility Cleanup * Solid Waste Management Storage, Treatment and Disposal Facilities (land farms, landfills, etc.) * Incinerators, Transfer Stations, Recycling Centers * Pollution Prevention (Assistance to Industry Regarding Source Reduction, Recycling or Treatment to Reduce Toxicity or Volume)
Land Quality Division (LQD) District Offices Cheyenne: 307-777-7756 Lander: 307-332-3047 Sheridan: 307-672-6488	* Mine Permits * Underground Mines * Above Ground Mines

Table III-2

AGENCY	INFORMATION AVAILABLE
Abandoned Mine Lands (AML) District Offices Cheyenne: 307-777-6145 Lander: 307-332-5085 Casper: 307-473-3460 Sheridan: 307-672-6457	* Abandoned Mine Areas * Acid Mine Drainage
OTHER STATE AGENCIES	
Wyoming Oil and Gas Conservation Commission (OGCC) Casper: 307-234-7147	* Oil & Gas Wells * Oil and Gas Production, Refining, Transport (Pipelines) & Storage Facilities
Wyoming State Geologic Survey Laramie: 307-766-2286	* General Geologic information * Geologic and Topographic Maps * Mineral Production and Reserves
Wyoming State Engineer's Office (SEO) Groundwater Division Cheyenne: 307-777-6163	* Well Completion Reports; Permits for water supply wells and monitoring wells * Ground Water Resource Information
Wyoming Department of Agriculture Technical Services Cheyenne: 307-777-6590	* Certification of Pesticide Applicators * Pesticide and Fertilizer Best Management Practices (BMPs)
Wyoming Department of Transportation (DOT) Maintenance Dept. Cheyenne: 307-777-6590	* Identification of DOT Storage Sites of regulated and non-regulated substances (e.g., salt) * Hazardous Cargo Shipments and Routes * Chemical Usage Locations * Aerial Photography Services
Wyoming Water Resource Center (WWRC) Laramie: 307-766-2143	* Groundwater Sensitivity Maps and Aquifer Vulnerability Maps * Water Quality Databases * Wyoming Water Bibliography
LOCAL/COUNTY AGENCIES	
County Health Departments	* Private small On-Lot Sewage Disposal Permits (e.g., septic tanks, leach fields) * Private Well Testing * Pollution Investigations
Weed & Pest District Offices	* Pesticide use data; Pesticide Best Management Practices

Table III-2

AGENCY	INFORMATION AVAILABLE
Road and Bridge Departments	* Guidelines for Road De-Icing, Chemical Storage & Application * Location of Hazardous Materials Storage and Use * Location of Road Salt Storage and Use
Local Emergency Planning Committees (May be part of Sheriffs Office/Fire Departments)	* Hazardous Materials Inventory * Spill, Leak and Accident Reports * Location of Hazardous Materials Storage and Use * Contingency Plans
Zoning and Planning Commissions	* Waste District Planning * Previous Pollution Source Inventories & Other Resource Evaluation Studies * Base Maps and Copies of Ordinances and Zoning Studies * Zoning and Land Use Maps
Agriculture Extension Service	* Education on Agriculture Best Management Practices, Well Construction and Maintenance, On-Lot Sewage Systems
Conservation Districts	* Technical Assistance & Agricultural Best Management Practices & Pollution Abatement Measures
Fire Marshall/Local Fire Departments	* Records of Underground Storage Tanks for Flammable and Other Potential Fire Hazards * Reports & Locations on Pollution Incidents Involving Toxic, Hazardous or Flammable Substances
City/County Engineers; Local Building, Zoning, & Utility Departments; Board of Public Utilities	* Building Permits, Inspection Records * Sewer, Water & Gas Lines * Zoning & Plat Maps * Proposed Utility Expansion Location
Waste Water Treatment Plant	* Location of Wastewater Treatment Ponds and Lagoons * Storage Location of Treatment Chemicals
City/County Engineers	* Locations of Water & Sewer Distribution Lines; Wastewater Discharge Locations
OTHER ENTITIES	
Local Golf Courses	* Storage Sites for Pesticides/Herbicides * Areas of Pesticide/Herbicide Application
Local Chamber of Commerce and Better Business Bureau	* Business/Industry Directory

Table III-2

AGENCY	INFORMATION AVAILABLE
Libraries University of Wyoming Geologic Library ("Fee for Service") Laramie: 307-766-3374	* Maps * Aerial Photographs * Documents * Larger Libraries may be connected to CARL (the on-line catalog of the University of Wyoming Library System)
Historical Society	* Historic Maps * Aerial Photographs * Other Records of Possible Interest
USDA's Agricultural Stabilization & Conservation Service (ASCS): Aerial Photo Field Office 2222 W 2300 S. St Salt Lake City, UT 801-524-5856	* Aerial Photographs
U.S. Geological Survey (USGS) Water Resources Division Cheyenne: 307-778-2931 National Mapping Office Denver: 303-236-7477	* Hydrogeologic Maps, Reports and Information * Geologic Maps, Reports and Information * Topographic Maps and Information
Federal Emergency Management Agency (FEMA)	* Flood Plain Maps (100-500-year flood areas)
U.S. Coast Guard-National Response Center Second Coast Guard District St. Louise, MO 314-425-4655	* Records of Reported Releases of Hazardous substances (e.g., from highway accidents)
USDA's Natural Resource Conservation Services (NRCS) (Formerly SCS)	* Soil-type Maps with Coverage of all of Wyoming

Table III-2

Federal Databases

CERCLA INFORMATION SYSTEM *(CERCLIS)*

Description: An inventory of potential hazardous waste sites in the United States. CERCLIS covers incidents of hazardous chemical spills as well as hazardous waste sites nominated or selected for cleanup under the provision of the Superfund Amendments and Reauthorization Action 1986 (SARA).

Developed by:

US EPA
Office of Emergency & Remedial Response
Office of Solid Waste & Emergency Response

Contacts:

FOI Office (A-101)
US EPA
401 M. Street, SW
Washington, DC 20460
(202)260-4048

US EPA
401 M. Street, SW
Washington, DC 20460
(202)260-9833

CERCLIS Hotline
(202)260-0056

US EPA Region VIII
(800)227-8917

Information Available:

- **Site identification**: EPA identification number, name, alternate name (if applicable), geographic location (e.g., street address, city, county, State, and ZIP code, EPA Region
- **Action taken at the site**: pre-cleanup investigations, cleanup activity status, and for some sites, descriptions of environmental problems encountered. During the Preliminary Site Investigation, if the site is found to pose no environmental threat and require No Further Action, a NFA flag appears in this column
- **Project dates**: actual start and completion dates
- Lead agencies
- **Off-site waste transfer information**: names and addresses of wastes transferred, estimated amounts transferred, and basis for these estimates

TOXIC CHEMICAL RELEASE INVENTORY *(TRI)*

Description: TRI contains a compilation of the annual toxic chemical release reports required under Section 313 of the Emergency Planning and Community Right-to-Know Act.

Developed by:

US EPA
Office of Toxic Substances
Emergency Response Division

Contact:

Information Management Division
Public Data Branch (TS-793)
US EPA
401 M. Street, SW
Washington, DC 20460
(202)260-8680

US EPA Region VIII
(800)227-8917

Information Available:

- **Facility identification**: name, address, public contact number, Dun & Bradstreet (D&B) number, and EPA Identification Number
- **Substance identification**: names, uses, Chemical Abstracts Service (CAS) Registry Number, and maximum amount onsite
- **Environmental release information**: estimates of the amounts of chemicals released into the air, water, land, and injected underground, and the source of these releases
- **Waste treatment information**: condition of the general waste stream, method, treatment efficiency, and waste minimization data
- **Off-site waste transfer information**: names and addresses of wastes transferred, estimated amounts transferred, and basis for these estimates

Table III-2

RCRA INFORMATION SYSTEM *(RCRIS) (replacing HWDMS)*	
Description: This database contains permitting and compliance monitoring activities for all generators, transporters, and Treatment, Storage and Disposal facilities.	
Developed by: US EPA Office of Planning, Policy & Information and Office of Solid Waste ***Contacts:*** US EPA 401 M. Street, SW Washington, DC 20460 (202)260-2670 US EPA Region VIII (800)227-8917	***Information Available:*** • Information on waste types • Estimated annual quantities • Management processes • Data derived from Part A permit application
HAZARDOUS MATERIAL INCIDENT REPORTING SYSTEM	
Description: This database provides a statistical compilation of all accidents and incidents involving hazardous materials. The system contains the following:	
Developed by: US Department of Transportation Research & Special Programs Administration Information Systems Branch ***Contacts:*** US Department of Transportation Research & Special Programs Administration Information Systems Branch DHM-63, Room 8112 401 M. Street, SW Washington, DC 20460 (202) 366-4555	***Information Available:*** • Information on each reported incident • Data elements: the data of the accident, location, shipper, carrier, commodity involved and other detailed information concerning the packaging and nature of the incident.

FEDERAL REPORTING DATA SYSTEM *(FRDS)*	
Description: FRDS organizes and stores information on public water supply systems (PWSS).	
Developed by: US EPA Office of Drinking Water ***Contacts:*** US EPA Region VIII Office of Drinking Water Denver (800)227-8917	***Information Available:*** • Inventory information, including physical characteristics of water supply, well-specific information, location and source of well • Compliance-related information, including violations, enforcement actions, variances, and exemptions

The following are examples of additional types of local information that can be used to screen for existing and potential contaminant sources within the WHPA, and are recommended for use in completing *'Source Identification'* forms and developing the *'Source Inventory'* list (described below):

- ☐ Zoning, fire insurance and other maps
- ☐ City/county permits, licenses, registrations
- ☐ Aerial photographs
- ☐ Chamber of Commerce membership lists
- ☐ Telephone and business directories
- ☐ Community planning, public works, engineering and health departments
- ☐ Police and Fire Departments
- ☐ Long-time residents of the community
- ☐ Local Emergency Planning Committees[7]

2. Identify 'potential' sources for further study:

A good map to consult when investigating potential sources is the town's map of the community sewer service network. The intent of the sewer network is to collect and transport raw waste to the sewage treatment plant where it can be treated prior to disposal. When a map of potential contaminant sources is compared to a utility map indicating where the sewers are, it will become obvious where to look for existing and/or potential discharges to groundwater - at those sources not served by the sewer network. City/town engineers also should be consulted to identify portions of the sewer system network that are known or suspected to have failed or are in need of repair.

Current zoning maps and aerial photos assist in identifying the various types of activities which may be occurring within the wellfield area. Comparison of current maps and photos with older versions often illustrates historical practices or sources which may have impacted groundwater or warrant closer study. Aerial photos usually are available through the local NRCS, survey firms, or historical archives in community libraries.

Additional sources of information documenting past and present land uses include 1) local registries of commercial and industrial activities; 2) property transfer records, titles and deeds; and 3) senior citizen interviews regarding locations and practices of historic sources which are no longer in existence.

The following steps discuss procedures which should be implemented to further refine and develop the *Source Inventory* list:

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[7] The Emergency Planning and Community Right-to-Know Act of 1986, enacted as Title III of the Superfund Amendments and Reauthorization Act (SARA) requires the owner or operator of any facility to prepare a list of any "extremely hazardous" substances on hand in amounts of 2 pounds or more. In addition, certain releases of hazardous chemicals to the environment must be reported. Title III establishes a network of State Emergency Response Commissions and Local Emergency Planning Committees charged with planning for responses to such releases. In Wyoming, most Local Emergency Planning Committees reside at the County level, although some larger communities also have their own committee.

3. Access Unknown Sources:

'Known' sources are those that already are included in files or data bases, while ***'unknown'*** sources generally are not subject to regulatory controls or have not been brought to the attention of authorities due to oversight or lack of concern. Collecting information on unknown sources generally requires some type of survey to collect information of concern for WHP. This step also provides an opportunity to check information obtained from other sources and to obtain information about previously identified sources that warranted further study. The most thorough and effective way to obtain additional and new information on potential sources usually is through one or more of the following survey types[8]:

- ☐ Mail surveys
- ☐ Telephone surveys
- ☐ Door-to-Door surveys
- ☐ Field searches ("Walking Tours")
- ☐ Windshield surveys
- ☐ Personal interviews

One, or a combination of the survey types listed above must be used to refine and develop the Source Inventory list. *WHP plans must identify the type of survey(s) implemented and discuss the measures which were taken to ensure thorough and complete survey coverage within the WHPA.*

4. Verify accuracy and reliability of the information gathered on 'Known' and 'Unknown' Sources:

One of the best ways to ensure accuracy of information gathered during source identification is through field checking via "walking tours" or windshield surveys. Information collected through personal interviews can be verified by actual site visits. Telephone confirmation can be useful where a source facility is unmanned (e.g. oil wells). Cross-checking existing databases with any of the survey approaches described above is an acceptable way to verify information on existing and potential sources.

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[8] The procedures, advantages and disadvantages of the surveys listed below are described in detail in EPA's "Guide for Conducting Contaminant Source Inventories for Public Drinking Water Supplies", EPA, 570/9-91-014, December, 1991.

III. Describe sources within the WHPA:

1. Complete *Source Identification* forms (See Model Form III-1: Appendix H) for each existing and potential source of contamination identified within the WHPA:

Form III-1 (Source Identification Form) is a model form recommended for use by communities performing source inventories.

At a minimum, a form containing the following information must be completed and maintained for each source identified:

- ☐ Source owner/operator name and location (by address or latitude/longitude).
- ☐ Source type (from Table III-1) and WHPA Zone in which it is located.
- ☐ Source Priority Method and Rank (described below).

Completed *Source Identification* forms must be included in the WHP plan.

IV. Develop the *Source Inventory* list from completed *Source Identification* forms:

Using information from the completed *Source Identification* forms, the *Source Inventory* list is developed.

The *Source Inventory* list must contain:

- ☐ The same minimum of information as that required on the *Source Identification* forms (above), including each source's priority rank as determined from one of the methods described below. Sources must be grouped by the WHPA Zones in which they are located.
- ☐ A description of the WHPA or WHPAs to which the inventory applies;
- ☐ The date of completion of Source Identification data collection and survey(s):
- ☐ A statement describing the timing of completion of the *Source Identification forms* with respect to the date of completion of the WHPA delineation and *identification of the Source Inventory as either 'Preliminary' or 'Final'*.*

* *Source Inventory lists developed from Source Identifications based upon an estimated WHPA, or which are developed from Source Identifications completed prior to delineation of the WHPA are **'Preliminary'** Source Inventory lists; a statement must be included that describes when and how the 'Preliminary' list will be updated (to a **'Final'** Source Inventory) upon delineation of the WHPA (as described in Section II) to ensure that the entire area within the delineated WHPA has been inventoried.*

A 'Final' Source Inventory list can be completed within one (1) year of completion of the WHPA delineation for which it was developed and still be considered valid by WDEQ/WQD.

Upon completion, information from the *Source Inventory* list should be used to complete Parts V and VII of the "Susceptibility Assessment Form" (Appendix F).

V. Prioritize sources within the WHPA for management purposes:

In order to evaluate the relative degree of risk that individual sources identified on the *Source Inventory* list pose to PWS wells, each source must be ranked (prioritized) according to one of the following methods:

- ☐ Distance or TOT to nearest public drinking water supply well;
- ☐ The 'sensitivity' of the uppermost aquifer underlying the source (as determined from *'Aquifer Sensitivity'* maps)[9].
- ☐ The number of residents served by the nearest public drinking water supply well that could be impacted;
- ☐ The susceptibility of the well, as determined from the 'Susceptibility Assessment Form' (Appendix F);
- ☐ Ranking as determined from source prioritization worksheets available in EPA's *"Managing Ground Water Contamination Sources in Wellhead Protection Areas: A Priority Setting Approach"*.

Prioritization of sources is intended to provide the WHP Management Committee an efficient and effective guide in developing and implementing source management approaches (e.g. site inspections, monitoring, data collection, education, etc.) to protect the well or wellfield from contamination.

VI. Transfer source location and information to WHPA delineation maps:

Once all potential sources have been identified, each source must be plotted on a 'Source Overlay' map of the WHPA delineation map (see Section II). The map must distinguish between **'existing'** and **'potential'** sources as defined at the beginning of this section. Each source must be identified by a number that links the map location to the information on the *Source Inventory* list. Different symbols or colors should be used to differentiate between source types, both existing and potential. The Source Overlay must be identified as either 'Preliminary' or 'Final', according to the definitions used above.

VII. Update, Refine and Expand *Source Inventory* information:

- **Expanding *Source Inventory*:**

Reasons to expand the *Source Inventory* include: 1) new categories (Table III-1) are identified; 2) new sources (Form III-1; Appendix H) are identified, and; 3) new information is obtained on inventoried sources.

- **Updating Information:**

Methods to update the *Source Inventory* list include: 1) periodic review of existing inventory database material and other information on existing and potential sources of contamination available from local, state and federal agencies, and other public information, and; 2) periodic performance of surveys. The *Source Inventory* list must be updated at least every two years

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[9] See Footnote #2.

(see Section VIII of this document), using any combination of the methods described earlier in this Section.

- **Refining Information:**

Communities are encouraged to convert *Source Inventory* data to more useable forms. Methods to accomplish this objective include: 1) standardize data collection methods; 2) organize data by source priority ranking, contaminant of concern, contaminant TOT to the well, etc., and; 3) development of computer databases for efficiency in tracking, organizing and querying source information (data) sets.

- **Data Bases:**

Development of a computerized data base on potential sources of contamination within each WHPA is strongly recommended in preference to a manual data base. The types and qualities of data that are to be incorporated into the data base should be specified and evaluated. Data base design involves the formation of a conceptual model of the data (i.e., relationships between different data fields) taking into account all the basic facts and constraints under which the data base will have to operate. Once a data base design is selected, detailed decisions are made on the logistic and physical organization and the layout of data records to facilitate the entering of data to create the data base. Finally, through the data base monitoring phase, the data management system can be fine tuned and modified to increase the effectiveness and efficiency of the system for data retrieval and analysis.

The primary objective of developing a data base is to enable the analysis and processing of data to reveal relationships among various facts and situations. The data base should contain and be organized using information on: (1) types of land-use activities; (2) the spatial location of the identified sources; (3) chemical composition of the material stored or processed at the identified sites; (4) the name of the facility and the owner or operator, and; (5) other information that may be collected as part of the survey.

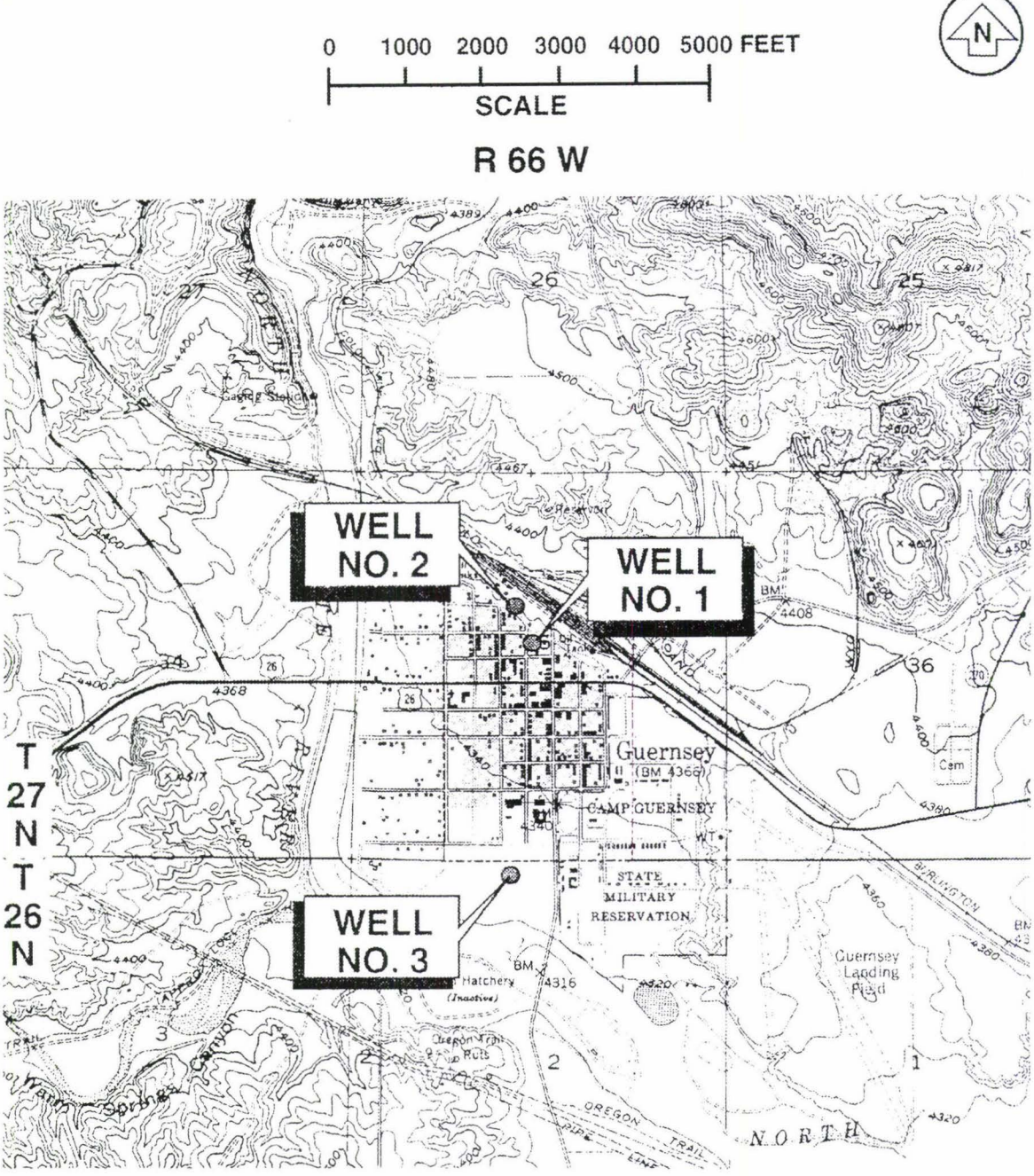
Ideally, information on potential sources of contamination should be analyzed in conjunction with hydrogeological data and water supply information to provide a basis for decision making on source reduction, aquifer protection, and water quality monitoring. A data base on the spatial distribution of chemical use and disposal is essential for evaluating the need for, type, and location of monitoring activities for potential contaminants. If a contamination event is detected, a data base on the distribution and use of chemicals would allow for a timely and efficient allocation of resources to determine the source or sources of contamination.

POTENTIAL CONTAMINATION SOURCE INVENTORY - A CASE STUDY

As an illustrative example, a basic inventory of potential contamination sources is presented in this section for the Town of Guernsey. Figure III-2 is the base map showing locations of the three municipal water supply wells. Municipal wells produce groundwater from the North Platte alluvium (CF p. 31 Section III; GW/SW Interaction Areas) located within and around the Town of Guernsey. Figure III-3 superimposes WHPAs on the base map. WHPA boundaries were delineated using the arbitrary fixed radius method at a 1000-ft radius around each water supply well. The fixed radius method for WHPA delineation was selected for illustrative purposes to step through the process of inventorying potential contamination sources. Figure III-4 shows potential contamination sources in relation to WHPAs, as discovered by a windshield survey.

Results of this delineation and inventorying process indicate of large amount of overlap of WHPAs for Well Nos. 1 and 2 within the Town, while Well No. 3 is more remotely located. For this example, it may be simpler for management purposes to combine WHPAs for Well Nos. 1 and 2, and treat as a single WHPA (refer to Figure III-3).

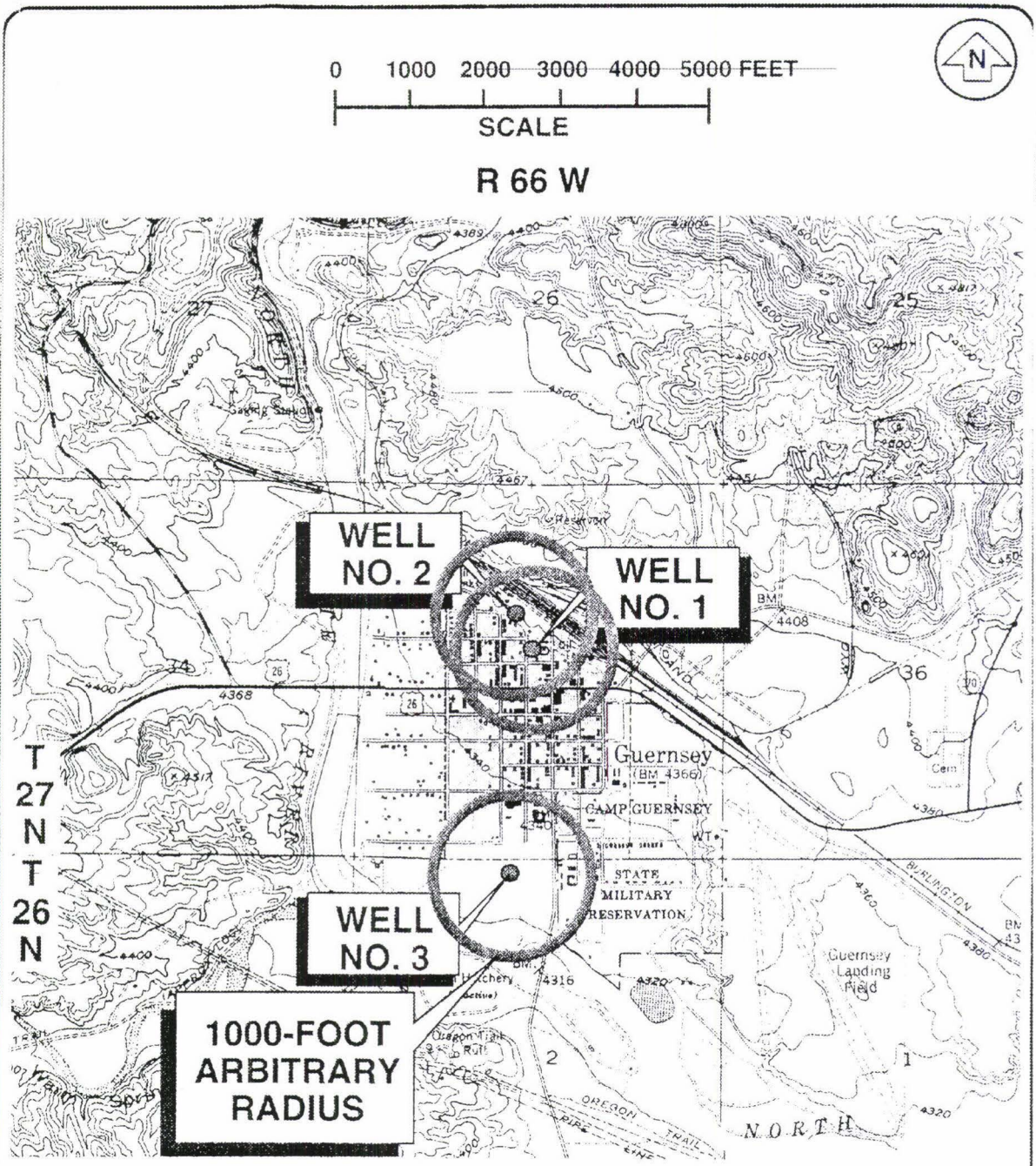
Although this preliminary inventory is based on a cursory, windshield survey, it is interesting to note the density of potential contamination sources is roughly similar for all wells, whether they are within the Town's boundary or located in an outlying, rural area.



Base Map Adapted From U.S.G.S. Guernsey and Guernsey Reservoir 7.5 Minute Topographic Quadrangles, 1978

TOWN OF GUERNSEY WATER WELLS
EXAMPLE OF WHPA DELINEATION AND
POTENTIAL CONTAMINANT SOURCE INVENTORY

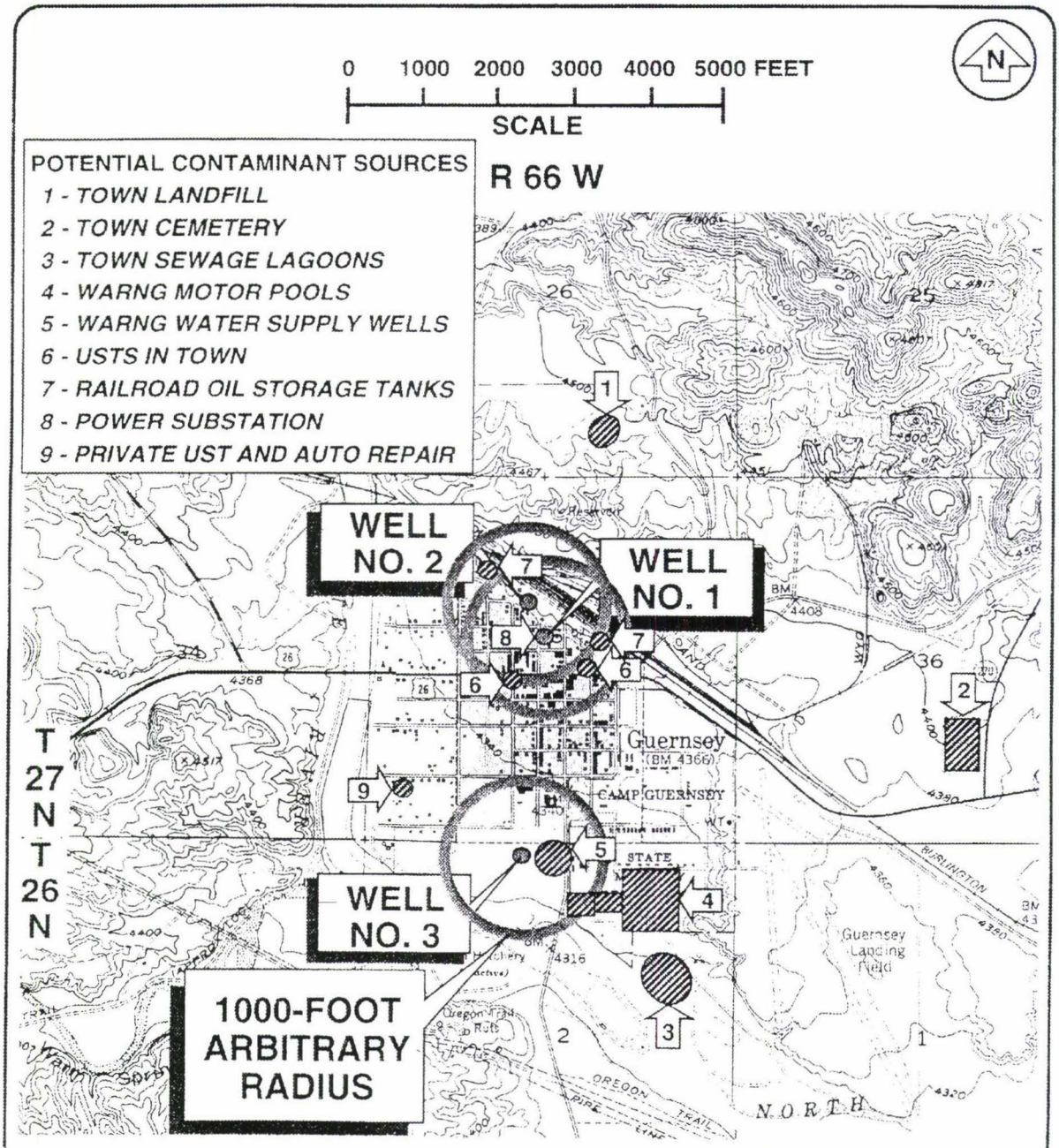
FIGURE III-2



Base Map Adapted From U.S.G.S. Guernsey and Guernsey Reservoir 7.5 Minute Topographic Quadrangles, 1978

TOWN OF GUERNSEY WATER WELLS
EXAMPLE OF WHPA DELINEATION AND
POTENTIAL CONTAMINANT SOURCE INVENTORY

FIGURE III-3



Base Map Adapted From U.S.G.S. Guernsey and Guernsey Reservoir 7.5 Minute Topographic Quadrangles, 1978

TOWN OF GUERNSEY WATER WELLS
EXAMPLE OF WHPA DELINEATION AND
POTENTIAL CONTAMINANT SOURCE INVENTORY

FIGURE III-4

SECTION IV

POTENTIAL CONTAMINANT SOURCES: WHPA MANAGEMENT STRATEGIES

Introduction:

Subsection 1428(a)(4) of the SDWA requires each state to:

> "describe a program that contains, as appropriate, ... implementation of control measures .... to protect the water supply within wellhead protection areas from such contaminants...".[1]

The underlying objective of WHP is to prevent contamination of the drinking water supply. Therefore, management of contaminant sources is an essential component of WHP. Communities have many tools at their disposal for the management of potential contamination sources. These may include:

- **Regulatory Management Strategies:**

  - Ordinances;
  - Sole source aquifer designation;
  - Source prohibition and permits;
  - Subdivision regulations and codes;
  - Land use agreements;
  - Tax incentives;
  - Design and operating standards;
  - Site plan review;
  - Purchase of property and development rights, and;
  - Inspectors at construction and drilling sites.

- **Non-Regulatory Management Strategies:**

  - Best Management Practices (BMPs);
  - Memorandum of Agreement or Understanding (MOA/MOU);
  - Training;
  - Water conservation programs;
  - Household hazardous waste collection programs;
  - Public education programs (news releases, brochures, etc.) , and;
  - Surface and groundwater monitoring.

Appendix I (*"Summary of Wellhead Protection Tools"*) illustrates a variety of both regulatory and non-regulatory source management approaches, including: their applicability to WHP; legal constraints; and administrative considerations.

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1 "Guidance for Applicants for State Wellhead Protection Program Assistance Funds Under the Safe Drinking Water Act", EPA, 440/6-87-011, June, 1987.

Each WHP plan must describe the techniques that will be implemented employed to manage and minimize the threats posed by the contamination sources identified in the Source Inventory (see Section III and Appendix J).

Management Strategies -- Selection Concerns

As part of the WHP plan development process, a host of concerns may arise regarding the selection of the most appropriate management strategies. Thorough consideration of all potential concerns should be given to all prospective management approaches prior to selection to ensure that only the most suitable management controls are implemented. The WHP Management Committee may propose to manage WHPAs in a variety of ways. Factors such as the size of the WHPA, the relative risk posed by the potential and known contaminant sources within the WHPA, the characteristics of the chemicals used, and the source management techniques already in place should be considered when evaluating source management approaches. The WHP Management Committee should address the following questions when selecting management strategies:

- Is cost a factor in implementing this strategy? If so, what is the cost?
- Is manpower and expertise available from existing resources?
- Is the strategy compatible and consistent with existing management approaches?
- Will the strategy afford the degree of control or risk reduction desired?
- Will the strategy conflict with existing laws, regulations, ordinances, or programs?
- Will the strategy be supported by the community?

Often a mix of management techniques is used to customize WHP management strategies to best fit the unique needs of a particular community's PWS. Also, the management techniques may vary, based upon the WHP Zone under consideration. For example, a PWS might choose to use an educational program to reduce risk in Zone 3, a zoning system to manage Zone 2, and a land purchasing system or zoning ordinances to immediately reduce threats in Zone 1.

As mentioned in Section III, *Groundwater Sensitivity* maps are very useful in helping to identify those parts of Wellhead Protection Areas where the aquifer is most susceptible, or 'sensitive', to a contaminant release at, or near, the ground's surface. Logically, potential and known contaminant sources within these areas might warrant different management approaches than those applied to areas where the aquifer is not as 'sensitive'.

Many communities find that political boundaries are easier to manage than areas delineated as WHPAs. Consequently, communities are encouraged to establish political boundaries, or WHP 'overlay' districts that coincide with WHPA boundaries. Since many source management strategies are difficult, if not impossible, for communities to implement outside of their own jurisdiction, it is recommended that communities coordinate management plans and activities with county governments to work collectively under a joint management agreement.

"Wellhead Protection Programs: Tools for Local Governments" (EPA 440/6-89-002) should be consulted to more thoroughly assess the ramifications of individual management strategies. This technical assistance document fully describes each management strategy and discusses

the limitations, constraints, and legal issues associated with each approach. Examples of the ways in which some communities are using management controls to protect groundwater are highlighted in the text.

The potential and known contaminant source priority ranking established upon completion of the Source Inventory list (see Section III) must be used to assess the reasonable perceived relative degree of risk posed by particular contaminant sources.

Once the relative degree of risk of a contaminant source is established more effective management strategies can be developed, focusing on those sources with the greatest risk, or potential risk, to the drinking water supply. Under this approach, where the level of management is commensurate with perceived risk to the groundwater resource, the highest degree of protection (through management strategies) should be afforded to nearby Zone 1, while Zone 3, farther away from the wellhead, may have a lower degree of management applied. Generally speaking, local regulatory management strategies afford a greater degree of protection, as compared to non-regulatory methods.

'Buffer Zones' for recharge areas lying outside of Zones 1,2 and 3:

The buffer zone is an area up gradient of Zone 3. It can extend outward to include the entire ZOC or may focus on selected areas of concern such as recharge areas or locations where the aquifer may be exposed at, or near, the surface. A buffer zone should be used to provide an area of added protection to the WHPA, particularly to WHPAs for wells and springs developing groundwater from karst, fractured or faulted aquifers. This zone affords important protection to recharge areas beyond the WHPA boundaries, and can provide information on potential and known contaminant sources outside Zone 3 which have released, or have the potential for releasing contaminants into the wellhead protection area.

Analysis may show the need for contingency plans to respond to uncontrolled surface discharges that may travel overland to enter a stream located in or adjacent to the WHPA. It may also identify other non-contiguous critical aquifer recharge areas requiring some from of protection.

Table IV-1 illustrates one approach for managing potential contamination sources that may be employed by local governments to protect their drinking water supplies. In this illustration, the stringency, or degree, of management is based upon the perceived risk that a contaminant source might present due to its distance from, or proximity to, the wellhead. In this example, higher rankings illustrate management approaches that typically offer the highest degrees of protection to the wellhead and/or drinking water aquifer and should be considered for areas closest to the well (i.e. Zone 1). Conversely, it is generally reasonable to expect that management approaches can become less stringent as the distance from source(s) to the well increases.

Table IV-1

LOCAL STRATEGIES FOR MANAGING POTENTIAL CONTAMINANT SOURCES

Rank	Zone 1- Accident Prevention Zone	Zone 2 - Attenuation Zone	Zone 3 - Remedial Action Zone	Recharge Area
1	Direct Ownership	Municipal Ordinance/Land Use Agreement	Municipal Ordinance/Land Use Agreement	Municipal Ordinance/Land Use Agreement
2	Source Prohibition	Source Prohibition	Inspections	Site Plan Review
3	Zoning	Zoning	Site Plan Review	Water Quality Monitoring
4	Operating and Design Standards	Operating and Design Standards	Best Management Practices	Best Management Practices
5	Land Use Agreements	Memoranda of Understanding	Memoranda of Understanding	Memoranda of Understanding
6	Easements	Public Education	Public Education	Public Education

Groundwater Monitoring in Wellhead Protection Areas (WHPAs):

Groundwater monitoring in WHPAs is a highly recommended management approach. A good groundwater monitoring program can provide an 'early warning' prior to the arrival of contaminated groundwater at the well. The monitoring wells should be located such that an early warning would provide enough lead time to either intercept the in-coming contamination before it can reach the well, or arrange for an alternate drinking water supply or treatment. The groundwater monitoring program should include periodic monitoring of groundwater for suspected or known contaminants that may be finding their way toward a drinking water supply well.

Groundwater monitoring would also serve as a way to measure the effectiveness of source management strategies. For example, the effectiveness of Best Management Practices (BMP's) implemented for fertilizer and/or pesticide applications to agricultural land could be evaluated with a groundwater monitoring program. Groundwater monitoring is also recommended when WHPA's lie within residential areas to evaluate the effects, if any, on the drinking water aquifer from septic systems, pesticide and fertilizer applications, etc.

To reduce costs, it may be possible to collect groundwater samples from existing wells (i.e., domestic, irrigation, etc.) although monitoring wells also might be needed where there is a need for monitoring but no existing wells are present. The WHP plan may consider the need to have potential contaminant sources that are susceptible to leaks or spills of contaminants conduct self monitoring of groundwater quality.

Developing and Documenting Existing and Proposed Management Strategies:

The 'Potential and Known Source, Hazards, Controls, Assessment, and Management Form' (Form IV-1: Appendix J) is provided as a worksheet to list existing controls and possible management strategies to ensure that potential and known sources identified within the WHPA are adequately managed. Using this Form, the WHP Management Committee should identify existing controls, assess the adequacy of existing controls, and describe management strategies and implementation dates for individual potential and known sources within the WHPA.

A completed 'Potential and Known Source, Hazards, Controls, Assessment, and Management Form' (Form IV-1: Appendix J) must be submitted for each potential and known contaminant source identified on the 'Source Inventory List' (see Section III).

Identification of Existing Local, State and Federal Source Management Authorities:

Table III-2 in the preceding section of this document lists many local, state and federal agencies that have existing authorities for management of certain types of contaminant sources and provides contact telephone numbers for these agencies. State agency responsibilities or authorities for managing specific sources (potential and known) of contamination are further described in Section III (*'State Sources of Information'*). When appropriate, these agencies may be cited as a component of the PWS's management strategy for a potential and known contamination source.

Federal and state agencies that manage public lands or regulate potential and known contaminant sources within WHPAs will coordinate with local governments to assure adequate management. Federal lands in Wyoming are managed by the U.S. Department of Agriculture, Forest Service; the U.S. Department of Interior, Bureau of Land Management, Bureau of Reclamation and Park Service. The recharge region of many groundwater resources developed as community drinking water supplies for many Wyoming communities often lie in areas under federal agency jurisdiction.

Local Authority to Protect Drinking Water Supplies:

Activities that are undertaken by counties and municipalities to protect drinking water sources or manage WHPAs are grounded in existing state law. Specifically, state statutes listed on Table IV-3 provide authority to counties and municipalities to regulate certain activities for public health, safety and general welfare.

Table IV-2

Possible Statutory Tools for Local Governments[1]

To Protect the Quality of Their Drinking Water and Well Field Areas

	1st Class Cities[2]	Incorporated Towns & Cities (Not 1st Class)	Counties	Water Districts
Zoning	15-1-601	15-1-601	18-5-105	
Regulations Ordinances or Rules	15-1-103(a)(xxxi) 15-1-103(a)(xli) 15-3-202 15-7-101(a)(ii) 15-7-704 15-7-707(a) 35-11-304	15-1-103(a)(xxxi) 15-1-103(a)(xli) 15-7-101(a)(ii) 15-7-704 15-7-707(a) 35-11-304	18-2-101(a)(vi) 18-5-201 35-11-304	 35-11-304
Inter-Governmental Agreement	16-1-105	16-1-105	16-1-105 18-2-101(a)(iv)	16-1-105 41-10-113(a)(vi) 41-10-113(a)(xi)
Land Acquisition	15-1-103(a)(iii) 15-7-101(a)(ii)	15-1-103(a)(iii) 15-7-101(a)(ii)	18-2-101(a)(ii)	41-10-113(a)(xiii)

(1) This is the WDEQ's perception of the various tools available to local entities to protect drinking water sources. This document is not intended as legal advice, and WDEQ does not intend to imply that actual authority exists. Each entity must consult with its legal counsel to ensure that authorities exist and are properly administered.

(2) A First Class City is any city or town with more than 4,000 residents and this fact has been certified to the governor by the mayor; the governor shall declare it by proclamation a First Class City.

Provisions explained:

15-1-103(a)(xxxi)
Cities and towns may regulate water sources within the city or town.

15-1-103(a)(xli)
Cities and towns may enact ordinances, regulations, resolutions to protect the health, safety and welfare of the city or town.

15-1-103(a)(iii)
Cities and towns may purchase land.

15-1-601

Cities and towns may zone to promote health and general welfare and to facilitate adequate provisions for water.

15-3-202

The mayor of a first class city has jurisdiction, if vested by ordinance, over all places within five miles of the corporate limits of the city for the enforcement of health.

15-7-101(a)(ii)

Jurisdiction of the city or town extends up and along the entire distance of the source of supply for the water works. Cities and towns may enact ordinances and regulations for the protection of the water works. Cities and towns may acquire property beyond corporate limits to prevent pollution or injury to the water works.

15-7-704

Cities and towns may protect the domestic water from pollution. To do this, the jurisdiction of the city or town extends over the entire area of the water works, even if outside the city or town.

15-7-707(a)

Cities and towns may enact ordinances to protect the water works.

16-1-105

Any two counties, cities, towns, or special districts may enter into agreements with each other. They may create a joint powers board.

18-2-101(a)(ii)

Counties may purchase property.

18-2-101(a)(iv)

Counties may make contracts.

18-2-101(a)(vi)

Counties may establish surface water drainage systems and drainage management.

18-5-105

Counties may zone to promote public health, safety and welfare of the citizens of the county.

18-5-201

Board of County Commissioners may regulate to promote the public health, safety and general welfare of the county.

35-11-304

WDEQ/WQD may delegate the enforcement and administration of 35-11-301(a)(iii) & (a)(v) to cities, towns, counties, and water and sewer districts.

41-10-113(a)(vi)

Water districts may make contracts, within or without the district, to abate or reduce pollution caused by facilities.

41-10-113(a)(xi)

Water districts may make contracts.

41-10-113(a)(xiii)

Water districts may acquire property.

To avoid possible confusion, a local WHP plan should identify the agency, board, or government entity with authority and jurisdiction over management strategies involving rules or ordinances. A guideline for developing a drinking water protection (i.e WHP) ordinance is provided in Appendix L.

Copies of any ordinances, memoranda of understanding, permits, and land use agreements and similar source management controls should be appended to the WHP plan.

SECTION V

PLANNING FOR THE FUTURE: CONTINGENCY PLANS AND PLANS FOR SITING NEW WELLS

Introduction:

Subsection 1428(a)(5) of the Safe Drinking Water Act (SDWA) requires that state WHP plans include Contingency Plans:

> "for the location and provision of alternate drinking water supplies for each public water system in the event of well or well field contamination..."[1]

"When a natural disaster strikes, an unprepared water system is no more immune from destruction than any other structure. However, preventive measures can be taken, both economically and structurally, to ensure that a water system minimizes the amount of damage inflicted by any future tornadoes, hurricanes, fires, floods, earthquakes, and other natural disasters. Returning a water system to normal operation is essential to protecting public health and aiding the community's recovery process.

Since natural disasters usually offer little or no advance warning, it is important that water systems be prepared for nature's destructive forces. And though some regions of the country are more prone to certain types of natural disasters, no place on earth is disaster-free, so water officials everywhere should expect the unexpected.

For this reason alone, water systems should develop an emergency response plan to prepare for natural disasters, limit damage, and expedite recovery. Many small water facilities simply do not have the resources to take such elaborate preventive measures. There are, however, agencies at the local, State, and federal levels that can help water facilities of all sizes prepare for and recover from natural disasters.

There are several measures all water systems can take to lessen the impact of disaster. Some of the more important measures include having an emergency preparedness guide for your utility and your customers and making sure you have adequate financial reserves for general repairs and equipment replacement. Systems should also make sure there are plenty of repair parts available and that all emergency back-up equipment functions properly.

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1 "Guidance for Applicants for State Wellhead Protection Program Assistance Funds Under the Safe Drinking Water Act", EPA, 440/6-87-011, June, 1987.

More specifically, ...water utilities should:

- establish emergency contacts; Chain-of-Command; lines of communication;
- provide for an emergency power source;
- waterproof sensitive electrical components;
- have extra chemicals on hand for plant start-up;
- protect office records, electronic equipment, computers, etc; and
- make sure all elevated storage tanks and reservoirs are filled to capacity and are secure.

Keeping good records is one of the most important emergency preparations a water system can make. This will help the system's efforts in assessing damage and evaluating restoration costs. Videos and photographs are excellent tools to inventory assets before a disaster and to document damage afterward.

Depending on where your water system is located and what type of disaster it's likely to face, the system will have to customize its emergency management plan to meet the system's most immediate needs before and after a natural disaster. Organizations such as the Federal Emergency Management Association (FEMA) and the American Water Works Association have created emergency management manuals for designing emergency preparedness plans for water systems."[11] The National Rural Water Association has also created an emergency management manual. See Appendix C for contact information.

CONTINGENCY PLANNING:

Contingency Plans address problems that PWSs may need to overcome in the event of water supply shortages or a contamination incident that impacts the system's ability to supply an adequate quantity of safe drinking water to the public. Contingency Plans should focus on the identification of problems that may arise if protective and preventative measures fail, and solutions to resolve those potential problems. Contingency Plans help communities answer questions such as:

- Based upon prioritization of the Contaminant Source Inventory list (see Section III), what are the most likely and significant threats to local water supplies?

- What specific steps should be taken to address existing and/or potential threats?

- Who is responsible for each step in responding to emergency situations, and how will response actions be coordinated?

- Where can temporary and permanent replacement water supplies be obtained, if needed?

- Where can technical, logistical, and financial resources be obtained?

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[11] Canody, J. 1997. "When Natural Disasters Strike: Is Your Water System Prepared?". *Water Sense*, Vol. 3, Issue 1. Nat'l. Drinking Water Clearinghouse.

WHP Contingency Planning Team:

Establishment of a planning team to develop the Contingency Plan is recommended. When forming the WHP Contingency Planning Team it is essential to include representatives from the various local agencies and community interests that would have a role to play in the case of an emergency. The following officials or representatives should be represented on the Planning Team:

- Mayor or City Administrator
- County Commission
- City/County Public Works Director
- City/County Engineer
- City/County Planner
- Fire and Police Departments
- "Hazmat" or Civil Defense response team
- Local Emergency Planning Committee
- County Emergency Planning Coordinator (see Appendix M)
- County Health Department
- Water system operator
- Local power company
- Heavy equipment contractors and operators
- Water testing lab
- Hospital
- Representative(s) from business and industry

Although the size of the team will vary with the size and characteristics of the community, the basic goal should be to provide for broad community participation in the planning process. The team should pick a leader (e.g. Emergency Coordinator) who will be capable of contacting, mobilizing and coordinating the team's work during an emergency situation. When the team defines potential 'problem' scenarios, specific duties will be more clearly defined. It is important to assign responsibility for each potential task to an individual or group leader during the planning process, rather than waiting until an emergency situation arises.

Local contingency planning has been required since 1986 under the Federal Emergency Planning and Community Right-to-Know Act (SARA Title III). Title III establishes a network of County Emergency Management Coordinators and Local Emergency Planning Committees charged with planning response to emergency releases of hazardous chemicals.

Wyoming Emergency Management Agency (WEMA):

The Wyoming Emergency Management Agency is responsible for the coordination and implementation of the state Emergency Management Program, including the state's Event Management Plan. During an emergency or disaster, WEMA coordinates state and federal resources to support local jurisdictions.

County Emergency Management Coordinators (CEMC):

The County Emergency Management Coordinator (CEMC) reports to the County Commission and is directly responsible for the administration and operation of the county emergency management program, including the County Emergency Operations Plan. The coordinator is an excellent resource and will be an asset to any contingency planning committee. The name and phone number of the coordinator for each county is contained in Appendix M.

Local Emergency Planning Committee (LEPC):

The Local Emergency Planning Committee (LEPC) has two primary roles: 1) to prepare a local hazardous materials response plan, and; 2) to manage the paperwork flow of submissions (under SARA Title III) from industry, and their disclosure in response to requests.

Transportation Community Awareness and Emergency Response (TRANSCAER):

TRANSCAER's "Regional Approach" program creates partnerships among manufacturers, distributors and transporters of hazardous materials, and state and local community emergency planning and response groups. TRANSCAER provides resources for establishing emergency response plans and training and can help local emergency response organizations draft and test emergency plans pertaining to hazardous materials transportation. TRANSCAER is sponsored by the Association of American Railroads (Washington, D.C.), Chemical Manufacturers Association, National Association of Chemical Distributors (Arlington, VA), National Tank Truck Carriers Inc. (Alexandria, VA), American Petroleum Institute (Washington, D.C.), Hazardous Materials Advisory Council (Washington, D.C.), American Trucking Associations (Alexandria, VA), The Chlorine Institute Inc. (Washington, D.C.) And National Propane Gas Association (Lisle, IL).

Oil and Hazardous Substances Pollution Contingency Plan:

The State of Wyoming has had its *Oil and Hazardous Substances Pollution Contingency Plan* in place since 1989. The purpose of the plan is to help ensure coordination of timely, effective response activities by various state agencies and other organizations to releases of oil or hazardous substances which enter, or threaten to enter, waters of the state. The plan details the responsibilities that each involved state and federal agency will have during an environmental emergency incident.

Both the CEMC and LEPC response plans may provide a starting point for WHP contingency planning. Operation and Maintenance (O&M) manuals designed for existing systems should also contain information on contingency planning.

In addition to forming a Contingency Planning Team, an "Emergency Control Center" should be designated. The center can be as simple as a desk drawer dedicated to emergency response; the idea is to make sure that all of the information needed to implement the Contingency Plan

is organized and accessible, and that all team members are aware of where the Contingency Plan is located. The center should be equipped with copies of the team roster and the names and phone numbers of other important contacts, and all pertinent information regarding the water supply sources, appurtenances, distribution system, and storage system. A list of contractors capable of repairing the various components of the system and of suppliers who carry power generators and any other equipment that might be necessary for repairs or emergency system operation should also be compiled and kept at the "Emergency Control Center". If available, a cellular phone or radio could be kept at this location to provide a means of communication in case of a phone service outage.

Appendix N (Form V-1) contains a model form that should be used to identify and record the capacity and demand (i.e. use) for each well included within the WHP Plan. This information can usually be obtained from PWS, City Engineer or town files and/or from consultant reports such as water supply master plans. This type of inventory will assist the PWS in determining if an emergency situation likely will arise in the event that one or more drinking water sources is lost because of contamination. Schematic (construction) diagrams of the water supply system are valuable for identifying the locations of the system components and evaluating alternatives for treatment, storage, distribution, etc. in the event of an emergency. Having this information readily accessible will expedite decision making during an emergency.

Appendix O (Form V-2) provides a general format for identifying and keeping track of personnel responsible for coordinating activities during an emergency or disaster and the state and federal agencies that must be contacted if a hazardous substance release occurs.

Identifying and Ranking Potential Problems:

Each PWS should decide for itself what it will consider a threat or contingency that needs to be addressed in the Contingency Plan. Regardless of how the PWS sets its priorities, it is useful to think of determining the appropriate contingencies as a screening process. The WHP Contingency Planning Team might first identify a variety of contingencies and then screen the contingencies to assess their importance.

Table V-1 on the following page presents a format that was adapted from EPA (1990) to be used for listing and ranking potential threats to drinking water supplies by assigning estimates for both *probability* and *severity*. Those threats with a high *probability* are typically more likely to occur, while those with high *severity* will likely have a greater adverse effect on the water system. Past experiences and the experience of other local PWSs should be considered when assessing each threat.

Whatever method or format is selected, the screening of a large set of potential contingencies should yield a smaller set of "primary" contingencies. These threats can then receive the most urgent attention in the planning process. Once the WHP Contingency Planning Team has identified the "primary" set of supply disruption contingencies, these threats should be summarized in a way that is useful in designing appropriate response actions; Form V-3 (Appendix P) is suggested as a basis to accomplish this.

TABLE V-1

EXAMPLE OF EMERGENCY PROBABILITY AND SEVERITY CHART

TYPE OF EMERGENCY	PROBABILITY 10-High - 1-Low	SEVERITY 10-High - 1-Low	REMARKS
Natural			
Drought			
Flood			
Ice & Snow Storm			
Wind			
Earthquake			
Fire			
Man-Made			
Spills/Chemical Contamination			
Sabotage			
Power Outage			
Operator Error			
Equipment Failure			
Explosion			
Vandalism			

One of the most effective ways of identifying threats for planning purposes is to describe potential water supply disruption scenarios that summarize situations in a brief, narrative form, as illustrated in the following examples:

Scenario 1 - Transmission Disruption Due to Landslide: Water from Well No. 2 to the town's water storage tanks is carried in a transmission line that is located in an area prone to landslides. In the autumn of 1994 a landslide occurred and ruptured the transmission pipeline. As a result, the town was left with a supply of approximately 15 gpm from its backup well.

Response: Town officials immediately implemented water rationing; the rationing order is advertised at Post Office and by word of mouth. They also immediately contacted the engineer who had been working on another part of the system. Repair work was completed the following day. The seriousness with which the residents of Elk Mountain responded to the rationing order allowed enough storage to remain in the tanks to provide emergency fire flow, which luckily was not needed during the event.

Scenario 2 - Chemical Spill: With the principal land use in the area being industrial, chemicals are potential threats to the Pleasantville drinking water supply. A release of these chemicals into the groundwater could gradually lead to a contamination problem. Storage and transportation of these substances poses an additional risk to groundwater, including the possibility of a sudden, accidental release to the drinking water supply.

Response: In the case of a sudden release of chemicals in Zones 1, 2 or 3 of the WHPA, Pleasantville officials will immediately contact the DEQ and the National Response Center. The wells closest (down gradient) to the spill will be isolated from the rest of the water supply system. Rationing will be imposed to limit the amount of water that is drawn toward the well field. The town will monitor water from the wells down gradient from the spill. Water from the remaining wells will be utilized until contaminants appear in the monitored wells. If contaminants appear in the monitored wells at levels exceeding EPA drinking water standards or guidelines the remaining wells in the field will also be removed from use. As soon as possible after the spill, bottled water suppliers, neighboring towns, owners of irrigation wells, and owners of water trucks will be contacted to determine the availability of an alternative water supply. If abandonment of the well field becomes necessary, Pleasantville will drill a new water supply well as soon as possible at the base of Windy Ridge.

Scenario 3 - Traffic Accident & Spill: Highway 123 passes within 200 feet of Windy City's Well No. 3. The transportation of hazardous substances along this major north-south route poses the risk of major spills which could threaten the safety of the drinking water supply. In addition, several gas stations built to serve highway traffic could contribute a well-defined set of petroleum derivatives to local groundwater, either through gradual leakage of the storage tanks or a sudden rupture or spill.

Response: In the case of a spill in Zone 1 of the WHPA, pumping at the well would cease. Windy City Well No. 3 is the sole source of drinking water for the city; however, older municipal wells supply the high school (Well No. 2) and the State Highway Patrol station and Veterans' Memorial Hospital (Well No. 1). While no longer connected to the distribution grid, these wells could be used to supply the town in an emergency situation. The city engineer estimates that the wells could be connected to the distribution grid within four working days. Until the wells are connected to the system, residents would have to haul water from one of the existing wells.

The key elements of planning scenarios can be seen in these examples; a brief description of the event triggering a supply disruption, perhaps a few facts or other events that complicate matters, and a summary of the immediate water supply implications.

It is most important to develop scenarios for those disruption threats considered as priorities for planning purposes. If there are numerous priority threats, however, it may not be necessary to capture all of them in scenario form. Many emergencies will involve similar response procedures. Within the set of priority threats planners should develop a variety of scenarios that will require use of different response equipment, personnel, and procedures (for example, contamination in the different Zones of the WHPA, well collapse, line break, or power loss) to allow development of different response approaches.

Considerations for Contingency Plan Responses:

Responses to water shortages will necessarily vary depending on the cause of water supply disruption. Short-term solutions may involve instructing users to boil water before use, trucking water from another source, or conservation during minor system repairs. Regardless of the type of response, the users of the water system should be notified immediately of the problem and of any treatment, rationing, or conservation measures to be implemented. Public meetings, the local newspaper(s), and local radio station can all be utilized for this purpose. A form that may be modified for use as a local press release is provided in Table V-2.

In the event that a source of drinking water is lost because of contamination, a new source of water may have to be developed, either within the same aquifer, or another aquifer if possible. If development of another aquifer is not possible, the remaining alternative may be to develop a new well in the contaminated aquifer (preferably in an area not subject to future contamination) or provide for treatment of the water supply to remove contaminants.

TABLE V-2

EXAMPLE PRESS RELEASE

(For distribution to television, radio and newspaper media.)

The following information regarding (1) protection of the Pleasantville well field, (2) detection of a substance in the Pleasantville water supply; or (3) the current water shortage problem:

It is vital that all residents served by the Pleasantville water supply system observe the following water use restrictions until further notice:

The characteristics and potential public health hazards associated with this contaminant are as follows:

City and water system personnel are taking the following steps to address the problem:

For further information please contact _____ at this phone number: _____.

A press conference is scheduled for _____ to be held at _____.

News updates will be provided as additional information becomes available. Attached please find a copy of an information sheet which provides details concerning the physical plans, organization structure, and function of the Pleasantville water system.

Time:

Date:

Signed:

Title:

Long-term response usually involves testing (e.g. sampling) the PWS (in the case of a contamination event), rationing uncontaminated water, treating contaminated drinking water, disinfecting the water system or taking other appropriate repair or clean-up actions.

Both the Wyoming Association of Rural Water Systems and WEMA can be contacted to learn of portable water purification units which may be available for use in emergency situations; frequent sampling and monitoring of the water may be necessary to ensure that the water supply remains safe for drinking. More detailed discussions of various treatment alternatives can be found within several of the reference aids listed in Appendix C.

Potential State and Federal Funding for Emergency Drinking Water Supplies:

Water systems must be financially prepared in the wake of a natural disaster to ensure that service will be restored quickly and safely. Some small water utilities, especially those without disaster insurance, emergency reserves, or financial reimbursement from disaster-relief funds, may struggle to restore service following a natural disaster.

There are a variety of financial reimbursement opportunities available to disaster-stricken water systems. The majority of this financial assistance comes in the form of loans, although sometimes grants are available, and most list specific requirements that applicants must meet before qualifying for assistance. All or a portion of the costs resulting from a disaster may be eligible for local, state, and/or federal disaster-relief funding, but only if those costs are clearly identified by the applicant.

Factors such as whether a system is public or private, whether it is insured, the system's size, and whether an official federal disaster has been declared can all determine the type of financial assistance and the amount of money that can be provided.

Since financial reimbursement from disaster relief funds can take up to a year to receive, water systems should maintain repair and replacement funds that can be tapped after an emergency. Although sometimes difficult, reserving funds should be an integral part of every water system's emergency preparedness effort.

As a general rule, emergency operations, including financial assistance, will begin at the level of government most appropriate to provide an effective response. At the local level, some counties, particularly in disaster-prone areas, have established emergency reserve funds for homeowners, small businesses, and small government utilities.

According to FEMA, much of what the federal government provides to small water/wastewater facilities are low-interest loans through the Small Business Administration and low-interest loans and grants through the U.S. Department of Agriculture's Rural Utilities Service (RUS). These funds can be used to repair and replace damaged property not covered by insurance.

For the most part, water systems become eligible for federal assistance if they are located in a county or area that has been declared a federal disaster area; suffer sufficient property damage or loss; and do not have sufficient income, insurance, or other cash resources readily available to cover the cost of damages. Even with reserve funds, systems may not be able to cover all expenses."[12]

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[12] Ibid.

The cost for the purchase and delivery of short-term and long-term water supplies must be determined on a case-by-case basis. Generally, the burden of the cost of clean up following a contamination incident rests with the person or persons responsible (i.e. 'responsible party') for the incident. However, there may be no identifiable responsible party, or none with sufficient financial resources to carry the burden or meet the immediately incurred costs.

In response to the possibility of such situations, in 1989 the Governor of Wyoming established provisions which allow the *Governor's Contingency Fund* to be utilized for containment, cleanup, and disposal of substances posing an eminent threat to the heath, safety or welfare of humans, wildlife and/or waters of the state (including groundwater). These funds are available only when immediate action is required or the responsible party is unknown. The funding must be requested from the Governor by the WDEQ Director.

Limited federal funding may be available through the Pollution Revolving Fund, administered by the U.S. Coast Guard, for the reimbursement of state and federal costs related to the containment, removal, mitigation, and disposal of oil releases. In addition, EPA may provide limited funds to ensure timely initiation of containment action when use of the Pollution Revolving Fund is not authorized. Requests for EPA funds must come from the Governor. Additional information is available in the *Wyoming Oil and Hazardous Substances Pollution Contingency Plan* (1989) and Section 311(k) of the Clean Water Act.

As a general rule, emergency operations, including financial assistance, will begin at the level of government most appropriate to provide an effective response. At the local level, some counties, particularly in disaster-prone areas, have established emergency reserve funds for homeowners, small businesses, and small government utilities.

According to FEMA, much of what the federal government provides to small water/wastewater facilities are low-interest loans through the Small Business Administration and low-interest loans and grants through the U.S. Department of Agriculture's Rural Utilities Service (RUS). These funds can be used to repair and replace damaged property not covered by insurance.

For the most part, water systems become eligible for federal assistance if they are located in a county or area that has been declared a federal disaster area; suffer sufficient property damage or loss; and do not have sufficient income, insurance, or other cash resources readily available to cover the cost of damages. Even with reserve funds, systems may not be able to cover all expenses.

Where to Go For Help:

"In the event of an emergency, there are several emergency assistance organizations and agencies that are able to help your water system prepare for, respond to, and recover from a natural disaster. Many of these organizations will appear on the scene following a natural disaster.

- Local government plays a key role in emergency management. Emergencies involving a single county or community will require the leadership of local officials, including emergency management representatives, mayors, public

works directors, and police and fire officials.

- Disasters that extend beyond a single community also may require the assistance of corresponding county and State level emergency response organizations. It is important to know your local emergency response coordinator(s) and include them in the development of your system's emergency management plan.

- State assistance is provided upon request when emergency needs exceed the capability of local governments. The role of State governments in emergency management somewhat parallels the role of the federal government. Each State has an emergency management office that operates on federal funding provided by FEMA. These emergency management offices work in conjunction with their regional FEMA offices to provide emergency education, training, and assistance to community emergency training staff.

- At the federal level, FEMA is the primary agency for emergency management. FEMA shares its emergency management responsibilities with states and local governments. There are regional offices that work jointly with 27 federal partners capable of responding to any kind of natural disaster. Virtually all interaction with FEMA following a natural disaster will be done through the regional offices.

  Federal assistance is supplemental to that of State and local governments and is available upon approval of a request by the governor to the appropriate federal agency or to the president. For example, FEMA responds to an emergency only when the president has declared an area a disaster or when a presidential declaration appears to be imminent.

- There are several non-governmental emergency response organizations that can quickly mobilize and assist in disaster situations. The National Rural Water Association and its state Rural Water Associations, the American Red Cross, and the Salvation Army should all play integral roles in any emergency management plan and appear on the scene of a natural disaster at the governor's request.

Some of the services these organizations provide include clearing debris; restoring power and utilities; providing food, shelter, and clothing; offering technical assistance; providing emergency -preparedness courses and literature; and providing emergency loans and grants following a natural disaster."[13]

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[13] Ibid.

CONTENT AND ORGANIZATION OF THE CONTINGENCY PLAN:

In formulating a Contingency Plan, the WHP Management Committee, or its designate, must address and include the following in its WHP Plan:

- Existing system conditions (Form V-1; Appendix N) and copies of maps and/or construction plans, specifications and drawings detailing the location of the water distribution and storage system;

- Chain of command and description of individual roles and responsibilities during an emergency (Form V-2; Appendix O);

- Emergency responses planned for 'high' probability and 'high' severity events identified on Form V-3; Appendix P), including:

  - Procedures to shut down or isolate a contaminated well from the distribution system.

  - Sources of emergency water for drinking and other household uses as well as sources of equipment to treat, transport and distribute the water.

  - Procedures to decontaminate the distribution system and well(s).

  - Procedures to coordinate with county and state emergency response agencies.

  - Procedures to effectively communicate with the water users.

  - A plan of action for siting a new permanent water supply in case the present one must be abandoned.

  - Sources of emergency funds and equipment, and procedures for requesting and dispersing such funds and equipment.

- Provisions for obtaining, distributing and funding *temporary* alternate drinking water supplies;

- Development and financing of new drinking water sources in case of long-term shortages because of contaminated supplies;

  - an inventory of alternative water supply sources (quantity, quality, and ownership), including existing back-up wells and springs and potential spring development, well sites, and surface water supplies.

- Plans and schedule to review and update the Contingency Plan (see Section VIII).

PLANNING FOR NEW WELLS:

Introduction:

Subsection 1428(a)(6) of the SDWA specifies that the State WHP plan shall require that:

"consideration be given to all potential sources of contamination within the expected wellhead area of a new groundwater source (i.e., well, spring, or tunnel) which serves as a public water supply system..."[14]

Planning for New Groundwater Based PWSs:

Because more planning is possible for a new groundwater source than is feasible for existing wells, the WHP Management Committee may find it beneficial to combine planning for the siting of new wells with other community planning and development activities. Development of new groundwater sources of drinking water should conform with overall community development plans. For example, assessing growth potential or the direction of future expansion into anticipated WHPAs should be factored into the new wellsite selection process. Communities in high growth areas may examine land-use patterns and elect to direct industrial development or other potential sources of contamination to areas that do not pose a threat to the water supply. Where communities determine that land-use controls alone are insufficient or inappropriate, they may wish to adopt other management strategies (see Section IV) to protect groundwater and drinking water quality. For potential wellhead areas identified as particularly 'sensitive' (see Section III) to contamination, communities may decide to restrict certain activities that pose a high risk of contamination.

Taking steps before a problem arises has the added advantage of avoiding disruptions to existing land uses and potential legal challenges. As another example of this proactive approach, major undeveloped aquifer areas may be designated and managed as potential WHPAs if they are logical sites for future drinking water sources. PWSs, local planning authorities, and zoning boards should work together to identify potential WHPAs for emergency or future uses. Potential contaminant sources that lie within these potential WHPAs may then be identified and managed in a manner similar to that applied to potential sources that lie within existing WHPAs.

Public participation is an essential component of water supply planning. The expansion of WHPAs due to increasing demand or the creation of additional WHPAs may be of concern to businesses and residents located within WHPAs. To foster responsible water supply practices at the local level, public hearings on water development plans and source management approaches are strongly encouraged. A public forum for long-term water supply planning issues may be a natural extension of the duties of a community's WHP Management Committee.

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[14] "Guidance for Applicants for State Wellhead Protection Program Assistance Funds Under the Safe Drinking Water Act", EPA, 440/6-87-011, June, 1987.

Existing Regulatory Requirements for Siting New and Modified Public Water Supply Wells:

Chapter XII of WDEQ's Water Quality Division Rules and Regulations establishes siting requirements (Section 8: General Design Considerations) and general considerations (Section 9: Source Development) for locating new (and modifying existing) public water supply wells serving 20 or more connections (see Glossary: PWS - DEQ) in relation to most potential sources of pollution. Specifically:

Section 8(b)(i) states:

"...[Water] Treatment facilities shall be located such that no sources of pollution may affect the quality of the water supply or treatment system. The facilities shall not be located within 500 feet of landfills, garbage dumps, or wastewater treatment systems".

Section 9(b)(i)(B) states:

"....Every well shall be located further from any sources of pollution listed below..."

Section 9(b)(i)(B)(IV) states:

"For wastewaters other than domestic wastewater, the isolation distance required shall be determined by a hydrogeologic study, in accordance with the requirements of Section 15 of Chapter III Water Quality Rules and Regulations".

<u>In order to determine and establish the required isolation distances from the well:</u>

- The Zone of Contribution (ZOC) to the well must be determined, using information provided from the hydrogeologic study required by Chapter XII, Section 9(b)(B)(IV);
- The delineation methodologies, criteria and thresholds set forth in Section II of this document (or an approved alternative method) must then be applied to determine the WHPA of the new/proposed well.

Additionally, Section 6(c)(v)(A)(III) *(Engineering Design Report)* of Chapter XII states that 'sources of water supply shall be described to include':

"Sources of possible contamination around the well and in any known recharge areas, including location of any waste site, industrial facilities and wastewater disposal areas".

- An inventory (and contaminant source 'overlay') of existing and potential sources of contamination within the WHPA must be completed.
  - The processes, procedures and requirements set forth in Section III of this document (or an approved alternative) must be applied to completing a contaminant Source Inventory list for the WHPA.

Progressing to a Final WHP Plan:

Using the WHPA delineation and Source Inventory list developed for permitting new and modified public water supply wells, the WHP Management Committee should undertake the remaining steps to complete the WHP plan for the new/modified water supply source. These remaining steps include:

- Development and implementation of Management Strategies (see Section IV);
- Development of a Contingency Plan and a plan for Siting New Wells (see Section V).
- Completion of the WHP pre-submittal checklist (Appendix Q) to ensure that all necessary components have been completed and included in the WHP Plan submittal.
- Submittal of Final WHP Plan to WDEQ/WQD for approval; see Section VIII for instructions.

SECTION VI

DEVELOPING AND IMPLEMENTING LOCAL WELLHEAD PROTECTION (WHP) PLANS

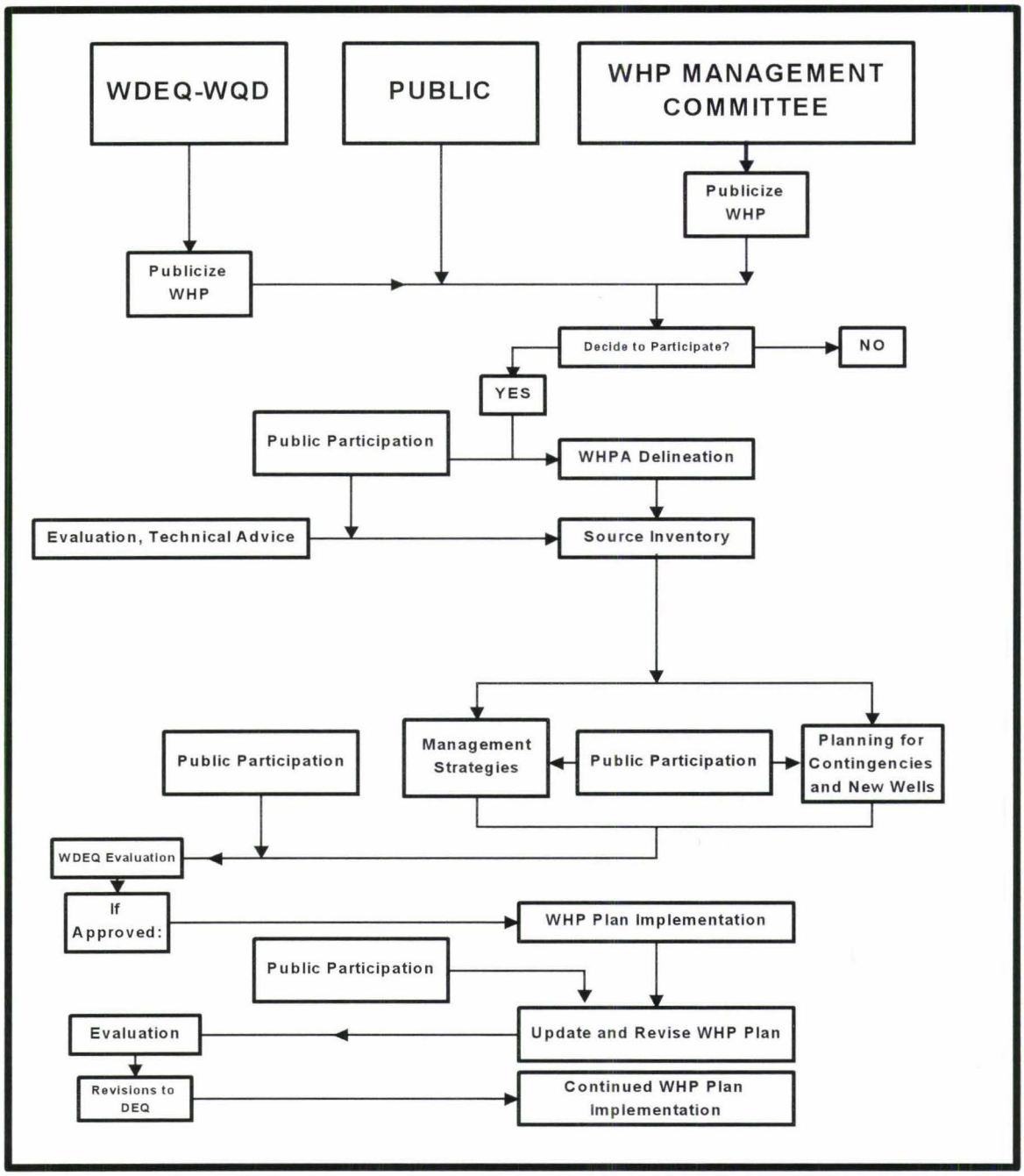
Figure VI-1, the *'WHP Plan Development Flowchart'* illustrates the preferred process for preparing and implementing a local WHP plan. The sequence of plan development events, starting from the decision to participate in the program through final approval, as well as the process for periodically updating WHP plans is depicted in the flowchart. Lesser roles of other resources (such as technical and legal consultants, and other governmental agencies) that may be called upon for development of individual plan elements are not shown.

Emphasis on Public Education and Participation:

The importance of involving all sectors of the public during the planning, development and implementation of Wellhead Protection Plans cannot be over emphasized. Examples of WHP planning efforts that have been short-circuited due to lack of public education and involvement up-front and in the early stages of plan development are too numerous to mention. Failure to involve the public in the early stages of planning is often the primary reason that local WHP plans fail to become implemented.

Figure VI-1 illustrates steps within the planning process where public participation is most critical. Appendix B lists numerous organizations that can provide information, assistance and materials to enhance and increase public involvement in WHP planning, development and implementation.

Perhaps one of the most useful tools is the experience gained from other communities that have gone through the WHP planning process and have discovered the delivery mechanisms that have worked best for them. More often than not, a few minutes spent visiting with individuals from these communities can save a great deal of time and frustration, and greatly enhance the ability to develop and implement a WHP plan.



WELLHEAD PROTECTION PLAN DEVELOPMENT FLOW CHART
FIGURE VI-1

SECTION VII

SUBMISSION, REVIEW & APPROVAL OF LOCAL WELLHEAD PROTECTION (WHP) PLANS

WDEQ\WQD review and approval of WHP plans is encouraged, but *only required in the event that a community or PWS wishes to participate in state or federal programs that require an approved Wellhead Protection (WHP) plan*. If seeking such approval, please forward three copies of the final plan to WDEQ/WQD for review and approval.

Appendix Q contains a checklist for use by ***'Community'*** PWSs in determining the completeness of draft WHP plans and must be included in WHP plans submitted for WDEQ/WQD approval.

'Non-Community' PWSs need only submit 3 copies of the completed condensed 'model' WHP plan (Appendix F: "State of Wyoming Groundwater Contamination Susceptibility Assessment Survey Form") together with a map (minimum 1:24,000 scale) illustrating the WHPA(s) (delineated using Arbitrary and Calculated Fixed-Radius Methods) for consideration of approval.

WDEQ will review submittals for completeness and adequacy in terms of the minimum acceptance criteria set forth in this guidance document; either review comments describing plan incompleteness/inadequacy or formal approval of the plan will be provided by WDEQ/WQD within sixty (60) days of receipt of the plan.

Three copies of the final plan should be submitted to:

Wyoming Department of Environmental Quality
Water Quality Division
Wellhead Protection Program
Herschler Building - 4W
Cheyenne, WY 82002

If possible, please provide a copy of the narrative sections of your WHP plan in WordPerfect format and attach hard copies of non-compatible maps, tables, figures, etc. included as part of the plan.

EPA Monitoring Waivers:

Under certain circumstances, EPA will allow *'community'* and *'non-transient non-community'* PWSs to obtain either *'use'* or *'susceptibility'* waivers from certain monitoring requirements established under the Safe Drinking Water Act; *'transient non-community'* systems are not subjected to monitoring requirements that may be waived.

PWSs wanting to use a WDEQ approved WHP plan to assist them in obtaining a *'Susceptibility'* waiver from EPA (Safe Drinking Water Act) monitoring requirements will need to meet additional requirements. (Please provide an additional (fourth) copy of the plan and indicate if you wish to have a copy of the final, approved plan forwarded to EPA for application for monitoring waivers.) PWSs should contact WDEQ/WQD or EPA to obtain information regarding

any additional requirements that will have to fulfilled in order to obtain a 'susceptibility' waiver. Further information on monitoring waivers is provided in Appendix G of this document.

SECTION VIII

UPDATING AND REVISING LOCAL WELLHEAD PROTECTION (WHP) PLANS

WHP plans should be updated and revised whenever new information relating to contaminant sources (existing and potential), aquifer characteristics, well construction, source management approaches, or contingency planning becomes available.

The WHP plan must be updated at least every two years, and revised as necessary to reflect new information or data pertaining to:

- Hydrologic characteristics of the producing aquifer.
- Changes in water supply, or pumping volumes.
- New potential sources of contamination.
- Changes in land use within the WHPA.
- New management strategy development or implementation.
- Contingency planning and emergency response.
- Planning or developing new water supplies.

Copies of revised WHPA delineations, Source Identification forms, Source Inventory lists, 'Source Overlays', source management strategies, Contingency Plans and plans for siting new wells must be submitted to WDEQ/WQD at least every two years, and must also be included in the community's copy of its WHP plan.

If there have been no changes over the previous two years, a letter must be submitted to WDEQ/WQD documenting that the WHP plan has been reviewed and that no changes within the factors listed above have occurred within the previous two years; the letter should be signed by a representative of the local government, or superintendent/manager of the PWS.

All documentation relating to reviews and updates must be amended to, or incorporated into the local WHP Plan.

GLOSSARY

The purpose of this Glossary is to provide a list of terms used in this document and commonly used by hydrogeologists, as well as some specific terms used in groundwater contamination assessments and Drinking Water Source Protections. These definitions are adapted from Gill and Lund (1984), EPA (1991) and the Drinking Water Source Protection Rule (R309-113).

Adit: Horizontal or nearly horizontal passage from the surface from which a mine is entered.

Alluvium: A general term for clay, silt, sand, gravel or similar unconsolidated material deposited during comparatively recent geologic time by a stream or other body of running water.

Analytical model: A model that provides approximate or exact solutions to simplified mathematical forms of the differential equations for water movement and solute transport. Analytical models can generally be solved using calculators or computers.

Anisotropy: The condition of having different properties in different directions. The condition under which one or more of the hydraulic properties of an aquifer vary according to the direction of flow.

Anticline: A fold in rock strata that is convex upward.

Aquifer test: A test to determine hydrologic properties of an aquifer, involving the withdrawal of measured quantities of water from, or addition of water to, a well and the measurement of resulting changes in head in the aquifer both during and after the period of discharge or addition. Same as pump test.

Aquifer/Aquifer System: A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield sufficient, economical quantities of water to wells, springs, and drain tunnels.

Aquitard: The less-permeable beds in a stratigraphic sequence that tend to restrict or impede groundwater flow relative to the more permeable beds that serve as aquifers.

Area of influence: Area surrounding a pumping or recharging well within which the water table or potentiometric surface has been changed due to the well's pumping or recharge.

Artesian Conditions: In a confined aquifer, when the water level in a well rises above the top of the aquifer.

Attenuation: The process of diminishing contaminant concentrations in groundwater, due to filtration, biodegradation, dilution, sorption, volatilization, and other processes.

Collection area: The area surrounding a groundwater source which is underlain by collection pipes, tile, tunnels, infiltration boxes, or other groundwater collection devices.

Colluvium: Loose, heterogeneous, incoherent mass of soil material and/or rock fragments deposited chiefly by mass-wasting.

Conduit Flow: Groundwater movement down-gradient along fractures, faults, joints, bedding planes and solution openings resulting in "flashiness" -- a rapid response to recharge, turbulence, and highly variable chemistry, temperature and flow rates. Darcy's law is not operative under conduit flow conditions. (See Section II for further discussion.)

Cone of depression: A depression in the groundwater table or potentiometric surface that has the shape of an inverted cone and develops around a well from which water is being withdrawn. Its trace (perimeter) on the land surface defines the zone of influence of a well. Also called pumping cone and cone of drawdown.

Confined aquifer: The following criteria are met in order to verify and maintain an upward hydraulic gradient in the producing aquifer: an effective confining layer must exist between the ground surface and the producing aquifer. This confining layer must have a lower hydraulic conductivity than the producing aquifer; and the potentiometric surface of the producing aquifer must remain higher in elevation than the potentiometric surface of the overlying aquifer. If there is no overlying aquifer, then the potentiometric surface of the producing aquifer must remain higher in elevation than the upper surface of the overlying confining layer. These criteria must be maintained during periods of maximum and long-term pumping and seasonal groundwater fluctuations. Not all confined aquifers in nature have an upward hydraulic gradient; however, for the purposes of R309-113, an upward hydraulic gradient must be maintained.

Contact: The surface where two different kinds of rock come together.

Contaminant: An undesirable substance not normally present, or an unusually high concentration of a naturally occurring substance, in water, soil, or other environmental medium.

Contamination: The degradation of natural water quality as a result of man's activities.

Controls: The codes, ordinances, rules, and regulations currently in effect to regulate a potential contamination source.

Criteria: The conceptual standards that form the basis for WHPA delineation to include distance, groundwater time of travel, aquifer boundaries, and groundwater divides.

DDW: Division of Drinking Water.

Designated person: The person appointed by a PWS to ensure that the requirements of R309-113 are met.

Diffuse Flow: Groundwater movement down-gradient through interconnected fractures, faults, joints and bedding planes, resulting in less turbulent flow, less dramatic response to recharge events, and more uniform chemistry than observed in conduit flow. Groundwater movement is similar to that in porous flow environments, and may be described using Darcy's law. Groundwater movement through a fractured-rock aquifer may be considered to be *diffuse* flow if: (1) the fractures are closely spaced, (2) the fractures are evenly sized, evenly distributed, and randomly oriented, and (3) the area of consideration is large relative to the spacing of the fractures. Criteria such as pumping test responses, configuration of the water table, water chemistry variations, distribution of hydraulic conductivity, and the ratio of the fracture scale

to the problem scale may be used to determine which type of flow regime exists. (See Section II for further discussion.)

Dike: Tabular igneous intrusion that cuts across planar bedding or foliation of the surrounding rock.

Dispersion: The spreading and mixing of chemical constituents in groundwater caused by diffusion and mixing due to microscopic variations in velocities within and between pores.

Drawdown: The vertical distance groundwater elevation is lowered, or the amount head is reduced, due to the removal of groundwater. Also the decline in potentiometric surface caused by the withdrawal of water from a hydrogeologic unit. The distance between the static water level and the surface of the cone of depression. A lowering of the water table of an unconfined aquifer or the potentiometric surface of a confined aquifer caused by pumping of groundwater from wells.

Existing groundwater source of drinking water: A public supply groundwater source for which plans and specifications are submitted to DDW on or before the effective date of the DWSP Rule.

Fissure: A fracture or crack in a rock along which there is a distinct separation.

Flow line: The general path that a particle of water follows under laminar flow conditions. Line indicating the direction followed by groundwater toward points of discharge. Flow lines generally are considered perpendicular to equipotential lines.

Flow model: A computer model that calculates a hydraulic head field for the study area using numerical methods to arrive at an approximate solution to the differential equation of groundwater flow.

Flow path: The path a water molecule or solute follows in the subsurface.

Flow System/Hydraulic Boundary: A hydrologic feature that prevents the flow of groundwater. Examples include groundwater divides or low permeability material that impedes groundwater flow.

Flowing Artesian: When the water level in a well rises above and flows at the ground surface.

Footwall: The lower side of a horizontal or inclined rock body or fault. If the fault has dip-slip translational movement along a normal fault, the footwall block is upthrown; the footwall block is downthrown along a reverse fault.

Fracture: A general term for any break in a rock, which includes cracks, joints, and faults.

Fractured (Rock) Hydrogeologic Setting: Groundwater movement down-gradient through any break in a rock (fracture). Fractures include cracks, joints, and faults caused by mechanical failure of the rock due to stress. Groundwater moving through fractures may behave as if it is in either porous (i.e. *'diffuse'*) flow or *conduit* flow.

Groundwater barrier: Rock or artificial material with a relatively low permeability that occurs (or is placed) below ground surface, where it impedes the movement of groundwater and thus may cause a pronounced difference in the heads on opposite sides of the barrier.

Groundwater basin: General term used to define a groundwater flow system that has defined boundaries and may include more than one aquifer. The basin includes both the surface area and the permeable materials beneath it. A rather vague designation pertaining to a groundwater reservoir that is more or less separate from neighboring groundwater reservoirs. A groundwater basin could be separated from adjacent basins by geologic boundaries or by hydrologic boundaries.

Groundwater divide: Ridge in the water table, or potentiometric surface, from which groundwater moves away at right angles in both directions. Line of highest hydraulic head in the water table or potentiometric surface.

Groundwater mound: Raised area in a water table or other potentiometric surface, aerated by groundwater recharge.

Groundwater source: Any well, spring, tunnel, adit, or other underground opening from or through which groundwater flows or is pumped from subsurface water bearing formations.

Hanging wall: The upper side of a horizontal or inclined rock body or fault . The hanging wall is downthrown along a normal fault with dip-slip movement; the hanging wall is upthrown along a reverse-slip fault.

Head, total: Height of the column of water at a given point in a groundwater system above a datum plane such as mean sea level. The sum of the elevation head (distance of a point above datum), the pressure head (the height of a column of liquid that can be supported by static pressure at the point), and the velocity head (the height to which the liquid can be raised by its kinetic energy).

Heterogeneity: Characteristic of a medium in which material properties vary from point to point.

Homogeneity: Characteristic of a medium in which material properties are identical throughout.

Hydraulic Conductivity (K): A coefficient of proportionality describing the rate at which water can move through a permeable medium. It is a function of the porous medium and the fluid.

Hydraulic Gradient (i): Slope of a water table or potentiometric surface. More specifically, change in head per unit of distance in a given direction, generally the direction of the maximum rate of decrease in head. The difference in hydraulic head divided by the distance along the flowpath.

Hydrogeologic methods: The techniques used to translate selected criteria and criteria thresholds into mappable delineation boundaries. These methods include, but are not limited to, arbitrary fixed radii, analytical calculations and models, hydrogeologic mapping, and numerical flow models.

Hydrogeologic unit: Any soil or rock unit or zone that because of its hydraulic properties has a distinct influence on the storage or movement of groundwater.

Impermeable: Characteristic of geologic materials that limit their ability to transmit significant quantities of water under the head differences normally found in the subsurface environment.

Interference: The result of two or more pumping wells, the drawdown cones of which intercept. At a given location, the total well interference is the sum of the drawdowns due to each individual well. The condition occurring when the area of influence of a water well comes into contact with or overlaps that of a neighboring well, as when two wells are pumping from the same aquifer or are located near each other.

Isotropy: The condition in which the properties of interest (generally hydraulic properties of the aquifer) are the same in all directions.

Karst Hydrogeologic Settings: Groundwater movement down-gradient through a network of permeable conduits which evolved as a consequence of dissolution of the host rocks (host rock must be soluble, e.g., limestone). Two major end-member types of groundwater movement occur in karst aquifers -- conduit flow and diffuse flow, as defined above.

Leakage: The vertical flow of groundwater; commonly used in the context of vertical groundwater flow through confining strata.

Limestone: A bedded sedimentary deposit consisting chiefly of calcium carbonate.

Management area: The area outside of zone one and within a two-mile radius where the Optional Two-mile Radius Delineation Procedure has been used to identify a protection area.

Management strategies: Zoning and non-zoning controls which include, but are not limited to, the following: zoning and subdivision ordinances, site plan reviews, design and operating standards, source prohibitions, purchase of property and development rights, public education programs, groundwater monitoring, household hazardous waste collection programs, water conservation programs, memoranda of understanding, written contracts and agreements, and so forth.

Maximum contaminant level (MCL). Maximum permissible level of a contaminant in water that is delivered to the users of a PWS. Maximum containment level is defined more explicitly in Safe Drinking Water Act (SDWA) regulations (40 CFR Section 141.2).

New groundwater source of drinking water: A public supply groundwater source of drinking water for which plans and specifications are submitted to DDW after the effective date of the DWSP Rule.

Nonpoint source: Any conveyance not meeting the definition of point source.

Normal fault: A fault, with an angle usually between 45-90 degrees, at which the hanging wall (upper block) has moved downward relative to the footwall (lower block) .

Observation well: A well drilled in a selected location for the purpose of observing parameters such as water levels or water chemistry changes.

Permeability: Capacity of a rock or soil material to transmit a fluid.

Piezometric surface: See potentiometric surface.

Point source: Any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, animal feeding operation with more than ten animal units, landfill, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture.

Porosity: The ratio of the volume of void spaces in a rock or sediment to the total volume of the rock or sediment.

Porous Flow: Groundwater movement down-gradient through the pore space of aquifer host rocks, such as uncemented or poorly-cemented sandstones. Darcy's law is operative in porous flow environments. Groundwater movement through a fractured-rock aquifer may be considered to resemble porous flow if (1) the fractures are closely spaced (2) the fractures are evenly sized, distributed, and spatially oriented, and (3) the area of consideration is large relative to the spacing of the fractures.

Potable water: Suitable for human consumption as drinking water.

Potential contamination source: Any facility or site which employs an activity or procedure which may potentially contaminate ground water. A pollution source is also a potential contamination source.

Potentiometric Surface: A surface that represents the level to which water will rise in tightly cased wells. If the head varies significantly with depth in the aquifer, then there may be more than one potentiometric surface. The water table is a particular potentiometric surface for an unconfined aquifer.

Public Water System (PWS): See PWS.

Pump Test: A test to determine hydrologic properties of an aquifer, involving the withdrawal of measured quantities of water from, or additional of water to, a well and the measurement of resulting changes in head in the aquifer both during and after the period of discharge or addition.

PWS (EPA): Public Water System. Any water system providing water for human consumption for an average of at least 25 persons per day (or 15 or more service connections) and in use for at least 60 days each year. Further defined as follows:

- **Community Water System:** A Public Water System which serves at least 15 services connections used by year-round residents or regularly serves at least 25 year-round residents.

- **Transient, Non-Community Water Systems:** A Public Water System that is not a community water system. These systems do not regularly serve at least 25 of the same persons over six months per year.

- **Non-Transient, Non-Community Water System:** A Public Water System that is not a community water system and that regularly serves at least 25 of the same persons over 6 months per year.

Radial flow: The flow of water in an aquifer toward a well.

Recharge area: Area in which water reaches the groundwater reservoir by surface infiltration. An area in which there is a downward component of hydraulic head in the aquifer.

Reverse fault: Fault with a dip greater than 45 degrees at which the hanging wall (upper block) appears to have moved upward relative to the footwall (lower block).

Sandstone: A cemented or otherwise compacted detrital sediment composed predominantly of quartz sand grains.

Shale: A laminated sediment in which the constituent particles are composed of clay. Same as mudstone, except mudstone may be composed of a percentage of silt and may or may not be laminated.

Stagnation point: A place in a groundwater flow field at which the groundwater is not moving.

Thrust fault: Fault with a dip of 45 degrees or less in which the hanging wall (upper block) appears to have moved upward relative to the footwall (lower block) .

Time of travel (TOT): The time required for a particle of water to move in the saturated zone from a specific point to a groundwater source of drinking water.

Unconfined Aquifer: Any aquifer that does not meet the definition of a confined aquifer. An aquifer over which there is no confining strata and the water table forms the upper boundary.

Well field: An area containing two or more wells supplying a public water supply system.

Wellhead Protection Area (WHPA): The surface and subsurface area surrounding a water well or wellfield, supplying a Public Water System, through which contaminants are reasonably likely to move toward and reach such water well or well field.

Wellhead: The physical structure, facility, or device at the land surface from or through which groundwater flows or is pumped from subsurface, water-bearing formations.

Zone of Contribution (ZOC): The area surrounding a pumping well, spring, or tunnel that encompasses all areas and features that supply groundwater to the well spring, or tunnel.

Zone of Influence (ZOI): The area of influence, or 'cone of depression' formed when pumping a well or well field.

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Long, J.C.S., Remer, J.S., Wilson, C.R., and Witherspoon, P.A., 1982. *"Porous Media Equivalents for Networks of Discontinuous Fractures"* in: Water Resources Research 18/3, p. 645-658.

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Appendix A

GROUNDWATER FLOW MODELS

Iowa State University
$400, unassembled, with instructional videotape and packet of groundwater information.
$460 fully assembled with carrying case.
Order from: SWCS Student Chapter
3212 Agronomy Hall
Iowa State University
Ames, IA 50011
515/294-3772
www.public.iastate.edu/~stu_org/swcc/

University of Nebraska
$350, includes shipping and carrying case (required if model is shipped).
$300 without case (model must be picked up). Can make some region-specific modifications.
Order from: 249 L.W. Chase Hall
University of Nebraska-Lincoln
East Campus
Lincoln, NE 68583-0726
402/472-1625

University of Wisconsin
$250 plus $10 shipping. Region-specific modifications cost extra.
Order from: Groundwater Model Project
College of Natural Resources
University of Wisconsin-Stevens Point
Stevens Point, WI 54481
715/346-4613
www.uwsp.edu/stuorg/awra/h2omodel.html

Western Michigan University
$195 plus $20 in-State shipping or $30 out-of-State shipping.
Can make some region specific modifications.
Order from Groundwater Education in Michigan
Institute for Water Resources
3327 Rood Hall
Western Michigan University
Kalamazoo, MI 49008
616/387-5502

Appendix A

The Western Group
$290 + S&H for the Standard Groundwater Simulator; $390 + S&H for the Bedrock Simulator. Includes Instructor's manual, carrying-storage case, pump and other accessories.
Order from: The Western Group, L.C.
PO Box 638
Augusta, MI 49012-0638
616-381-4355

The Groundwater Foundation
$18.95; Simple, easy and affordable.
Order from: The Groundwater Foundation
PO Box 22558
Lincoln, NE 68542-2558
800/858-4844

Groundwater Model Demonstration videotape (15 min.) Shows how to operate and maintain a groundwater model. $15.
Order from: League of Women Voters of Enid
1722 E. Maple
Enid, OK 73701
405-242-5012

whp/gwmodels.doc

Appendix B

Concern Inc.
1794 Columbia Road, NW
Washington, DC 20009
202/328-8160
Concern provides environmental information to individuals and groups and encourages them to act in their communities. Concern publishes concise reports defining key environmental issues and containing suggestions for individual and group action, organizes workshops, conferences and exhibits and undertakes other educational activities.

Environmental Defense Fund
257 Park Avenue South
New York, NY 10010
212/505-2100
A national research, education and advocacy organization, EDF has conducted research on leaking storage tanks and works on public policy issues including wetlands, restoration of the Everglades and reauthorization of the Clean Water Act. EDF has offices in seven states and the District of Columbia.

Farm-A-Syst/Home-A-Syst
Steenbock Library, Room B142
550 Babcock Drive
Madison, WI 53706
608/262-0024
Farm-A-Syst is a volunteer program to help farmers and rural residents on private wells conduct water pollution risk assessments and develop an action plan to reduce the risks identified. The program is under way in 22 states and in the planning stages in others. In fall 1993 the program started work on a Home-A-Syst program to serve nonfarm private well users in the northeast.

Freshwater Foundation
Spring Hill Center
725 County Road Six
Wayzata, MN 55391
Freshwater Foundation pursues the protection of freshwater resources through educational programs, resource management, demonstration projects and freshwater research. Since 1985 the foundation has been a partner in *U.S. Water News* (see publications).

Freshwater Institute
The Conservation Fund
P.O. Box 1746
Shepherdstown, WV 25443
304/876-2815
Freshwater Institute is a program of The Conservation Fund, a national nonprofit land and water conservation organization. The institute explores practical, innovative approaches to the protection, conservation and use of our nation's fresh water resources.

Friends of the Earth
1025 Vermont Avenue, NW, Suite 300
Washington, DC 20005
202/783-7400
FOE is an international environmental organization that works on a range of public policy issues. FOE works to protect groundwater through influencing federal legislation, providing technical assistance to local groups, and holding a biennial citizen's groundwater conference. FOE has offices in Seattle, Washington, and the District of Columbia, as well as 51 international affiliates.

Appendix B

The American Water Works Association (AWWA)
6666 Quincy Ave.,
Denver, CO 80235
303/794-7711
The AWWA has developed an award program to recognize water systems which have developed and are implementing exemplary Wellhead Protection (WHP) Programs. This program will include awards (up to three per state per year) to water systems selected by each section that has qualifying water systems.

The Urban Institute
2100 M Street, NW
Washington, DC 20037
202/833-7200
The Urban Institute is a nonprofit, nonpartisan policy research organization that works on a range of public interest issues including groundwater protection. The institute has produced "Suggestions For State and local Groundwater Protection Programs", a series of publications providing guidance on accessing information, encouraging local efforts and encouraging business and public involvement in groundwater protection. Write or call for more information.

EPA Safe Drinking Water (SDW) Hotline: (800)426-4791
The SDW Hotline is available to help State and local officials and the public understand the regulations and programs developed in response to the Safe Drinking Water Act Amendments of 1986 and 1996. For groundwater and wellhead protection issues, the Hotline can provide general information about the national program, and State and EPA Regional groundwater contacts. The Hotline also has information about the National Rural Water Association's program to assist small communities to develop local drinking protection plans.

EPA Office of Water Resource Center
The Center has a complete listing of all wellhead protection, groundwater, and drinking water publications. If the documents are available, the Resource Center will send copies to interested parties free of charge. If the document requested is currently unavailable from EPA, the Resource Center has alternate ordering information. For information on the Compendium of Local Wellhead Protection Ordinances (EPA Doc. No. 570/9-91-024A-D), please contact your EPA Regional Groundwater Office.

Contact: Water Resource Center (RC4100)
Room G099B 401 M St., S.W.
Washington, DC 20460
(202)260-7786
(202)260-0386 (fax)
Internet: Waterpubs @ EPAmail.epa.gov.

Appendix B

The Groundwater Foundation

The Groundwater foundation is a national nonprofit organization dedicated to educating the public about the conservation and management of groundwater. The Foundation sponsors a variety of youth programs, such as the Nebraska Children's Water Festival and Groundwater University. The Foundation also sponsors the Groundwater Guardian program and a fall symposium that each year explores all aspects of a groundwater-related issue. Foundation publications include the *Aquifer*, a quarterly journal on groundwater issues; *Sprinkles*, a water festival newsletter; and guides, such as *Making Waves: How To Put On A Water Festival*, to help communities establish their own youth programs.

Contact: The Groundwater Foundation
P.O. Box 22558
Lincoln, NE 68542-2558
(800)858-4844

Groundwater Guardian Program

This is a national program to support and recognize communities actively protecting their groundwater. Communities form a Groundwater guardian team to develop and implement a program to increase groundwater awareness and protection. Communities designated Groundwater Guardians receive national recognition at an annual conference in November. The *Groundwater Guardian Program Guide* includes helpful information on forming a local team and activities to both educate the community about groundwater and involve the community in protecting local groundwater resources. All Guardian communities receive the quarterly newsletter, *Infiltration*.

Contact: The Groundwater Foundation
P.O. Box 22558
Lincoln, NE 68542-2558
(800)858-4844

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Give Water a Hand: Youth Action Program Promoting Good Water Management Practices at home and in the Community. Kadi Row, Project Coordinator. *Leader Guidebook and Site Action Plan. Give Water a Hand* is a national youth water education program developed to engage you g people in community-based, natural resource service projects. The materials help young people protect and improve local water resources with the assistance of local resources experts. Using a watershed approach, the program illustrates the natural link between community action and environmental problem solving.

Contact: Kadi Row, Project Coordinator
University of Wisconsin-Extension
1450 linden Drive, Room 216
Madison, WI 53706
(800)928-3720
(608)262-2031 (fax)

Spread the Word for Water: The National Drinking Water Week Kit. American Water Works Association.
Drinking Water Week, a cooperative effort by the National Drinking Water Alliance, is an annual event in the first week of May. This kit contains a wide variety of resources to help communities plan media coverage and events for all ages. Included are informational materials on conserving and protecting water resources and getting involved in local drinking water issues. Outreach materials include information for the local media and student handouts and worksheets.

Contact: Public Affairs Department
American Water Works Association
6666 W. Quincy Avenue
Denver, Co 80235
(303)794-7711

Wellhead Protection Training Kit.
The Training Kit includes nine modules that describe each phase of wellhead protection program development and implementation. The modules cover each step of a wellhead protection program, an introduction to local ordinances, information specific to working with Native American tribes, and a brief description of the EPA technical assistance document on wellhead protection. Each module includes slides, detailed "instructors notes" for each slide, and "briefing notes" that describe the main points of each slide. The briefing and instructors notes may be copied for distribution to participants. For additional information about the kit, please contact your local EPA Regional Groundwater office.

Precious GEMS: Groundwater Education Strategies that Work. Sandy Fugate. W.K. Kellogg Foundation. 1993.
This report shares the experiences of the Groundwater Education in Michigan (GEM) program, which focuses on educating and empowering local citizens to protect their groundwater at the grass roots level. The report is full of advice and examples of what worked and failed in getting a community active in groundwater protection. The areas of importance are: local ownership, networking, education, leadership, and project sustainability. The report contains the contacts for various GEM projects and an extensive list of groundwater educational materials proven useful by GEM.

Contact: W.K. Kellogg Foundation
Literature Department
One Michigan Avenue
East Battle Creek, MI 49017-4058
(616)968-1611

Appendix B

Protect Your Groundwater: Educating for Action. Christine Mueller, Lucilla Tan, Monica Sullivan, and Elizabeth Kraft. League of Women Voters Education Fund. 1994. This publication is specifically written to help prevent groundwater contamination by educating the public and others about the sources of contamination. Informative diagrams in the introduction make one familiar with groundwater geology. Seven steps to a successful groundwater education program are covered. They are: getting started; researching and developing information, development and distribution of materials, organizing public meetings, forums, and workshops; publicity; fundraising, and keeping the program going. Specific tips, examples of projects, surveys, and publications covers, and case studies show how programs may be implemented. Five appendices provide more addresses, possible sources of groundwater contamination, forms to assist in the implementation of programs, and a list of resources.

Contact: Publications Department
League of Women Voters Education Fund
1730 M. Street, NW, 10th Floor
Washington, DC 20036
(202)429-1965

***Water Sourcebook*: A Series of Classroom Activities for Grades 3-5.**
Produced for Legacy, Inc., Partners in Environmental Education, in cooperation with US EPA. Prepared by Tennessee Valley Authority - Environmental Education Section.

Contact: Water Environment Federation
601 Wythe St.,
Alexandria, VA 22314-1994
(800)-666-0206

Water Wise, Colorado.
A curriculum project consisting of manuscript, computer software and field laboratory kits designed to educate primary and secondary school children in the wise use of water and improving water quality.

Contact: Central Colorado Water Conservancy District
3209 W. 28th St.,
Greeley, CO 80631
(303)-330-4540

Volunteers for the Environment: How-to Manual for Groundwater Protection Projects. Lillian Smith Mandarchik. National Association of RSVP Directors, Inc. 1992. This publication presents a case study of the groundwater protection program in El Paso, Texas, that used the technical training and guidance of volunteers to conduct an inventory of potential sources of groundwater contamination. This inventory was then used to delineate wellhead protection areas. It includes concise steps for recruiting volunteers and advice as to how to: use the media, conduct information seminars, conduct the inventory, and reward volunteers. An extensive list of suggestions for conducting the inventory is included, along with samples of volunteer information, and inventory form, a seminar agenda, and news releases.

Contact: RSVP Program
2 Civic Center Plaza
El Paso, TX 79901

Appendix B

Source Water Protection: An Ounce of Prevention.

This four-hour, two-cassette-length videotape captures the American Water Works Association's teleconference as it was broadcast live on August 3, 1995. All presentations, panel discussions, and question-and-answer sessions are included. Each teleconference video is accompanied by a copy of the 180 page Participant Guide, containing outlines and graphics of all presentations, as well as reprinted articles on related topics.

Contact: American Water Works Assoc.
(800)926-7337
Catalog number of the video and Participant guide: 65098
Catalog number for additional Participant Guides: 20408

Appendix C

There is a wealth of additional published information and technical resources available pertaining to all aspects of the WHP plan. The following materials are available for use by individuals, city/county planners and engineers, elected officials, Public Water System operators and others interested in learning more about protecting groundwater. Internet Web Sites listed on page C-5 are an excellent source of information. For background or basic information regarding the WHP plan, the general guidance documents may be consulted. If more specific or technical information is required, the technical assistance documents may be utilized. Copies may be obtained through the sources listed below; many are free.

Technical Assistance WHP Documents and Videotapes:

General: (Many of these also contain technical guidance on specific elements of WHP plans.)

- "Business Benefits of Wellhead Protection - Report No.1" (EPA 813-B-95-004);
- "Benefits and Costs of Prevention: Case Studies of Community Wellhead Protection - Volume 1" (EPA 813-B-95-005);
- "Benefits and Costs of Prevention: Case Studies of Community Wellhead Protection - Volume 2" (EPA 813-B-95-006);
- "Wellhead Protection: A Guide For Small Communities," (EPA 625/R-93/002);
- "A Guide to Wellhead Protection", American Planning Association - Planning Advisory Service, Report #457/458, August, 1995.
- "Protecting Local Ground-Water Supplies Through Wellhead Protection," (EPA 570/09/91-007);
- "Why Do Wellhead Protection?" (EPA 570/9-91-014);
- "Wellhead Protection Programs: Tools for Local Governments," (EPA 440/6-89-002);
- "The Power To Protect: 3 Stories About Ground Water," (EPA Videotape);
- "Protection of Public Water Supplies from Ground-Water Contamination," (EPA 625/4-85/016);
- "Case Studies in Wellhead Protection: Ten Examples of Innovative Wellhead Protection Management Programs," (EPA 813-R-92-002);
- "An Annotated Bibliography of Wellhead Protection References", (EPA 440/6-87-014);
- "Citizen's Guide To Ground-Water Protection," (EPA 440/6-90-004).

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Delineating Wellhead Protection Areas (WHPAs):

- "Guidelines For Delineation Of Wellhead Protection Areas," (EPA 440/5-93-001);
- "Model Assessment for Delineating Wellhead Protection Areas", (EPA 440/6-88-002);
- "Delineation Of Wellhead Protection Areas In Fractured Rocks," (EPA 570/9-91-009);
- "Wellhead Protection Strategies For Confined-Aquifer Settings," (EPA 570/9-91-008);
- "Wellhead Protection in Confined, Semi-confined, Fractured, and Karst Aquifer Settings", (EPA 813/K-93-001);

Contaminant Source Inventories:

- "Guide For Conducting Contaminant Source Inventories For Public Drinking Water Supplies," (EPA 570/9-91-033);
- "A Review of Sources of Ground-Water Contamination from Light Industry," (EPA 440/6-90-005);

Contaminant Source Management Approaches:

- "Managing Ground Water Contamination Sources In Wellhead Protection Areas: A Priority Setting Approach," (EPA 570/9-91-023);
- "Compendium of Wellhead Protection Ordinances", (EPA 570/9-91-024B, 024C and 024D)

Contingency Planning:

- "Registry of Equipment Suppliers of Treatment Technologies (RESULTS)", National Drinking Water Clearinghouse, 1996.
- "Guide To Ground-Water Supply Contingency Planning For Local And State Governments," (EPA 440/6-90-003);
- "Emergency Management Manual for Rural Water Systems", National Rural Water Association, 1996;
- "Emergency Planning: The Big Picture for Water Utilities", AWWA (#65068V);
- "Emergency Planning for Water Utility Management, Third Edition", AWWA (#30019PA).

Appendix C

- "Wyoming Oil and Hazardous Substances Pollution Contingency Plan", Wyoming , Department of Environmental Quality, November 1989.
- "Emergency Response Handbook", Utah Department of Environmental Quality, Division of Drinking Water (DEQ-DDW), Salt Lake City, Utah, March 1992.
- "Manual of Small Public Water Supply Systems", EPA 570/9-91-003, May, 1991.
- "Protection of Public Water Supplies from Ground--Water Contamination", EPA 625/4-85/016.
- "Environmental Pollution Control Alternatives: Drinking Water Treatment for Small Communities", EPA 625/5-90/025, April, 1990.

Funding:

- "Local Financing For Wellhead Protection," (EPA 440/6-89-001).

To Order Copies of EPA Documents:

- Use Form(s) at the end of this Section:
- EPA Safe Drinking Water Hotline: (800)-426-4791
- Groundwater Protection Document Request Hotline: (800)-426-4791
- National Technical Information Service Hotline: (703)-487-4650

Others:

- American Water Works Association (AWWA): (800)-926-7337
- National Drinking Water Clearinghouse (NDWC): (800)-932-7459.
- National Rural Water Association (NRWA): (307)-436-8636

List of Contacts to Obtain Copies of State WHP Plan Guidance Document:

- Wyoming Department of Environmental Quality/Water Quality Division:

  Cheyenne: (307)-777-7781
  Sheridan: (307)-672-6457
  Lander: (307)-332-3144

- Wyoming Association of Rural Water Systems: (307)-436-8636

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List of Technical Information Contacts:

- Wyoming Department of Environmental Quality/Water Quality Division:

  Cheyenne: (307)-777-7781
  Sheridan: (307)-672-6457
  Lander: (307)-332-3144

- Wyoming Association of Rural Water Systems: (307)-436-8636

- Wyoming State Engineer's Office:

  Cheyenne: (307)-777-6163
  Torrington: (307)-532-2248
  Sheridan: (307)-674-7012
  Riverton: (307)-856-0747
  Cokeville: (307)-279-3441

- Wyoming Oil & Gas Conservation Commission: (307)-234-7147

- Wyoming Department of Agriculture: (307)-777-6792

- Wyoming Water Development Commission: (307)-777-7626

- Wyoming Water Resources Center: (307)-766-2143

- Geological Survey of Wyoming: (307)-766-2286

- Department of Health: Local

- UW Cooperative Extension Service: Local

- EPA (Region VIII): (800)-227-8917

- US Geological Survey - Water Resource Division: (307)-778-2931

- Natural Resource and Conservation Service: Local

- Bureau of Land Management: Local

- US Forest Service Local

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Internet Web Site Addresses:

WDEQ: http://deq.state.wy.us

Wyoming Natural Resources Data Clearinghouse: http://www.sdvc.uwyo.edu/clearinghouse

EPA Home Page: http://www.epa.gov

EPA Office of Ground Water and Drinking Water: http://www.epa.gov/OGWDW

EPA Office of Wetlands, Oceans and Watersheds: http://www.epa.gov/OWOW

EPA's "Surf Your Watershed": http://www.epa.gov/surf

USGS: http://water.usgs.gov

Nat'l. Drinking Water Clearinghouse: http://www.ndwc.wvu.edu

Appendix C
(EPA Document Request Forms)

GROUND-WATER PROTECTION DOCUMENT REQUEST

NAME: _____ TITLE: _____

ORGANIZATION: _____

ADDRESS: _____

CITY: _____ STATE: _____ ZIP: _____

EPA Region
Fed/Other
State
Local
Company
Individual
Int'l.
Other

EPA NUMBER	REF. NO.	TITLE	QTY
440/6-84-002	*G-1	EPA Ground-Water Protection Strategy	
	*G-2	Guidelines for Ground-Water Classification Under the EPA Ground-Water Protection Strategy	
440/6-87-013	*G-3	Improved Protection of Water Resources from Long-Term and Cumulative Pollution Prevention of Ground-Water Contamination in the U.S.	
440/6-84-001	*G-4	Protecting Ground-Water: The Hidden Resource	
440/6-85-006	*G-5	Protecting Our Ground-Water	
440/6-89-004	G-6	Funding of Ground-Water Protection: Quick Reference to Grants Available Under the Clean Water Act	
440/6-90-001	G-7	Progress in Ground-Water Protection and Restoration	
440/6-90-004	G-8	Citizen's Guide to Ground-Water Protection	
440/6-90-008	G-9	Compendium of Federal Financial Assistance Programs. Targeting Programs for State and Local Ground-Water Protection	
21Z-1020	G-10	Protecting The Nation's Ground-Water: EPA's Strategy For The 1990s	
440/6-87-014	*WP-1	An Annotated Bibliography of Wellhead Protection References	
440/6-88-003	WP-2	Developing a State Wellhead Protection Program: A User's Guide to Assist State Agencies under the Safe Drinking Water Act	
440/6-87-011	*WP-3	Guidance for Applicants for State Wellhead Program Assistance Funds under the Safe Drinking Water Act	
440/6-87-010	WP-4	Guidelines for Delineation of Wellhead Protection Areas	
440/6-88-002	WP-5	Model Assessments for Delineating Wellhead Protection Areas	
440/6-87-009	WP-6	Wellhead Protection: A Decision Makers' Guide	
440/6-89-002	WP-7	Wellhead Protection Program: Tools for Local Governments	
440/6-89-001	WP-8	Local Financing for Wellhead Protection	
440/6-90-002	WP-9	Hydrogeologic Mapping Needs for Ground-Water Protection and Management: Workshop Report	
440/6-90-003	WP-10	Guide to Ground-Water Supply Contingency Planning for Local and State Governments: Technical Assistance Document	
570/9-91-007	WP-11	Protecting Local Ground-Water Supplies Through Wellhead Protection	
570/9-91-008	WP-12	Wellhead Protection Strategies for Confined Aquifer Settings	
570/9-91-009	WP-13	Delineation of Wellhead Protection Areas in Fractured Rocks	
440/6-87-008	*SG-1	State and Territorial Use of Ground-Water Strategy Grant Funds (Section 106 of the CWA)	

* Available through NTIS only - see back for more information

ORDERED BY: _____ DATE: _____

METHOD OF DELIVERY: (Circle one) Pick-up/Courier Overnight Regular Mail 1st Class UPS

Appendix C
(EPA Document Request Forms)

EPA NUMBER	REF. NO.	TITLE	QTY
440/6-88-007	*SG-2	Survey of State Ground-Water Quality Protection Legislation Enacted 1985-1987	
440/6-87-002	*SC-1	EPA Activities Related to Sources of Ground-Water Contamination	
0/6-86-002	*SC-2	Pesticides in Ground-Water: Background Document	
440/6-88-001	*SC-3	Protecting Ground-Water: Pesticides and Agricultural Practices	
440/6-86-006	SC-4	Septic Systems and Ground-Water Contamination: A Program Manager's Guide and Reference Book	
440/6-86-005	SC-5	Septic Systems and Ground-Water Contamination: An Executive's Guide	
440/6-87-007	SC-6	Septic Tank Siting to Minimize the Contamination of Ground-Water by Microorganisms	
440/6-90-005	SC-7	A Review of Sources of Ground-Water Contamination from Light Industry: Technical Assistance Document	
670/9-91-010	SC-8	A Review of Methods for Assessing Nonpoint Source Contaminated Ground-Water Discharge to Surface Water	
440/6-88-005	DM-1	EPA Workshop to Recommend a Minimize Set of Data Elements for Ground-Water: Workshop Findings Report	
600-M-86-007	*DM-2	Ground-Water Data Management with STORET	
440/6-87-006	*DM-3	Ground-Water Data Requirements Analysis	
440/6-88-006	DM-4	Indicators for Measuring Progress in Ground-Water Protection	
440/6-87-016	*SS-1	Sole Source Aquifer Background Study: Cross-Program Analysis	
440/6-87-003	*SS-2	Sole Source Aquifer Designation Petitioners Guidance	
904/6-88-001		Application of Dye-Tracing Techniques for Determining Solute-Transport Characteristics of Ground-Water in Karst Terranes	

Send Orders To:

U.S. Environmental Protection Agency
Ground-Water Protection Division
Washington, D.C. 20460

Phone Orders:

(202) 260-7779

For NTIS Request, Please send NTIS Document Number To:

U.S. Department of Commerce
National Technical Information Service (NTIS)
Springfield, VA 22161
(703) 487-4650

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OFFICE OF WATER

NAME: _____

ADDRESS: _____

_____

_____

1. _____ 570/9-89-AAA Lead Contamination Control Act
2. _____ 570/9-89-BBB The Lead Ban
3. _____ 570/9-89-CCC Public Notification: Reporting Violations
4. _____ 570/9-89-DDD Public Water Systems
5. _____ 570/9-89-EEE Volatile Organic Chemicals
6. _____ 570/9-89-FFF Unregulated Contaminant Monitoring
7. _____ 570/9-90-GGG Bottled Water:. Helpful Facts and Information
8. _____ 570/9-90-HHH Home Water Treatment: Filtering Fact From Fiction
9. _____ 570/9-89-005 Is Your Drinking Water Safe?
10. _____ 570/9-89-006 Public Notification for Public Water Systems (Flyer)
11. _____ 570/9-89-007 Cross-Connection Control Manual
12. _____ 570/9-89-008 Protection Our Drinking Water From Microbes
13. _____ 570/9-90-001 Maintaining Safe Drinking Water
14. _____ 570/9-90-002 Your Drinking Water: From Source to Tap (EPA Regulations & Guidance)
15. _____ 570/9-90-005 Citizen Monitoring: Recommendations to Public Water System Users
16. _____ 570/9-90-006 Citizen Monitoring: Recommendations to Household Well Users
17. _____ 570/9-90-007 Science Demonstration Projects in Drinking Water (Grades K-12)
18. _____ 570/9-90-013 Drinking Water from Household Wells
19. _____ OPA 87-006 Lead and Your Drinking Water
20. _____ 570/9-91-000 Office of Drinking Water Publications Listing
21. _____ 570/9-90-600 SDWA - Pocket Guide to the Requirements for the Operators of Small Water Systems

MAIL TO: CHARLENE SHAW OR CALL: PAT WOODS
OFFICE OF DRINKING WATER (202) 382-7786
USEPA, WH-550A, E1013B FTS 382-7786
401 M STREET
WASHINGTON, D.C. 20460
(202) 382-2285/FTS 382-2285

Appendix D

METHODS FOR THE DELINEATION OF WELLHEAD PROTECTION AREAS (WHPAs)

The Environmental Protection Agency (EPA) has recognized a wide variety of techniques to determine WHPAs ranging from very simple non-analytical methods to complex numerical transport models (see EPA, 1993, Guidelines for Delineation of Wellhead Protection Areas, EPA-440/5-93-001). According to Hasfurther and others (1992), selection of these methods is based on user expertise, available resources, existing and field collected data, and the desired degree of confidence in meeting protection goals.

The delineation method(s) chosen in establishing a WHP plan will determine the type and quantity of data required for delineation.

The techniques which EPA has identified for delineation of WHPAs are:

- Arbitrary Fixed Radius (AFR);
- Calculated Fixed Radius (CFR);
- Simplified Variable Shapes (SVS);
- Analytical models (AM);
- Hydrogeologic Mapping (HM); and
- Several Numerical Flow/Transport Models (NM).

These methods are listed generally in order of increasing complexity (i.e. sophistication) and not all of these methods may be applicable in every case. Hasfurther and others (1992) have outlined the limitations and strengths of each method and the differing amounts of data required to implement each method as described below.

The Arbitrary Fixed Radius, Calculated Fixed Radius, Hydrogeologic Mapping and Analytical Models methodologies have been adopted by the Wyoming Wellhead Protection Advisory Committee for use in delineating Wellhead Protection Areas (WHPAs) in Wyoming.

Arbitrary Fixed Radius (AFR):

The AFR method sets a fixed distance from a well, spring or tunnel, circumscribing a zone of equal distance around the well. It is used to define Zone 1 (**Accident Prevention Zone**) for wells completed in all types of aquifers (i.e. unconfined, semi-confined and confined) and flow conditions (i.e. diffuse and/or conduit flow). The AFR method is simple to apply and normally inexpensive.

As the name implies, the AFR technique is not based on in-depth knowledge of aquifer

properties or well characteristics, but rather considers existing regulatory drinking water supply set-back distances to establish the threshold for Zone 1. This gives the technique its virtue (simplicity), and its weakness (it may or may not afford adequate protection, resulting in either over-protection or under-protection of the drinking water supply). Since the AFR method is based on limited scientific criteria, the method has a degree of uncertainty attached to it.

Calculated Fixed Radius (CFR):

The CFR method is a relatively simplistic method that can be applied to many sources (i.e. wells, springs, tunnels) and is used to determine the circular areas (around the source) through which groundwater will travel over some period of time. The travel time of groundwater from the edge of the circle to the source well is dependent on the radius of the circle.

CFR is an appropriate method to use when groundwater flow to the well, spring or tunnel can be characterized as *'porous'* or *'diffuse'*, as opposed to *'conduit'* flow. Use Table II-1 (Section II of *Wyoming's Wellhead Protection Guidance Document*) to first determine if *'conduit'* flow conditions prevail; apply the CFR equation (Appendix D, Table D-1) to determine the 2 year and 5 year Time-of-Travel radii if *'porous'* or *'diffuse'* flow is confirmed when following Table II-1. If *'conduit'* flow is confirmed, refer to Table II-2 (Section II of *Wyoming's Wellhead Protection Guidance Document*) for instruction.

The CFR technique establishes a cylinder down into the aquifer where the radius of the cylinder is based on the Time of Travel (TOT) to the well; Table II-2 in Section II of this document establishes minimum TOT criteria (i.e. 2 years and 5 years) for using the CFR method to delineate Zones 2 and Zone 3 of the WHPA when *porous* or *diffuse* flow types prevail. TOT is an operationally defined measure of the rate of groundwater flow to the well, wellfield, spring or tunnel. The method is called the *"Calculated Fixed Radius"* (CFR) method because the area it describes is a circle, which has an equal radius in all directions. The radius is the distance from the well to a point where groundwater (and contaminant) travel time to the well is 2 years (or 5 years). Input data requirements are limited, consisting of the pumping rate, open (screened interval) of the well, porosity of the aquifer, and the selected TOT.

The CFR technique may not provide sufficient protection for the well-field. While it does take some aquifer properties into account, its tendency to generalize leads to errors, especially where the subsurface geology is markedly heterogeneous. Wyoming aquifers are frequently very heterogeneous, even on a relatively small geographic scale. An alluvial aquifer usually draws its water from alluvial type sediments which are often laced with pockets of cobbles, silt, and clay and may provide preferential flow paths or act as barriers to flow. Applying the CFR technique to wells completed in alluvium may not completely protect the wellfield from contamination arising from surface activity. For this reason, a **Factor of Safety (F.S.)** is incorporated in the CFR technique. Figure D-1 illustrates the CFR Method and Table D-1 provides the CFR equation and definitions of the required input data, including default values and Factors of Safety to be used for delineating Zones 2 and 3. An example of calculating the *annual average pumping rate* for a well follows Table D-1.

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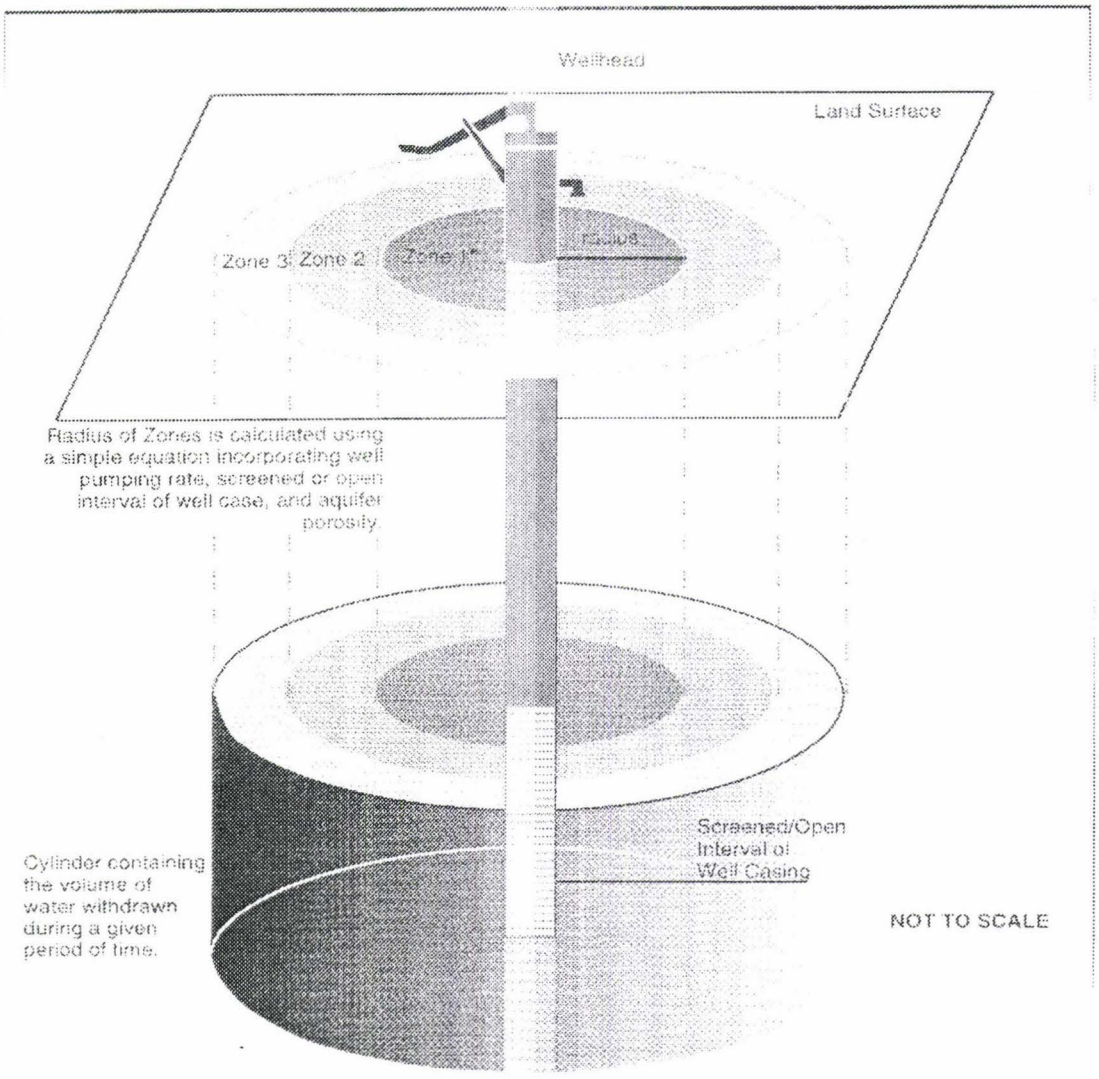

$$r = FS\sqrt{\frac{Qt}{7.48nH\pi}}$$

Where:
Q = Pumping Rate of Well
n = Aquifer Porosity = (See Table D-1)
H = Open Interval or Length of Well Screen
t = Time of Travel (2 years, 5 years)
F.S.(Safety Factor) = 1.3 if all values known
= 1.5 otherwise

*Note that for Zone 1, r = 50 or 100 feet
(See Table D-1 for more information)

Figure D-1
WYOMING WHP PROGRAM
ILLLUSTRATION OF A CALCULATED FIXED RADIUS MODEL

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The 2 year (Zone 2) and 5 year (Zone 3) radii should be plotted, together with Zone 1, on a base map that shows major landmarks and topography. A 7 1/2 minute U.S. Geological Survey topographic map is generally acceptable. This is a map with a map scale of 24,000:1 or approximately 2.5 inches per mile. A map with a larger scale (3 to 4 inches per mile) is preferable in order to locate and identify potential contaminant sources that will be added to the map.

Table D-1
Calculated Fixed Radius (CFR) Equation, Definitions and Default Values

Calculated Fixed Radius Equation:	$r = FS\sqrt{\frac{Qt}{7.48nH\pi}}$
r_{min}	*Radius* of Zones 2 (and 3) measured from the well (in feet).
Q	*Annual average pumping rate* in gallons per year. Calculate or estimate as accurately as possible; should not be less than 5,000,000 gallons/year.
t	*Time-of-Travel* = 2 years for Zone 2; 5 years for Zone 3
n	*Porosity* (Ratio of pore volume in aquifer to total volume) Use actual value if known. If aquifer lithology is known, but not porosity, use: Fractured Shale or Fractured Crystalline Rock (Diffuse Flow) 0.02 Fractured Soluble Rocks (e.g. Limestone) (Diffuse Flow) 0.05 Sandstone or Glacial Till 0.15 Fractured Sandstone (Diffuse Flow) 0.17 Alluvium, Gravels, Sands, and Unconsolidated to Partially Consolidated Sandstone and Conglomerate 0.25
H	*Screened or perforated interval*[1] of well (feet). Actual Length, or 10 feet.
π	*pi* = 3.1416
7.48	*Conversion factor*: Gallons to ft^3.
F.S.	*Factor of Safety:* (to provide 'Buffer Zone') = 1.3 (when all values are known) = 1.5 (when one or more values is not known)

1 "Screened Interval" refers to the length of screening or perforation in the well through which water is pumped from the aquifer. If there is more than one screened interval, add the lengths together and use the sum for this value. For an unscreened well, the equivalent term is "Open Interval". This information may be available on the well log, the State Engineers' Office *Statement of Completion*, geologic or engineering reports. It is possible that the well has no screened (open) interval. If this is the case, or if you are unable to obtain this information, or for springs and tunnels, use a value of 10 feet.

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Example Calculation: Annual Average Pumping Rate

Use water meter data to perform this calculation if your source is metered. If your source is not metered, you will have to estimate your annual water volume (gal/year). If you know your pumping rate in gallons per minute (gpm) you can estimate annual usage in the following manner:

gal/min. x 60 min/hr x hr/day x day/year = gal/year

The next best method would be to substitute the value for pump capacity in place of pumping rate to estimate annual usage.

A third alternative would be to estimate your annual pumping based on the number of service connections on your system. For planning purposes, WDEQ/WQD considers 400 gallons a day per connection to be an average rate of consumption. This method works best for small community systems with single primary sources. With this method, the calculation would be:

# of service connections	X 400 Gallons per day per connection	X Average use days per year (365 for most)	= Estimated average pumping rate per year
50 connections	X 400 Gallons / day / connection	X 365 days / year	= 7,300,000 gallons / year

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Simplified Variable Shapes (SVS):

As detailed in Guidelines for Delineation of Wellhead Protection Areas (EPA-440/5-93-001), the SVS procedure involves generating a set of shapes that represent an array of hydrogeologic and pumping conditions. The variable shapes are calculated by computing the distance to downgradient and lateral extent of the groundwater flow boundaries around a pumping well according to analytical equations such as the uniform flow equations. The appropriate shape is then selected for the hydrogeologic and pumping conditions matching or similar to those found at the wellhead, and the shape is oriented around the well according to the groundwater flow patterns. A TOT or flow-system boundary criterion then determines the upgradient extent of the WHPA. The method is fairly easy to apply and requires little sophistication on the part of the modeler once the shapes have been defined. Data input is only slightly more involved than the CFR with the additional account of basic hydrogeologic parameters.

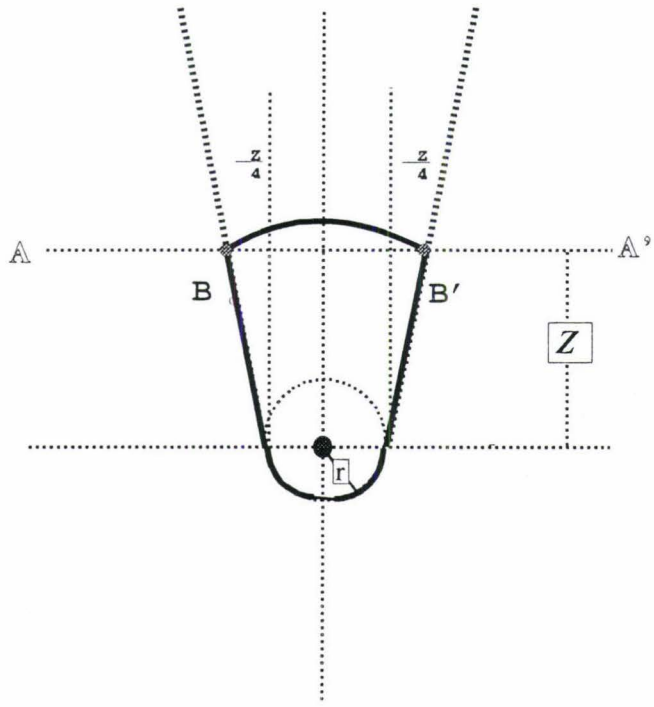
Where reasonable estimates of the hydraulic conductivity and hydraulic gradient can be determined (such as from median or conservative values cited in the literature, and generalized, regional potentiometric surface maps) a slightly more sophisticated method (Figure D-2) than the CFR may be employed. This **"Modified Simplified Variable Shapes"** method is particularly suitable for rural, non-community PWSs where site-specific data is limited, but regional or generalized information is available. The principle behind this method is in providing a factor of safety or buffer zone around what would be a good assessment of a WHPA if the data were more accurate, detailed, and reliable. For instance, in delineating a WHPA using the uniform flow equations (see Analytical Models below), the ZOC may be interpreted as a long, narrow band upgradient from the well. However, if the hydraulic gradient used in this delineation is over-estimated, the ZOC should be more circular and include more of the downgradient and lateral regions. In fact, as the hydraulic gradient goes to zero (stagnant groundwater), the CFR best estimates the ZOC. The Modified Simplified Variable Shapes method thus accounts for under-estimated hydraulic gradients by including a buffer zone in the upgradient direction, over-estimated hydraulic gradients by including a buffer zone in the downgradient direction, and poorly estimated flow lines by including a buffer zone defined by extending the region out 250 feet for every 1000 feet upgradient from the CFR. These buffer zones also serve as a factor of safety given uncertainty in the hydraulic conductivity value.

This method does not adequately represent aquifers with substantial hydrogeologic variability (heterogeneity) and does not take into account hydrologic boundaries such as irrigation canals, lakes, or streams. As previously described, flow in many Wyoming aquifers is affected by geologic and hydrologic boundary conditions. For example, the hydrology of some Wyoming community's water supplies is influenced by the irrigation canals upgradient and a major river downgradient. The degree of influence of these boundaries may vary seasonally as the water levels from these features change. Where hydrologic boundaries may exist, *Hydrogeologic Mapping and/or Field Test Data* should be employed to and applied to appropriately establish Zones 2 and 3 of the WHPA.

Figure D-2

Appendix D

Modified Simplified Variable Shape



To delineate a WHPA using the Modified Simplified Variable Shape method:

1) Draw a circle around the well using the Calculated Fixed Radius method (see Fig. D-1):

$$r = F.S.\sqrt{\frac{Qt}{7.48nH\pi}}$$

2) Draw a centerline though the well in the up-gradient direction of flow to determine the approximate distance of travel from the well ("*z*") using

$$z = \frac{Ki}{n}t$$

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Table D-2
Modified Simplified Variable Shape method
Equation Constants

Equation Constants	Description
n	*Porosity* (Ratio of pore volume in aquifer to total volume) Use actual value if known. If aquifer lithology is known, but not porosity, use: Fractured Shale or Fractured Crystalline Rock (Diffuse Flow) 0.02 Fractured Soluble Rocks (e.g. Limestone) (Diffuse Flow) 0.05 Sandstone or Glacial Till 0.15 Fractured Sandstone (Diffuse Flow) 0.17 Alluvium, Gravels, Sands, and Unconsolidated to Partially Consolidated Sandstone and Conglomerate 0.25
K	Hydraulic Conductivity
I	Hydraulic Gradient
t	*Time-of-Travel* = 2 years for Zone 2; 5 years for Zone 3

3) Draw a line perpendicular to the centerline at a distance '*z*' from the centerpoint; label this line A-A'

4) Draw two lines tangent to the circle and parallel to the centerline. Where these cross line A-A', measure outward a distance z/4; show as points B and B'.

5) Draw tangent lines from B and B' to the circle.

6) Using the well as the centerpoint draw as arc from B to B'. (Hydrologic boundaries, when present, may provide this up-gradient boundary)

Appendix D

Analytical Models (AM)[1]:

The AM approach uses well established hydrologic equations to model groundwater flow and pollutant transport. A host of such analytical equations are available. The equations are generally fairly simple to solve but require a number of input hydrologic parameters which are generally assumed to be homogeneous throughout the saturated depth of the aquifer. This method tailors the results to a specific site through the use of the input parameters and, thus, can achieve considerable accuracy at a modest cost. Again, assumed subsurface uniformity may be a problem.

EPA's guidance document *"Delineation of Wellhead Protection Areas in Fractured Rocks"* contains good descriptions of established hydrologic equations such as the Uniform Flow Equation and TOT calculations based on groundwater velocity. These equations can be used to delineate WHPAs that are more sophisticated, accurate, and defensible than WHPAs delineated by the CFR method.

Despite the increase of accuracy and defensibility, there is always some level of uncertainty involved. This is especially true where analytical equations and models derive long and narrow WHPAs which have a high sensitivity to the position of the potentiometric contours. From the perspective of implementation, there is a significant problem with a narrow WHPA because a relatively small error in the potentiometric map can result in a major shift in the ZOC. Therefore, a factor of safety or "buffer zone" around WHPAs delineated by analytical equations and models is, again, a practice that is strongly encouraged. For example, a buffer zone may extend outward from the mapped ZOC boundary by 250 feet for every 1000 feet of distance upgradient from the well.

What follows is a list and brief discussion of analytical and semi-analytical computer software developed by EPA which uses hydraulic and groundwater flow equations to model WHPAs based upon time-of-travel criteria. Sources and contacts for additional information (including WHPA and W*h*AEM software and user guides) available for use in completing WHPA delineations and *Delineation Reports* are provided in Appendix C.

WHPA, version 2.2, is a semi-analytical groundwater flow model that consists of four computational modules designed to delineate WHPAs. This model was developed for the EPA Office of Groundwater Protection to assist communities in delineation of WHPAs. WHPA is thought to be an appropriate technique for many situations where the contaminant of interest is conservative. In other words, groundwater flow approximates solute movement in an unconfined, shallow aquifer. An example of the output from WHPA, version 2.2 for one of the

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[1] Copies of the WHPA and W*h*AEM semi-analytical models, including instruction manuals can be obtained free of charge by sending requests to: NRMRL/SPRD, CSMoS, P.O. Box 1198, Ada, OK, 74821-1198, (405)-436-8594. Contact NRMRL for instructions prior to ordering. Models and manuals can also be downloaded off the Internet via NRMRL's Homepage at http://www.epa.gov/ada/kerrlab.html.

wells serving the City of Cheyenne (which taps the Ogallala aquifer) is depicted on Figure D-2. Three of the modules calculate capture zones for two-dimensional, steady state groundwater flow. The fourth module, called Monte Carlo, performs an uncertainty analysis of the delineated capture zone and is not individually discussed herein. The four modules are: (1) RESSQC, (2) the Multiple Well Capture Zone module (MWCAP), (3) the General Particle Tracking module (GPTRAC), and (4) the Monte Carlo module (Montec).

GPTRAC Option. The General Particle Tracking module (GPTRAC) contains two components, a semi-analytical and a numerical option. The numerical option is designed to be used as a post processor for numerical groundwater flow models. This option requires as input the hydraulic heads at nodes of the rectangular grid system. The head information is utilized to calculate x and y direction velocity components of groundwater flow at the edges of each grid block. Numerical integration of velocity components with respect to time and space is then applied to describe capture zones and streamlines.

The primary advantage of the numerical option is that a heterogeneous aquifer with complex boundary conditions can be considered. This method allows the aquifer to be divided into many zones with varying porosity, saturated thickness, and transmissivity in both the x and y directions. The numerical option delineates capture zones around pumping wells for steady state groundwater flow. Consequently, some assumptions are necessary as to the average daily pumping rates of municipal wells.

One shortcoming of this module is that it sometimes fails to produce reasonable results for smaller time-related capture zones. For simulation times less than three years, the capture zone pathlines sometimes do not conform to the regional hydraulic gradient. The EPA Office of Groundwater Protection recommends time periods of 10 to 25 years when determining time-related capture zones. It is necessary with this method to balance, when considering the lengths of simulation periods, the limited size of the study area and constraints of the model.

In conclusion, the GPTRAC numerical module appears to be the most versatile method. It is capable of delineating WHPAs for a heterogeneous aquifer(s) with a complex flow system. This module is limited only by the numerical model used to obtain the potentiometric head map.

The semi-analytical option assumes a system of pumping and injection wells that fully penetrate a homogeneous aquifer under steady state conditions. A constant-head or no-flow boundary can be specified along any edge of the study area. Well interferences are accounted for by superposition of solutions. Specifically, the input requirements include: (1) the regional hydraulic gradient, (2) the direction of groundwater flow, (3) porosity, (4) saturated thickness, and (5) transmissivity, etc. From the input information, it is evident that this module is best suited for a one-directional, homogeneous flow system with simple boundary conditions and a constant hydraulic gradient.

RESSQC Option. RESSQC is used to delineate time-related capture zones for a steady-state flow system including both injection and pumping wells in a homogeneous aquifer. Stream and

barrier boundaries can be implemented using image well theory. Well interferences arising in a multiple well system are determined by superposition. The primary disadvantage of this method is that aquifer flow parameters such as, hydraulic gradient and flow direction, are held as constants. The impermeable zones in a study area have to be simulated with image wells.

MWCAP Option. The Multiple Well Capture Zone module (MWCAP) is designed to delineate time-related capture zones for steady-state pumping wells in a homogeneous aquifer. Streams or boundaries can be simulated and are assumed to be linear and fully penetrating. Well interferences are neglected; each well is assumed to operate independently.

This module provides a little more flexibility, in some ways, than the RESSQC module discussed previously. Input parameters can be specified for each well rather than for the entire aquifer. Input requirements for each well include: (1) regional hydraulic gradient, (2) flow direction, (3) conductivity, (4) saturated thickness, (5) porosity, and (6) the boundary type and the perpendicular distance from the well.

WhAEM, also developed by EPA, has superseded and improves upon WHPA 2.2 and is an analytical groundwater model developed to determine time-of-travel capture zones in relatively simple hydrological settings for either confined or unconfined aquifers. WhAEM consists of two executables: the preprocessor GAEP, and the flow model CZAEM. GAEP is designed to simplify the procedures for getting data into a groundwater model; specifically it facilitates the interactive process of groundwater flow modeling that precedes capture zone delineation. WhAEM can handle fairly realistic boundary conditions such as streams, lakes and aquifer recharge due to precipitation.

The WHPA modeler must have some familiarity with the site being delineated and be able to use sound judgment in selecting input information from the range of hydrologic values likely to be available. Costs associated with obtaining input data are about the same as for the Simplified Variable Shapes (SVS) technique.

Hydrogeologic Mapping (HM):

HM identifies the physical and hydrologic features that control groundwater flow within an aquifer system. Included within this method is ***Flow-System Mapping*** which delineates the ZOC for a well, spring, or tunnel by identifying flow system boundaries. Physical boundaries to groundwater flow can include the geologic contacts that form the limits of the aquifer, structural features such as fault-block walls or zones of fracturing, and topographic features that may function as groundwater divides. Hydrologic features, including rivers, canals, and lakes can also function as flow-system boundaries.

Vulnerability Mapping is another HM technique which identifies areas particularly vulnerable to groundwater contamination. Such areas include shallow or exposed bedrock, permeable soils, faults zones, fracture zones, and karst features such as solution cavities and sinkholes. For the purposes of wellhead protection, it is most important to find the vulnerable areas where

contaminants potentially released at the surface may be most likely transported to the water supply. Vulnerability mapping does not necessarily produce a ZOC for a given well; used in combination with flow-system mapping however, it is an excellent method for assessing the susceptibility of more specific regions within the flow-system boundaries to groundwater contamination.

Aquifer 'sensitivity' maps are available for many Wyoming counties[2] and are excellent tools for identifying areas within WHPAs where the 'uppermost' aquifer is most 'sensitive', or susceptible to contamination from a release of a contaminant at the surface. Generally speaking, 'sensitive' areas within WHPAs may be considered to be vulnerable to contamination unless adequate protection measures (see Section IV of *Wyoming's Wellhead Protection Guidance Document)* are in place.

HM works well in regions where subsurface geology is variable, such as in fractured rocks, and where near surface boundaries occur. EPA (see EPA, 1991, *Delineation of Wellhead Protection Areas in Fractured Rocks*, EPA-570/9-91-009) suggests the flow-system boundary criterion is an excellent approach to use when hydrologic boundaries are close to a well, spring or tunnel; however, when boundaries are distant, EPA (1991) indicates the WHPA may be too large to manage effectively.

The information required for hydrogeologic mapping is available for most of the populated areas of the state. These include topographic maps, aerial photos, geologic and hydrogeologic maps and reports, well logs, geologic field reconnaissance data, and aquifer test data. Topographic maps suggest the location of groundwater divides in unconfined aquifers. Aerial photos can be used to locate faults and fracture traces; infrared photos identify riparian vegetation that can indicate the extent of an unconfined alluvial aquifer. Hydrogeologic maps and reports contain information on aquifer parameters such as gradient, transmissivity, direction of flow and hydraulic conductivity. Geologic reports show outcrop areas and strike and dip of aquifer formations; they also show the location of faults, synclines and anticlines. Well logs contain a description of aquifer materials, evidence of fracturing, well completion, pump test, depth of the well and static water level.

Professional geologic/hydrogeologic training and experience is required on the part of the investigator to interpret all mapping data. For example, hydrogeologic investigations in fractured rock aquifers typically requires two approaches to fracture characterization. The discrete approach requires investigating each individual fracture. Conversely, the continuum approach assumes the fractured medium approaches a porous medium at some working scale. The mapping data may not be sufficiently detailed to accurately reflect the subsurface conditions. Costs accrued in obtaining required hydrologic knowledge will vary with the complexity of the subsurface lithology. An example of a WHPA delineated using HM is depicted on Figure D-3 for a PWS in the Overthrust Belt area near southwestern Wyoming.

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[2] Contact the Wyoming Water Resources Center or WDEQ/WQD (Appendix C) for information on availability and ordering.

Appendix D

Aquifer ***Field Tests*** also can provide information useful for the characterization of aquifer (and well) flow systems and boundary conditions. While not exclusively a subset of the *Hydrogeologic Mapping* method, scientists and engineers can often delineate WHPAs from field test data and observations. For further descriptions and additional information on these types of tests and the results they produce, please refer to the EPA document referenced above.

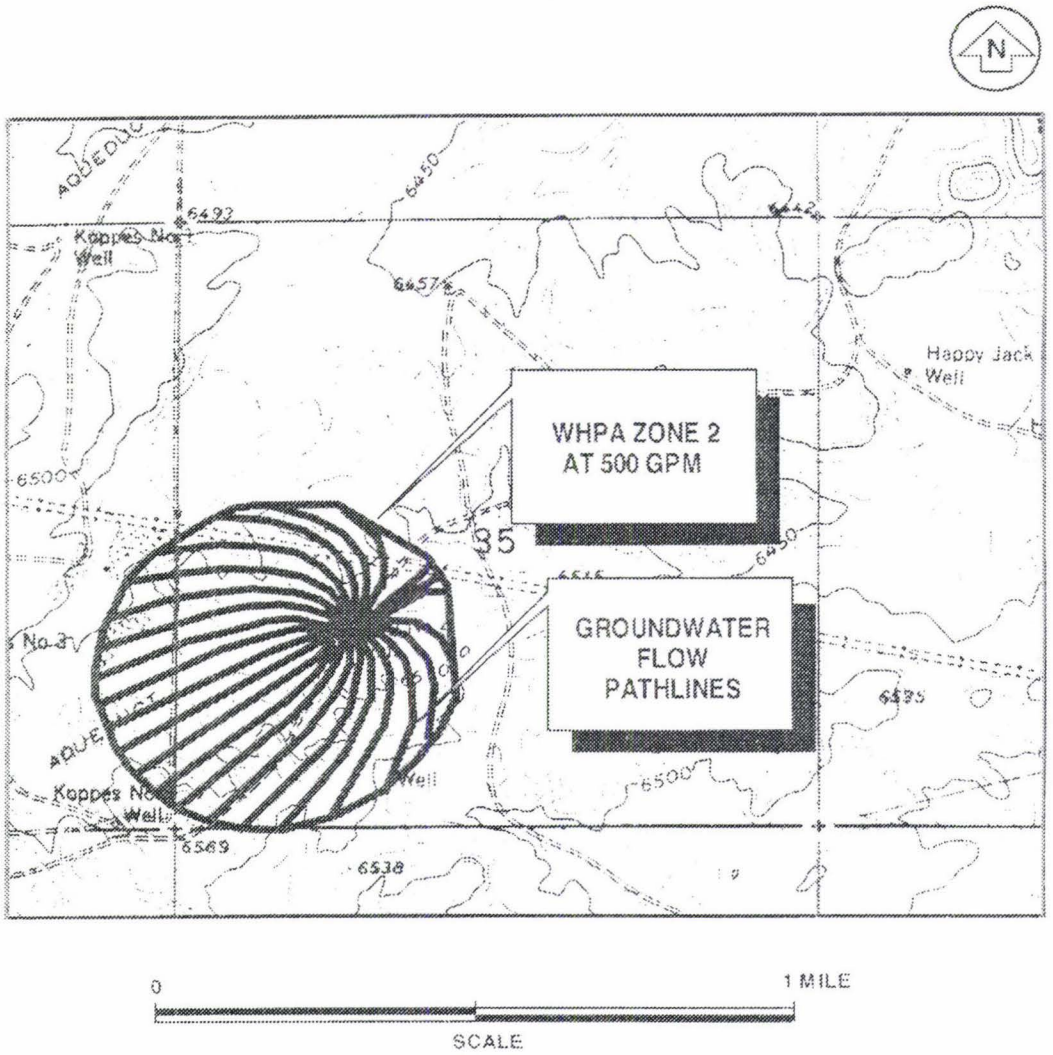

Figure D-3
EXAMPLE OF EPA MODEL
CITY OF CHEYENNE BOARD OF PUBLIC UTILITIES
KING No. 4 WELL

Appendix D

Numerical Models (NM):

Numerical models allow intricate subsurface conditions and hydrologic features to be represented with a fair degree of accuracy. Some models may use analytical models to depict contaminant transport, affixing the analytical transport model to the numerical flow model which includes advection and dispersion processes within the aquifer. The models demand a considerable amount of input information, particularly if they have analytical components. If the model is to be accurate, the number of grid cells needs to be numerous in regions where strong changes are occurring. This increases the overall cost of the modeling and may require the use of a mainframe or larger microcomputer. The modeler must be experienced in its use and be able to recognize the model's limitations and quirks. Generally, communities in Wyoming do not have people on staff with sufficient expertise to readily and accurately apply the NM technique, and an outside consultant would generally be needed in order to carry out numerical WHPA delineation studies.

WHPA Version 2.2: GPTRAC - Numerical Option. The General Particle Tracking module (GPTRAC) contains two components, a semi-analytical and a numerical option. The numerical option is designed to be used as a post processor for numerical groundwater flow models. This option requires as input the hydraulic heads at nodes of the rectangular grid system. The head information is utilized to calculate x and y direction velocity components of groundwater flow at the edges of each grid block. Numerical integration of velocity components with respect to time and space is then applied to describe capture zones and streamlines.

The primary advantage of the numerical option is that a heterogeneous aquifer with complex boundary conditions can be considered. This method allows the aquifer to be divided into many zones with varying porosity, saturated thickness, and transmissivity in both the x and y directions. The numerical option delineates capture zones around pumping wells for steady state groundwater flow. Consequently, some assumptions are necessary as to the average daily pumping rates of municipal wells.

One shortcoming of this module is that it sometimes fails to produce reasonable results for smaller time-related capture zones. For simulation times less than three years, the capture zone pathlines sometimes do not conform to the regional hydraulic gradient. The EPA Office of Groundwater Protection recommends time periods of 10 to 25 years when determining time-related capture zones. It is necessary with this method to balance, when considering the lengths of simulation periods, the limited size of the study area and constraints of the model.

In conclusion, the GPTRAC numerical module appears to be the most versatile method. It is capable of delineating WHPAs for a heterogeneous aquifer(s) with a complex flow system. This module is limited only by the numerical model used to obtain the potentiometric head map.

Other commonly used numerical models include MODFLOW, FLOWPATH, PLASM and SUTRA.

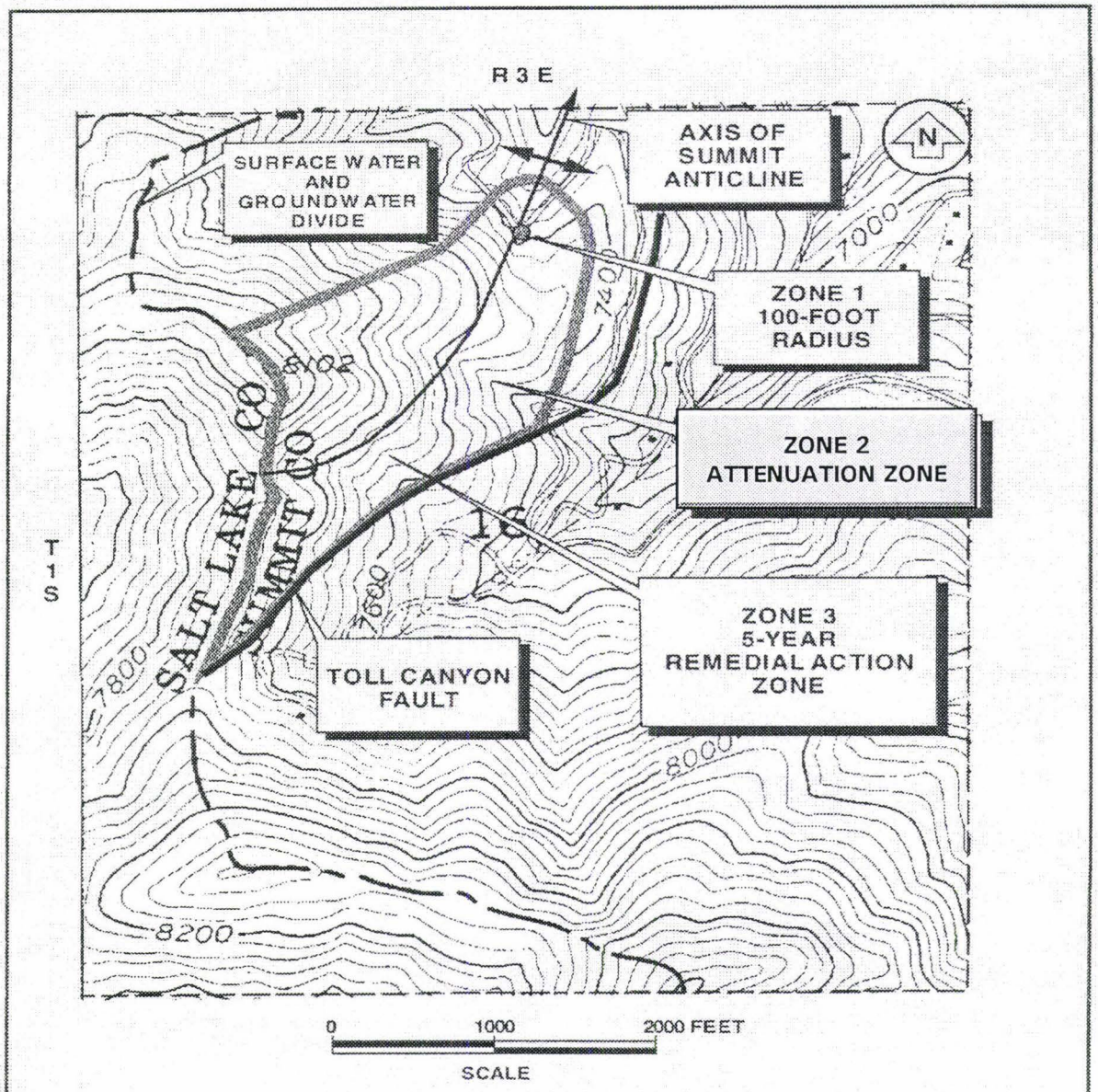

Figure D-4
WYOMING WHP PROGRAM
EXAMPLE OF WHPA ZONES USING HYDROGEOLOGIC MAPPING FOR PWS IN OVERTHRUST BELT

Appendix E

THE AQUIFERS AND AQUIFER SYSTEMS IN WYOMING: OVERVIEW OF GEOLOGIC AND HYDROGEOLOGIC SETTINGS IN WYOMING[1]

Wyoming is a diverse state in terms of physiography, geology and hydrogeology. As one drives across the state, it is obvious from the surface terrain that the State is composed of massive, rugged glaciated mountains interspersed with relatively featureless large sedimentary basins. The bulk of the Wyoming ranges are cored with Precambrian metamorphic and igneous rocks which constitute some of the oldest rocks in North America. Some of the mountains in northwest and northeast Wyoming are composed of Tertiary and Quaternary intrusive and volcanic rocks. The mountains are usually uplifted along deep seated faults which in many cases effectively sever the hydraulic continuity of the regional aquifers. Large thicknesses of sedimentary rocks overlie the Precambrian complexes and generally appear as asymmetrical synclinal basins interspersed between mountain ranges (see Figure E-1). These basins contain tens of thousands of feet of sedimentary rocks from Cambrian to Tertiary. Sedimentary formations generally are steeply dipping along the margins of the basins and flatten out a short distance from the mountain front. Locally, the relief is significant between the mountain ranges and the adjacent sedimentary basins. The diverse geologic features result in significant differences in the occurrence and availability of groundwater in the state.

Virtually all of the stratigraphic units in Wyoming basins play a hydrologic role either as a major aquifer, a minor aquifer, aquiclude or aquitard. Over 100 aquifers and aquifer systems have been identified within the State by Antcil (1994); however, many are limited in extent and yield only small amounts of water to wells and springs. The principal aquifer systems in the State include the unconsolidated alluvial deposits principally found along or adjacent to major drainages; semi-consolidated to locally consolidated sedimentary rocks forming the Tertiary aquifers; the consolidated sedimentary rocks (including carbonates) found within or flanking the structural basins and the Overthrust Belt of western Wyoming, and the crystalline and metamorphic rocks coring the mountain uplifts. Principal recharge of deeper aquifers is from basin margin outcrop areas, whereas more shallow aquifers receive recharge from outcrops, infiltration and vertical leakage between adjacent water-bearing units.

Figure E-2 depicts the generalized hydrostratigraphy of the State, along with a partial listing of Wyoming communities tapping the principal aquifers in the State. Note the majority of groundwater development in the State relies upon the alluvial aquifers situated along major drainages, the Tertiary aquifers, and the Paleozoic aquifer system.

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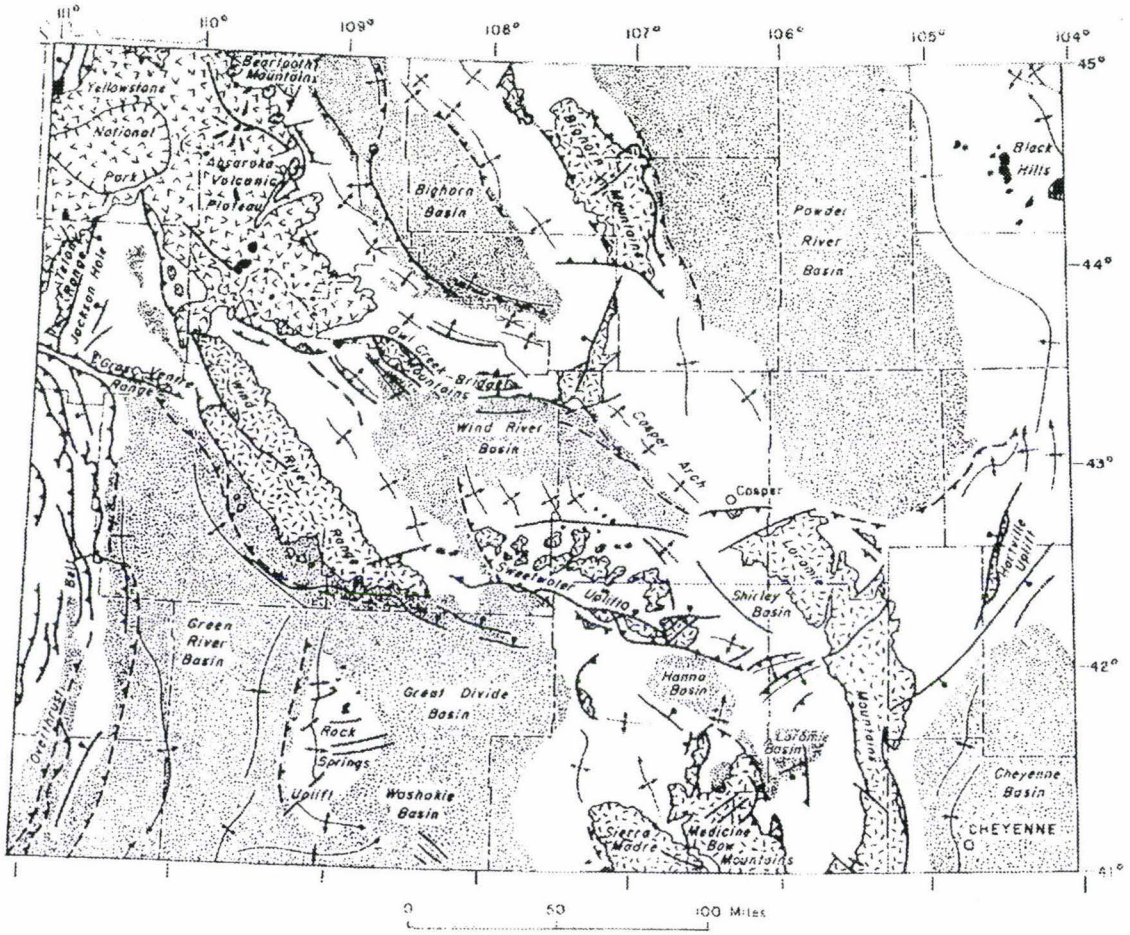
[1] For more detailed studies, the reader is referred to the comprehensive reports prepared by the Wyoming Water Resources Center at the University of Wyoming, that describe the occurrence and characteristics of groundwater in all basins involving most parts of the State of Wyoming. A listing of these reports, along with the principal aquifers developed in each basin is included in this Appendix. A summary of the hydraulic properties of the principal aquifers can also be found in this Appendix.



(Map courtesy of Geological Survey of Wyoming)

FIGURE E-1
WYOMING WHP PROGRAM
IDEALIZED GEOLOGIC MAP OF STATE OF WYOMING

Appendix E

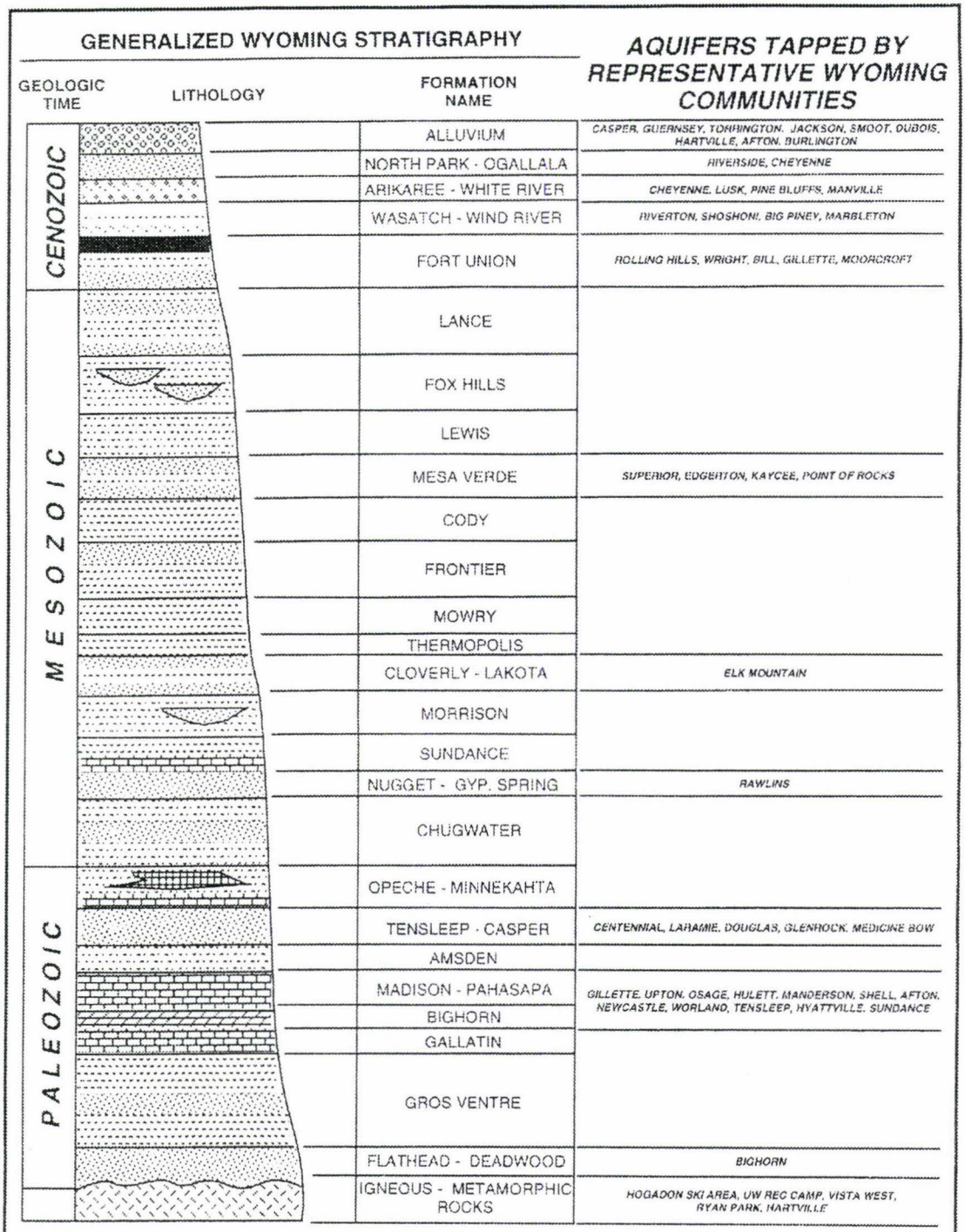


FIGURE E-2
WYOMING WHP PROGRAM
PRINCIPAL AQUIFERS DEVELOPED IN WYOMING

Appendix E

Hydrogeologic conditions vary for the PWSs across the state. Well depths range from tens to thousands of feet below the land surface. The types and thicknesses of overlying materials that may protect the aquifer from contamination also vary. Variations in individual WHPA delineation methods and criteria will need to reflect these hydrogeologic differences.

Because of the diversity of the hydrogeology in the State of Wyoming, this section describes in summary form the major aquifers and/or aquifer systems of Wyoming. The purpose of this overview is to assist in first-order WHPA delineations by characterizing and documenting the hydrogeologic properties, water quality, availability, and use of the principal water-bearing units throughout the state.

The bulk of the following information has been adapted from Antcil (1994). Antcil completed extensive literature search of the available groundwater investigations, test data, and general stratigraphic and structural geology to identify currently-producing aquifers and those with a potential for development. No attempt was made to identify existing or potential groundwater availability or quality problems. These and other problems would be better addressed in more local studies.

By definition, the sedimentary and other rock sequences in the State that are comprised of permeable, water-saturated units which yield water to wells and springs are aquifers. Relatively impermeable rocks above and below aquifers are defined as aquitards, leaky aquitards, or confining layers. Aquifer systems refer to a series of stacked or serial aquifers that have similar hydraulic and geologic properties and are hydraulically connected, of reasonably large areal extent, and sealed from each other by regionally extensive confining layers.

HYDROGEOLOGY

There are three types of aquifers present in Wyoming, most of which have differing characteristics and requirements for evaluation, management, vulnerability and exploitation. In the state, unconfined aquifers consist of shallow flood plain (alluvial) and terrace deposits. Locally, glacial outwash deposits are important water-bearing units. Other unconsolidated bedrock deposits (such as the Ogallala Formation) can be several hundreds of feet deep and may be unconfined, semi-confined, and confined aquifers due to the complex stratigraphic architecture associated with deposition of the formation materials. Generally, these relatively shallow units are composed of sand, silt and gravel. These are the most vulnerable of all aquifers because of their shallow depths and general lack of laterally extensive confining layers.

Confined aquifers are those that exist within bedrock formations of differing permeabilities, such as sandstone or shale, and are stratigraphically bound by less permeable strata. As the water in these aquifers is under pressure greater than atmospheric, it causes water levels in wells to rise above the top of the confining unit in many instances. Often, a free-flowing artesian system is established. Groundwater from the confined aquifer may also discharge as a spring or from a flowing well, particularly those situated along an uplift or valley margin. These aquifers are the least vulnerable to human activities, except in special instances, such as penetration by a well which is poorly constructed or abandoned.

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Fractured bedrock or solution-enhanced karst systems constitute some of the most productive aquifers in Wyoming. However, groundwater time of travel can be rapid and may be several orders of magnitude greater than groundwater circulation in other aquifers, thus increasing the vulnerability of the aquifers to contamination. Post depositional tectonic forces created most of the enhanced hydraulic characteristics of fractured bedrock aquifers, whereas fresh water derived from the mountain highlands created solution-enhanced channels in the carbonate rock units.

Alluvial Aquifers:

The U.S. Geological Survey has established three criteria that are used to differentiate alluvial aquifers from other types of aquifers (see Heath, 1984): (1) the valleys contain sand and gravel deposits thick enough to supply water to wells at moderate to large rates; (2) the sand and gravel deposits are in hydraulic connection with a perennial stream which serves as a source of recharge and whose flow commonly exceeds the demand; and (3) the sand and gravel deposits occur in a clearly defined band (or channel) that normally does not extend beyond the floodplain and adjacent terraces (the width of the deposits is small compared with its length).

The alluvial aquifers of Wyoming fit these criteria and consist mostly of alluvial and terrace deposits that border the major rivers in the State. Those deposits of importance are located along the North Platte, the upper Snake, the Bear, and the Greybull Rivers. Antcil (1994) reports that at least five additional rivers systems have been classified as alluvial aquifers, but are mostly of local concern.

The North Platte is an interstate stream that begins in northern Colorado, flows northward into Wyoming to the general area of Casper where it loops southeastward and exits the state into Nebraska near Torrington. Alluvium along the North Platte constitutes the largest alluvial aquifer in the state in terms of length, drainage-basin size and water storage, and availability for agricultural, municipal and industrial uses. It is comprised of unconsolidated sand, silt, clay and gravel, the local mix of which provides a variety of geologic and hydrologic aquifer conditions. The principal Wyoming communities relying on the alluvium along the North Platter River as a water supply include the City of Casper, and the Towns of Guernsey, Hartville, and Torrington.

Alluvium deposited along other major rivers in Wyoming also serve as community water supplies derived from wells. The upper Snake River heads in the Teton National Park area and flows southward ultimately entering Idaho. The Town of Jackson wells may partially tap the alluvium and older sediments along the Snake River. The Wind River heads in the Wind River Mountains and flows southeast to the Bighorn River. Wells serving the Town of Dubois tap the alluvium along the Wind River. Many of the small communities in the Star Valley located in western Wyoming may partially tap the alluvium and deeper sediments along the Salt River. It is certain other communities rely on alluvium associated with other rivers and streams in Wyoming.

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High Plains Aquifer System:

Although the High Plains aquifer system underlies portions of eight states, in Wyoming it occurs only in the southeast quarter of the state. There it consists mostly of Tertiary and Quaternary sediments that are mostly unconsolidated with varying degrees of confinement by lower permeability strata. In general, the water-bearing strata in the upper portions of the aquifer are poorly consolidated and unconfined; the deeper water-bearing strata are typically more consolidated and semi-confined to confined by lower permeability strata.

Most groundwater in the High Plains aquifer system is found in the Ogallala Formation and the underlying Arikaree Formation. The Ogallala is generally unconsolidated and consists of poorly sorted silt, sand and gravel with minor clay, which becomes coarser and less cemented in the lower parts of the formation. The Arikaree rocks are predominantly massive, fine-grained sandstone with localized beds of other fine grained to amorphous sediments. The aquifer can exceed 1,000 feet in thickness in some places. Locally, the Oligocene Brule Formation is considered a part of the High Plains aquifer where it contains sandstones or secondary permeability in the form of karst or fractures. Representative Wyoming communities relying on this aquifer system include the City of Cheyenne, and the Towns of Lusk, Pine Bluffs, and Manville.

Wyoming Basins:

The asymmetrical structural basins of Wyoming are somewhat similar to one another in that surrounding tectonic elements are mountain uplifts cored by faults with up to several miles of structural offset. Precambrian igneous and metamorphic rocks are exposed as cores of the mountain uplifts with steeply-dipping Paleozoic sediments outcropping on their slopes. A variety of folds and faults can be found in the basin interiors. The principal anomaly to the structural style of the basins is the Overthrust Belt in the southwest corner of the state where a thick block of sedimentary rocks has been thrust eastward into the Green River Basin along low angle faults.

Virtually all of the stratigraphic units in Wyoming basins play a hydrogeologic role either as a major aquifer, a minor aquifer or a confining layer, which separate deep and shallow aquifer systems. Principal recharge of the deeper aquifers is from basin margin outcrop zones, whereas shallower ones receive recharge from outcrop areas, infiltration and vertical leakage from adjacent aquifers.

In most basins, hydrostratigraphic systems have been defined as water-bearing units consisting of possibly several formations. They are commonly adjacent units which have similar areal extent, hydraulic properties, water quality and are not separated by areally extensive confining units. Thick sequences of shales and siltstones usually separate the Paleozoic from the shallower Mesozoic and Tertiary aquifer systems. Exploitation of the deeper systems, particularly those with overlying highly productive aquifers, may limit the development of deeply buried production in the foreseeable future.

Appendix E

Rather than repeat the information prepared on the individual Wyoming Basins by the Wyoming Water Research Institute (Water Resource Center), the key reference and important aquifers are summarized by individual basin:

Powder River Basin:

Feathers, K. R., Libra, R., and Stephenson, T. R, 1980, Occurrence and Characteristics of Ground Water in the Powder River Basin, Wyoming: University of Wyoming Water Resources Research Institute report to U.S. Environmental Protection Agency, Vol. I-A and I-B (1981), 203 pp., 8 plates.

Major aquifers identified within the Powder River Basin:

- Quaternary Deposits
- Wasatch/Fort Union Formations
- Fox Hill/Lance Formations
- Dakota Sandstone
- Madison Limestone

Denver-Julesburg Basin:

Libra, Robert D., Collentine, M., and Feathers, K. R., 1981, Occurrence and Characteristics of Ground Water in the Denver-Julesburg Basin, Wyoming: University of Wyoming Water Resources Research Institute report to U.S. Environmental Protection Agency, Vol. VII-A and VII-B, 101 pp., 8 plates.

Major aquifers identified within the Denver-Julesburg Basin:

- Quaternary Deposits
- Tertiary Aquifer System (Ogallala and Arikaree Formations)
- Lance Formation- Fox Hills Sandstone
- Discontinuous Mesozoic Sandstones
  (within the Pierre Shale, Niobrara Formation, Frontier Formation)
- Paleozoic Aquifer System
  (Hartville, Casper, Guernsey, and Flathead Formations)
- Precambrian Rocks (weathered surficial zones)

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Bighorn Basin:

Libra, R., Doremus, D., and Goodwin, C., 1981, Occurrence and Characteristics of Ground Water in the Bighorn Basin, Wyoming: University of Wyoming Water Resources Research Institute report to U.S. Environmental Protection Agency, Vol. II-A and II-B, 104 pp., 5 plates.

Major aquifers identified within the Bighorn Basin:

Quaternary Deposits
Upper Cretaceous-Tertiary Aquifer System
(Mesaverde, Meeteetse, Lance, Fort Union, and Willwood Formations)
Paleozoic Aquifer System
(Flathead Sandstone, Bighorn Dolomite, Madison Limestone, and Tensleep Sandstone)

Wind River Basin:

Richter, H. R., 1981, Occurrence and Characteristics of Ground Water in the Wind River Basin, Wyoming: University of Wyoming Water Resources Research Institute report to U.S. Environmental Protection Agency, Vol. IV-A and IV-B, 149 pp., 11 plates.

Major aquifers identified within the Wind River Basin:

Quaternary Deposits
Upper Cretaceous-Tertiary Aquifer System
(Mesaverde, Lance, Fort Union, Wind River, and Arikaree Formations)
Muddy Sandstone
Cloverly Group (Dakota and Lakota Sandstones)
Sundance Formation - Nugget Sandstone
Phosphoria Formation
Paleozoic Aquifer System
(Tensleep Sandstone, Amsden Formation, Madison Limestone, Darby Formation, Bighorn Dolomite, and Flathead Sandstone)

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Green River Basin and Overthrust Belt:

Ahern, J., Collentine, M, and Cooke, S., 1981, Occurrence and Characteristics of Ground Water in the Green River Basin and Overthrust Belt, Wyoming: University of Wyoming Water Resources Research Institute report to U.S. Environmental Protection Agency, Vol. V-A and V-B, 123 pp., 6 plates.

Major aquifers identified within the Green River Basin and Overthrust Belt:

Quaternary Deposits
Tertiary Aquifer System
(Late Tertiary sandstones and conglomerates, Fowkes, Bridger, Wasatch Formations)
Mesaverde - Adaville Formations
Nugget Aquifer System
Paleozoic Aquifer System
(Tensleep Sandstone, Madison Limestone, Darby Formation, and Bighorn Dolomite)

Great Divide and Washakie Basins:

Collentine, M., Libra, R., Feathers, K. R., and Hamden L., 1981, Occurrence and Characteristics of Ground Water in the Great Divide and Washakie Basins, Wyoming: University of Wyoming Water Resources Research Institute report to U.S. Environmental Protection Agency, Vol. VI-A and VI-B, 112 pp., 10 plates.

Major aquifers identified within the Great Divide and Washakie Basins:

Quaternary Deposits
Tertiary Aquifer System
(Wasatch, Battle Spring, Fort Union, and Lance-Fox Hills Formations)
Mesaverde Formation
Paleozoic Aquifer System
(Tensleep Sandstone, Madison Limestone, undifferentiated Cambrian rocks)

Laramie, Shirley and Hanna Basins:

Richter, H. R., 1981, Occurrence and Characteristics of Ground Water in the Laramie, Shirley, and Hanna Basins, Wyoming: University of Wyoming Water Resources Research Institute report to U.S. Environmental Protection Agency, Vol. III-A and III-B, 117 pp., 6 plates.

Major aquifers identified within the Laramie, Shirley, and Hanna Basins:

Tertiary Formations
Cloverly Group (Dakota and Lakota Sandstones)
Casper-Tensleep Formations

Appendix F

Susceptibility Assessment Form
(Version 1.0)

IMPORTANT! **When submitted by a *'Non-community'* Public Water System and approved by WDEQ, this form and its accompanying map illustrating the delineated Wellhead Protection Area (WHPA), may serve as that PWS's Wellhead Protection Plan. This form (and accompanying map) may not serve as a complete Wellhead Protection Plan for a *'Community'* Public Water System; *'Community'* systems must meet the requirements (i.e *WHPA Delineation Report*, etc.) identified in *Wyoming's Wellhead Protection Guidance Document,* including completion of this form, in order to obtain WDEQ approval of their Wellhead Protection Plan.**

Please complete one form for each groundwater source (well, spring, or tunnel) used in your Public Water System (PWS). Photocopy this form as necessary. Refer to Appendix G (Assistance Package) for details and instructions for completing this form.

Part I: System Information

Well owner/manager: _____

City: _____

County: _____

PWS Name: _____

PWS ID # (EPA): _____

Well depth (feet): _____

Source (e.g. well) name: _____

State Engineer's Office Permit No.: _____

Number of connections: _____ Population Served: _____

Township: _____ Range: _____ Section: _____ ¼, ¼ Section: _____

Latitude/longitude (if available): _____

How was lat./long. determined?

___ global positioning device ___ survey ___ topo. map other: _____

Appendix F

Part II: Well Construction and Aquifer Characteristics Information

1. Date well originally constructed (month/day/year): _____

   Last re-construction (month/day/year): _____

2. Well driller: _____

3. Type of well:

Drilled	Rotary	Bored	Cable Tool	Dug	Springs	Ranney Collector	Driven	Jetted

   Other: _____

   Additional Comments: _____

   _____

4. State Engineer's Office (SEO) *Statement of Completion* report available?

Yes (attach copy to form)	No

   If no well log is available, please attach any other records documenting well construction, such as boring logs, "as-built" diagrams, engineering reports, or well reconstruction logs.

5. Average pumping rate: ___ gallons per minute (gpm).

   SEO adjudicated (permitted) pumping rate: ____ gallons per minute (gpm).

   Source of information: _____

   If not documented, how was pumping rate determined? _____

   _____

   _____

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6. Is this source treated?

Yes	No

If so, what type of treatment is used?

Disinfection	Filtration	Carbon Filter	Air Stripper	Other

Purpose of treatment (describe materials to be removed or controlled by treatment): ____

_____

7. Is source chlorinated?

Yes	No

Residual chlorine level:___ (Point closest to source)

8. Wellhead Elevation (feet above mean sea level): _____

How was wellhead elevation determined?

topo. map	altimeter	drill/well log

Other: _____

9. Depth to top of screened interval: ___ Feet below wellhead.

10. Depth to groundwater (static water level): ___ Feet below wellhead.

Flowing well/spring?

Yes	No

How was water level determined?

____ Well log Other: _____

____ Measured

Appendix F

11. If the source is a flowing well or spring, what is the shut-in pressure?

_____ psi (pounds per square inch), or

_____ feet above wellhead

12. If source is a flowing well or spring, is there a surface impoundment, reservoir, or catchment associated with this source?

Yes	No

13. Confining layers: *(This question can be completed only for those sources with a drilling log, well log, or geologic/engineering report describing subsurface conditions).*

Is there evidence of a confining layer in the drilling log, well log, or geologic/engineering report?

Yes	No

If there is evidence of a confining layer, is the depth to groundwater more than 20 feet above the bottom of the lowest confining layers?

Yes	No

14. *'Accident Prevention Zone'* (Zone 1 of WHPA):

50 ft.	100 ft.

The criteria that determine an acceptable radius (i.e 50' or 100') of the *'Accident Prevention Zone'* (Zone 1 of WHPA) are established in Section II, *Wyoming's Wellhead Protection Guidance Document.*

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15. Wellhead control and access:

No wellhead control _____

Wellhead enclosed in a wellhouse: _____

Wellhead enclosed in a pitless adapter: _____

Controlled access (please describe):_____

_____

Other uses for wellhouse (please describe): _____

_____

16. Surface casing and annular seal:

Surface casing present? _____

Depth of surface casing: _____

Surface casing material: _____

Annular seal present? _____

Depth of annular seal: _____

Annular seal material: _____

17. Surface seal and well opening:

Surface (protective) casing present? _____

Height of surface casing above ground: _____

Surface casing material and diameter: _____

Well cap in place? _____

Well cap locked? _____

Surface seal present? _____

Surface seal material: _____

Length: _____

Width: _____

Thickness: _____

Condition of seal: _____

Seal slope away from casing? _____

Appendix F

Part III: Assessment of Water Quality

1. Indicate if any of the following potential contaminant sources listed on the Table are present within Zones 1, 2 or 3 of your Wellhead Protection Area (WHPA).

Type of Potential Source	Zone 1	Zone 2	Zone 3
Pesticide application			
Stormwater injection wells			
Other injection wells			
Abandoned water wells			
Abandoned oil wells			
Landfills, dumps, disposal areas			
Known hazardous materials clean-up site			
Known water quality problems			
Population density > 1 house/acre			
Septic systems, Cesspools, Outhouses, Privies			
Wastewater or sewage treatment lagoons			
Sites used for land application of sewage sludge or other wastes			

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If other recorded or potential sources of groundwater contamination (See Table III-1, *Wyoming's Wellhead Protection Guidance Document*) exist within the WHPA, please describe below (use additional sheets if necessary):

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2. Source-specific water quality records:

Please indicated the occurrence of any test results since 1986 that meet the following conditions:

A. Nitrate as N:

(Nitrate MCL = 10 mg/L)

	Yes
Results greater than MCL	
<2 mg/L nitrate	
2-5 mg/L nitrate	
>5 mg/L nitrate	
No nitrate sampling records	

B. VOCs:

(VOC detection level 0.5 μg/L)

	Yes
Results greater than MCL	
VOCs detected at least once	
VOCs never detected	
No VOCs sampling records	

C. SOCs (Pesticides, etc.):

	Yes
Results greater than MCL	
SOCs detected at least once	
SOCs never detected	
No SOCs sampling records	

If any SOCs were detected, please identify and date. Laboratory data sheets may be submitted in lieu of compiling list. If SOCs tests were performed, but no SOCs detected, list test methods here:_____

_____

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D. Bacteria contamination:

	Yes
Any bacterial detection(s) in past 3 years in samples collected from the source (not distribution sampling records)	
In past 3 years, has anyone found a bacteriological contamination problem in distribution samples that were attributed to the source?	
No bacteria sampling records	

Appendix F

Part IV: Geographic or Hydrologic Factors Contributing to a Non-Circular Zone of Contribution

1. Is there evidence of a potential *hydrologic boundary* within the WHPA? (i.e. Does the boundary extend over a stream, river, lake, up a steep slope, or over a mountain or ridge?)

Yes	No

If yes, please mark and identify on your WHPA map; describe: _____

_____

_____

2. Aquifer Material:

A. Have drilling logs, well logs, geologic maps, aerial photos, geologic/engineering reports and/or aquifer/pump test data been reviewed and analyzed for the presence of *faulting, fracturing and karst conditions*, both within the aquifer as well as within any overlying strata or sediments?

Yes	No

Indicate which of the above have been reviewed; cite references used: _____

_____

_____

_____

_____

B. Do any of the information sources in (A) above indicate that the well is located in an area where the underground conditions are *fractured, faulted or karst*?

Yes	No

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3. Do any of the information sources in 2(A) above indicate that the well is located in an area where the underground conditions are primarily identified as *coarse sand and gravel*?

Yes	No

4. Are there other *high-capacity wells* (municipal, agricultural, and/or industrial) located within the WHPA?

Yes	No

A. Presence of groundwater extraction wells pumping more than approximately 500 gallons per minute within . . .

	Yes	No	Unknown
Zone 1			
Zone 2			
Zone 3			

B. Presence of groundwater recharge wells (e.g. drainage wells, etc.) or heavy irrigation within...

	Yes	No	Unknown
Zone 1			
Zone 2			
Zone 3			

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Please identify or describe *additional hydrologic or geographic conditions* that you believe may affect the shape of the WHPA for this source. Where possible, reference them to their location on the map.

Appendix F

Part V: Potential Source Hazards, Controls, Assessment, and Management

Only *'Non-Community'* Public Water Systems need to complete this part.

Name and describe the management strategy (or strategies) you are planning to implement to help reduce the potential for contamination of the drinking water supply by the potential contamination source(s) located within the Wellhead Protection Area (WHPA). Also, please include the date you will begin implementation of each strategy. Complete this form for each potential contamination source.

* Plan additional controls for inadequately controlled potential contamination sources.
* Set an implementation date for each additional control.

Example:

Potential Contamination Source: Residential sources of pesticides and fertilizers

Existing Controls: Manufacturers' guidelines prescribe safe handling and application of chemicals.

Adequately managed? No, highly vulnerable aquifer thought to require additional controls.___

Strategy 1: Acme Lawn Care - Description: Establish an agreement for them to install spill protection in their bulk mixing area.

Implementation Date: 3/15/95

Strategy 2: Public education - Description: Issue an educational brochure to homeowners about the proper use of pesticides and fertilizers within source protection areas.

Implementation Date: *4/21/95*

Potential Contamination source:_____

Existing Controls:_____

_____

_____

Adequately Managed? _____

Strategy 1: _____ Description: _____

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_____

_____

_____ Implementation Date: _____

Strategy 2: _____ Description: _____

_____

_____

_____ Implementation Date: _____

*** Keep Records**

File Copies of all public education programs, letters, memoranda of agreement, memoranda of understanding, permits, etc., for this potential contamination source behind this cover sheet.

NOTES: _____

_____

_____

_____

_____

_____

_____

_____

_____

Appendix F

Part VI: Contingency Planning

Emergency Contractors (list names and phone numbers):

Pump Servicing Contractor: _____

phone: _____

Well Drilling Contractor: _____

phone: _____

Heavy Equipment Operator: _____

phone: _____

Water Treatment Chemical Supplier (e.g., chlorine supplier): _____

phone: _____

Bottled Water Supplier: _____

phone: _____

County Emergency Coordinator: _____

phone: _____

Technical Consultants (e.g., geologist, engineer): _____

phone: _____

List causes of last three water supply service interruptions, shortages or contamination events and briefly explain how each situation was resolved and steps take to prevent the recurrence of each:

1. _____

_____

2. _____

_____

3. _____

_____

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List the three most likely causes of future service interruptions, shortages, or supply contamination:

1. _____
2. _____
3. _____

List anticipated response(s) to the above scenarios:

1. _____
2. _____
3. _____

List steps that could be taken to lessen the possibility of the above scenarios occurring (e.g., provide back-up emergency power supply, installation of a backup well, etc.):

1. _____
2. _____
3. _____

List possible alternative water sources that could be used in the case of a service interruption or contamination event. (If the alternative is a nearby well, indicate whether it develops water from the same aquifer as main water supply well, if known.): _____

_____

List emergency funding source(s) that may be utilized to prevent interruption of the water supply or to restore the water supply. _____

_____

_____

Appendix G

Assistance Packet
(Susceptibility Assessment Form)

This form has been developed in order to help assess the susceptibility of your groundwater source(s) to potential sources of contamination. The Wyoming Department of Environmental Quality, Water Quality Division (WDEQ/WQD) will use the information on this form to evaluate geologic and hydrologic factors associated with each of your Public Water System (PWS) sources (i.e. well, spring or tunnel) in order to estimate the source's potential vulnerability to contaminants that are regulated under the Safe Drinking Water Act (SDWA).

IMPORTANT! **When submitted by a *'Non-community'* Public Water System (See Glossary) and approved by WDEQ, this form and its accompanying map illustrating the delineated Wellhead Protection Area (WHPA) may serve as that PWS's Wellhead Protection Plan. This form (and accompanying map) <u>may not</u> serve as a complete Wellhead Protection Plan for a *'Community'* Public Water System; *'Community'* systems must meet the requirements (i.e *WHPA Delineation Report*, etc.) identified in *Wyoming's Wellhead Protection Guidance Document,* including completion of this form, in order to obtain WDEQ approval of their Wellhead Protection Plan.**

Regardless of the type of Public Water System (Community, Transient Non-community, or Non-transient Non-community) the Susceptibility Assessment Form (Appendix F) must be completed and included as part of any Wellhead Protection Plan submitted to WDEQ for approval.

The information requested on this form may be gathered from a variety of records. Some information can be found on your *Statement of Completion and Description of Well or Spring (Form UW 6)* filed with the State Engineer's Office (SEO). Please take the time to verify this information. If this information is not current, please note any needed changes. Other useful records include your source and system monitoring records as well as system design plans, water right records, engineering and geologic reports, and water quality monitoring records. If your records are not complete, you may be able to obtain some of this information from the SEO, WDEQ/WQD, or the Wyoming Water Development Commission.

Many of the questions request information about the construction of your well. If your water system utilizes only springs or tunnels, you should still complete the Susceptibility Assessment Form; simply leave blank those questions which do not apply.

Incorrect information or incomplete forms may raise your susceptibility risk evaluation. For these reasons it is important that you take some time to complete the form to the best of your ability. You may not have all of the information that is requested on the form. You may indicate "information unavailable/unknown" in response to certain queries if this is the case.

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EPA and Vulnerability:

In 1986 Congress passed amendments to the Safe Drinking Water Act (SDWA). These amendments have been implemented in phases. The most recent phases to be implemented are Phase II and Phase V monitoring requirements which went into effect between 1993 and 1995. Phase II and V deal mainly with monitoring for volatile organic and synthetic organic compounds (VOCs and SOCs). Under Phase II & V the monitoring requirements for these compounds are significantly increased for Public Water Systems (PWS). Realizing that the increased monitoring requirements can be very costly to water systems, EPA has allowed PWSs to reduce or waive monitoring requirements depending upon how vulnerable the water system's sources are to contamination. That is, those sources which are vulnerable to contamination may have more monitoring requirements while those sources that are less vulnerable may have reduced or no monitoring required for many chemicals.

What is Vulnerability?

Vulnerability can be thought of as a water source's (e.g. well, spring or tunnel) potential for contamination. Vulnerability is composed of two factors: the physical susceptibility to the infiltration of contaminants; and the source's risk of exposure to contaminants. Susceptibility is determined by conditions that affect the movement of contaminants from the land surface into a water supply. This would include the depth of the well, its construction, the geology of the area, the pumping rate, the source(s) of groundwater recharge, and the aquifer material. The risk of exposure to contaminants is determined by whether or not contaminants were used in the area of a water supply.

Susceptibility Assessments:

In order to determine a drinking water source's vulnerability to contamination WDEQ/WQD has developed the Susceptibility Assessment Survey Form. This survey form catalogs key susceptibility factors for each source in order to evaluate overall susceptibility. The following information is needed to evaluate hydrologic susceptibility:

1) Well logs, or other indicators of aquifer characteristics,
2) Depth and length of open interval,
3) Date and description of construction,
4) Record of past monitoring results (nitrates, VOCs, SOCs, metals, and bacteria),
5) A specific (and accurate) location of the source,
6) Water level information,
7) Estimate of wellhead elevation,
8) A general evaluation of land-use surrounding the wellhead,
9) Size of the water system, and
10) Contingency planning.

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Monitoring Waivers:

Depending on the results of the susceptibility assessment, EPA may allow that some or all of the monitoring requirements (number and type of paramters, frequency of monitoring) for certain chemicals be waived. This type of waiver is considered to be a "susceptibility waiver". If source information does not allow a system to qualify for a susceptibility waiver, the system can pursue other types of waivers. One option, the Contaminant Use Waiver, involves a more intense inventory of the contaminants that may be found within the source's recharge area. "State-wide waivers" may also offer some monitoring relief. These are blanket waivers granted for chemicals not commonly detected in the state.

Appendix G

PART I: System Information

With a few exceptions, all of the information in this section can be taken from your State Engineer's Office (SEO) *Statement of Completion (Form UW 6)*. The SEO should have a copy on file if your copy has been misplaced. Of particular concern is the information concerning source location and quarter/quarter section, and well depth. You should also note the population served and number of connections in this section; this information should be available from the water system records. Please use this opportunity to review your system records and make sure they are up-to-date.

There are optional items in this section. These include the State Engineer's Office permit number and a latitude and longitude location. If this information is not readily available, these areas can be left blank.

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PART II: Well Construction and Aquifer Characteristics Information

Most of the well information can be obtained from the *Statement of Completion* (Form UW 6 filed with the State Engineer's Office) and design plans that were prepared for the water system. In some cases the information may be found in other system records. Estimates can be made for some factors but these responses must be identified as estimates.

1) **Date Well Constructed/Reconstructed:**

   This information may be found in Item 8 on the SEO *Statement of Completion*. If you have multiple records representing reconstruction or redevelopment of the well, use the most recent one. Please include a copy of the well log (*Statement of Completion* - Item 13) with this form.

2) **Well Driller:**

   This can be found in Item 7 on the SEO *Statement of Completion*. Please enter the name and address if possible.

3) **Well Type:**

   Mark the type of well construction. It can often be found in Item 5 of the SEO *Statement of Completion*. If this area has not been filled in, please check system records.

4) **Well Report (Well Log):**

   This would include a driller's log, well log, or a detailed design that includes an engineer's "as built" along with a geologic log. The *Statement of Completion* items 6 and 13 should include a information regarding well construction and the well log(s) for your system if you cannot locate this information in your files. Please attach a copy to your response form.

5) **Average Pumping Rate:**

   This may be available from the system plan or from Item 9 of the SEO *Statement of Completion*. It is an estimate of the pumping rate in gallons per minute (gpm). If the current pumping rate is different than that listed on the *Statement of Completion*, or if documentation is absent, please explain how the pumping rate was determined.

6) **Source Treatment:**

   If your water source is treated in any way prior to delivery to your customers, please record that information here. Many water sources are not treated. Of those that are, chlorination (for disinfection) is the most common. Some other common types of water treatment include: other type of disinfection, filtration, fluoridation, or softening (to remove unwanted minerals or chemicals).

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It is possible that your system has more than one source that is combined prior to treatment. If that is the case, please record this information in the comment section.

7) **Chlorine Residuals:**

To be completed only for those sources that are chlorinated. If your system is chlorinated, please record the average chlorine residual for that source (within the distribution system). If more than one source is combined before treatment be sure to record the same information on both susceptibility assessments.

8) **Depth to Top of Open Interval:**

This is the depth to the top of the screen/perforated area of the well. If there is more than one screened interval, use the depth to the top of uppermost one. If the well is not fully cased use the depth to the bottom of the casing. This information is generally found on the SEO *Statement of Completion*, Item 6 or in an engineer's "as built" design report. If the well is cased but there is no screen(s) simply mark the depth to the bottom of the casing.

9) **Depth to Groundwater:**

On the SEO *Statement of Completion* this would be listed in Item 6. It is the static level of water in the well measured as the depth from the top of the well. It may be significantly different from either the depth of the well or the top of the open interval. If this information is not available on the well log, a current water level measurement can be used as an estimate. If the well is under pressure, or is a flowing well or spring, please mark the form accordingly.

10) **Flowing Wells and Springs:**

If this source is a flowing well (artesian or free flowing well) or is spring, is there a measure of the flowing or confining pressure? This is an alternative way to measure the aquifer pressure associated with a source. Some artesian wells and springs are under pressure and flow freely at the land surface without the aid of a pump.

This information may be listed in pounds per square inch (psi) or as a flow rate in gallons per minute (gpm). If the information is listed as a flow rate be sure it is not a pumping rate.

11) **Surface Impoundments and Reservoirs:**

If your source is a flowing well or spring, does it include a surface impoundment, reservoir, pond, catchment basin, or lake as part of its collection system? For this question, "surface impoundments" do not include dosed or covered spring boxes, but refer to impoundments that are open to the atmosphere.

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12) Wellhead Elevation:

This is the elevation above sea level of the top of the well casing (that extends above the ground). Sometimes this information can be found on the well log in part 8. An estimate can be made by altimeter or by using a topographic map and estimating the approximate elevation of the wellhead. Elevation can also be estimated relative to a nearby reference point. If an alternative method is used please explain how the estimate was made.

13) Confining Layers:

This section can only be completed with the use of a drilling log, well log, or geologic/engineering report. The log will show the depth, thickness and type of material that was encountered during drilling. These materials may be described in the log as cobbles, gravel, sand, rock, fractured rock, basalt, shale, till, hardpan, or clay. The log should also identify the strata that yielded water. They may be clearly identified or simply noted as "wet" or "seepage". Generally the most productive water bearing zone is where the well has been screened.

14) *'Accident Prevention Zone'* (Zone 1 of the WHPA):

Public Water Systems should establish a control zone (i.e. WHPA Zone 1) around the well that excludes major potential contaminant sources. Zone 1 is either a 50 foot or 100 foot radius around the well (See Section II, *Wyoming's Wellhead Protection Guidance Document*) but can be larger in some cases. This area should exclude buildings, roads, driveways, storage facilities, drainfields and other possible contaminant sources.

15) Wellhead Control and Access:

Note if there is a well-house constructed around the pump and wellhead built specifically to protect the wellhead. Is there controlled access to the wellhead (fenced area, locking cap or access port)? If the wellhead is housed in a building used for other purposes (storage of treatment materials, etc.), please describe.

16) Surface (or Inner) Casing and Annular Seal:

Surface casing and the annular seal of a well commonly extend some distance down the annular space (the space between the well casing and the borehole wall) to protect the well from direct infiltration of surface contaminants. Indicate the type and depth of the surface (or inner) casing and the annular seal.

17) Surface (Protective) Casing, Seal and Well Cap:

A protective casing installed above ground over the well helps to prevent infiltration of surface water into the wellbore during periods of flooding of high runoff; a protective concrete seal set at the surface, sloping away from the well is further protection against the

introduction of surface contaminants into the well. A locking well cap helps prevent unauthorized entry or tampering with the source.

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PART III: Assessment of Water Quality

The purpose of this section is to evaluate existing evidence of water quality problems in your specific water supply source(s) and to inventory possible threats to future water quality in order to minimize the risk of future contamination.

1) Regional Sources of Risk to Groundwater:

Please indicate if any of the following potential contaminant sources listed on the Table are present within Zones 1, 2 or 3 of your Wellhead Protection Area (WHPA).

***'Non-Community'* PWSs**: Mark and identify the potential sources on the WHPA map, together with other potential sources (see Table III-1, *Wyoming's Wellhead Protection Guidance Document*) within your WHPA.

***'Community'* PWSs**: Mark and identify the potential sources on the WHPA map, together with other potential sources in your 'Contaminant Source Inventory' (see Section III, *Wyoming's Wellhead Protection Guidance Document*).

"Pesticide application" refers to those areas, excluding residential areas, where pesticides, hebicides, insecticides, etc. are commonly applied. Examples include agricultural land, managed forest land, nurseries, and recreational areas (golf courses, parks), all with areas greater than about 2 acres. Also consider right-of-ways (state/county highways, railroads, electric/telephone lines) where herbicides are applied and mosquito/vermin control areas. State and County Public Works Departments, County Weed and Pest Control Offices, and County Agricultural Extension Offices can often supply much of this information.

"Other injection wells" can include French drains (stone-lined pits or trenches) into which liquid waste is poured and allowed to percolate into the ground.

Local governments and health departments may also be able to provide information concerning known contaminant sources such as landfills, clean-up sites, permitted waste discharge sites and businesses or industries that store or dispose of significant quantities of hazardous waste materials in the immediate vicinity of your water supplies (service stations, auto shops, dry cleaners, chemical manufacturing/processing, etc.). This information may also be obtained by contacting WDEQ-Division of Solid and Hazardous Waste. Telephone numbers of municipal and county agencies can be found in the government listings in the White Pages of your telephone directory; state agency contacts are provided in Table III-2 of *Wyoming's Wellhead Protection Guidance Document*.

If you are unable to obtain sufficient information from public agencies to respond to this question, a simple alternative is to identify the area on a local map and complete either a walking or driving survey of the area, noting potential sources of contamination as discussed in Section III of *Wyoming's Wellhead Protection Guidance Document*.

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2) **Source Specific Water Quality Records:**

The following four sections will require the review of your water quality testing records. Of primary interest are any records indicating past water quality problems for your source(s) since 1986.

A) **Nitrate Monitoring History** - The U.S. EPA Maximum Contaminant Level (MCL) for nitrates plus nitrites (as Nitrogen) is 10 mg/l. Levels between 5 and 10 mg/l may indicate some nitrate leaching from surface sources. Note in the appropriate boxes whether you have had nitrate detections below the MCL.

B) **Volatile Organic Compounds (VOCs)** - MCLs vary for each VOC. Use EPA or lab notification of MCL violations. Total Trihalomethane (TTHM) data should not be considered here.

C) **Synthetic Organic Compounds (SOCs)** - If you have completed any pesticide monitoring the results should be recorded in this section.

D) **Bacterial Contamination** - Use coliform monitoring records to respond. IMPORTANT: The main emphasis in this set of questions is to identify those water sources that have a history of source related bacterial contamination. Most of the current bacterial testing is done within a system's distribution system and not at the source. Bacterial contamination in the water system does not necessarily indicate contamination of the groundwater source.

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PART IV: Geographic or Hydrologic Factors Contributing to a Non-Circular Zone of Contribution

The *Calculated Fixed Radius (CFR)* delineation method is simple and relatively easy to apply (see Appendix D); however, it is based on a number of assumptions concerning the aquifer and underground conditions. Very rarely are all of these assumptions true.

The following questions will help identify aquifer conditions which may not be accurately represented by the *Calculated Fixed Radius (CFR)* method; answer these questions only if you are a *'Non-Community'* PWS, or a *'Community'* PWS using the *Calculated Fixed Radius (CFR)* method to delineate the WHPA. If you answer 'Yes' to questions #1, 2(B), 3 or 4 you must either modify the WHPA accordingly or apply one or more alternative delineation methods (see Appendix D, *Wyoming's Wellhead Protection Guidance Document*) in order to obtain WDEQ approval.

1) Hydrologic Boundaries:

Hydrologic boundaries are natural features in the earth which shape groundwater flow patterns. Examples include surface streams, lakes, reservoirs, mountains, ridges and other steep changes in elevations. A topographic (topo) map is useful in determining whether such features are present within the circular area around your source(s) having a 5-year travel time radius. If possible, simply attach to this form a copy of such a map with your water source(s) marked and labeled.

Topo maps can be purchased locally throughout the state at map stores, camping stores, etc. You may need more than one map to include your WHPA. If you use a U.S. Geological Survey topographic map please use one that is based on a 7 1/2 minute scale.

2) Aquifer Material:

These questions help identify those sources that may be found in geologic conditions that may affect the source's overall susceptibility. An important consideration can be the nature of the material that makes up the underground environment and forms the aquifer. The information needed to answer these questions might be found in drilling logs, well logs, aerial photos, geologic maps or reports, or engineering reports of aquifer/pump test data and interpretations.

A) The *Calculated Fixed Radius* best applies to groundwater exhibiting *'porous'* or *'diffuse'* flow behavior, as opposed to *'conduit'* flow behavior. The presence of faulting, fracturing and karst conditions are often indicators that conduit flow exists. Have any of the above mentioned sources of information been reviewed and analyzed for the presence of *faulting, fracturing and karst conditions*, both within the aquifer as well as within any overlying strata or sediments?

B) Do any of the above mentioned sources of information reveal or indicate that the well

is located in an area where the underground conditions are *fractured, faulted or karst*?

3) **Groundwater Flow Type and High Horizontal Flow Rate:**

This question will help identify those wells that are located in settings that produce very high natural groundwater flow rates, such as those which often occur in areas where underground conditions include multiple or extensive stratification of coarse sand or gravel. These may be identified in the drilling logs as: gravelly sands, sands and gravel, cobbles, gravel, boulders, or pebbles and are often associated with alluvial fans and outwash deposits, fluvial flood plains and glacial outwash deposits. In these settings, it is possible that the area of contribution around the well is influenced more by the aquifer flow conditions than by the pumping rate of the well, and the WHPA may be highly elongated and not circular. Do any of the above mentioned sources of information reveal or indicate that the well is located in an area where these highly porous and transmissive conditions exist?

4) **High-Volume Wells:**

These types of activities can have a tremendous effect on the shape of the flow system providing groundwater to your source. Wells located near these types of activities may be influenced by them. Indicate if you are aware of other high-capacity groundwater wells (> 500 gal/min) located within the WHPA. Indicate if there are any large recharge wells (e.g.stormwater run-off, drainage wells, etc.) or large-scale irrigation wells within the WHPA.

Appendix G

PART V: Potential Source Hazards, Controls, Assessment and Management

Only *'Non-Community'* Public Water Systems need to complete this part; *'Community'* PWSs must follow the guidelines set forth in Section IV of *Wyoming's Wellhead Protection Guidance Document.*

The ultimate objective of Wellhead Protection is to prevent groundwater contamination within the Wellhead Protection Area (WHPA). Therefore, management of potential contaminant sources (within the WHPA) is an essential component of Wellhead Protection. *Non-community PWSs* that submit this form (as their WHP plan) to WDEQ/WQD must describe the techniques that will be employed to manage and minimize the threats posed by the potential contamination sources identified

1) Management of Existing and Future Contaminant Sources:

As described below, varying levels of source management approaches are suggested based upon the potential of contaminant sources to impact the drining water supply (i.e. aquifer) or source (i.e. well, spring or tunnel). Public Water Systems should appropriately identify existing controls, assess the adequacy of existing controls, and propose management strategies for potential contaminant sources; on the form, indicate the strategies to be implemented and related information.

Regulatory Management Strategies:

- Source prohibition and permits;
- Subdivision regulations, and codes;
- Land use agreements;
- Tax incentives;
- Design and operating standards;
- Site plan review;
- Purchase of property and development rights;
- Zoning ordinances; and
- Inspectors at construction and drilling sites.

Non-Regulatory Management Strategies:

- Best management practices;
- Memoranda of understanding;
- Training;
- Water conservation programs;
- Household hazardous waste collection program;
- Public education programs (brochures, etc.); and
- Surface and groundwater monitoring.

Regulatory management strategies generally can afford a greater degree of protection, as

compared to non-regulatory methods. A more complete description of the applicability, including examples of these strategies is provided in Section IV and Appendices I and L of *Wyoming's Wellhead Protection Guidance Document*.

Appendix G

PART VI: Contingency Planning (Non-Community PWSs Only)

Only *'Non-Community'* Public Water Systems need to complete this part; *'Community'* PWSs must follow the guidelines set forth in Section V of *Wyoming's Wellhead Protection Guidance Document.*

The purpose of this section is to address problems that Non-community Public Water Systems need to overcome in the event of water supply shortages or contamination incidents that may impact the system's ability to supply an adequate quantity of safe drinking water to the public. Contingency plans should focus on the identification of, and solutions for, problems that may arise if protective and preventative measures fail. Potential emergencies such as well, wellfield, or spring contamination, water shortages due to droughts, and interruption of water supply due to power outages or infrastructure failure should be identified and addressed in a contingency plan.

1) Contingency Plan Organization:

The formulation of the contingency plan can be substantially completed and implemented by the public water system. Broader contingency planning has been required since 1986 under the Federal Emergency Planning and Community Right-to-Know Act (SARA Title III). Title III establishes a network of State Emergency Response Commissions and Local Emergency Planning Committees charged with planning response to emergency releases of hazardous chemicals; local emergency response plans may provide a starting point for WHP contingency planning.

In formulating a contingency plan, the Non-Community PWS must address the following considerations: (1) existing system condition and the possible water system failure modes; (2) responsibilities during an emergency; (3) emergency response procedures and contacts; (4) development of new ground and surface water sources in case of long-term shortages or abandonment of contaminated supplies; and (5) sources of emergency funds and procedures for requesting and dispersing such funds. Chapter V of *Wyoming's Wellhead Protection Guidance Document* (Planning for the Future) can be referenced for more specific contingency planning, additional guidance and information.

Appendix H

SOURCE IDENTIFICATION FORM
(FORM III-1)

City/Town _____ Well Name _____
EPA PWS ID# _____ WHPA Zone # (1,2,3) _____
Form Completed By _____ Date _____
Type of Survey (i.e., windshield survey, personal interview, site inspection, etc.) _____
Name of Person(s) Interviewed _____

SITE INFORMATION:

Site Name _____ Owner/ Leaseholder _____
Phone # _____ Site Location/Address _____
Owner's/ Leaseholder's Address _____

NATURE OF PROPERTY:

Residential ___ Retail ___ Agricultural ___ Industrial ___ Government ___
Other ___

POTENTIAL AND KNOWN SOURCES OF CONTAMINATION

Using Table III-1 (Section III), list the *Facility Type (i.e. Agricultural, Residential, etc.)* and Contaminant Source (i.e. feedlot, septic system) code numbers (e.g. (K-0009)) for each source found at this site. Under quantity, indicate the number of each identified source present.

POTENTIAL SOURCE	CODE	QUANTITY	COMMENTS
1) (Example) Animal Feedlot	0006	1	Approximately 150 Head of Cattle
2)			
3)			
4)			
5)			
6)			

(Continued On Back)

whp/seciii-1.frm

(SKETCH OF SITE OR ADDITIONAL COMMENTS ON BACK)

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POTENTIAL SOURCE	CODE	QUANTITY	COMMENTS
7)			
8)			
9)			
10)			
11)			
12)			

Sketch of Site or Additional Comments:

Appendix I.

Summary of Wellhead Protection Tools[1]

	Applicability to Wellhead Protection	Land Use Practice	Legal Considerations	Administrative Considerations
Regulatory: Zoning				
Overlay GW Protection Districts	Used to map WHPAs. Provides for identification of sensitive areas for protection. Used in conjunction with other tools that follow.	Community identifies WHPAs on practical base/zoning map.	Well-accepted method of identifying sensitive areas. May face legal challenges if WHPA boundaries are based solely on arbitrary delineation.	Requires staff to develop overlay map. Inherent nature of zoning provides "grandfather"protection to pre-existing uses and structures.
Prohibition of Various Land Uses	Used within mapped WHPAs to prohibit known groundwater contaminants and uses that generate contaminants.	Community adopts prohibited uses list within their zoning ordinance.	Well-recognized function of zoning. Appropriate technique to protect natural resources from contamination.	Requires amendment to zoning ordinance. Requires enforcement by both visual inspection and on-site investigations.
Special Permitting	Used to restrict uses within WHPAs that may cause groundwater contamination if left unregulated.	Community adopts special permit "thresholds" for various uses and structures within WHPAs. Community grants special permits for "threshold" uses only if groundwater quality will not be compromised.	Well-recognized method of segregating land uses within critical resource areas such as WHPAs. Requires case-by-case analysis to ensure equal treatment of applicants.	Requires detailed understanding of WHPAs sensitivity by local permit granting authority. Requires enforcement of special permit requirements and on-site investigations.
Large-Lot Zoning	Used to reduce impacts of residential development by limiting numbers of units within WHPAs.	Community "downzones" to increase minimum acreage needed for residential development.	Well-recognized prerogative of local government. Requires rational connection between minimum lot size selected and resource protection goals. Arbitrary large lot zones have been struck down without logical connection to Master Plan or WHPA program.	Requires amendment to zoning ordinance.

1 This is Appendix C of *A Guide to Wellhead Protection*. Reprinted with permission from *A Guide to Wellhead Protection* by Jon Witten and Scott Horsley with Sanjay Jeer and Erin K. Flanagan, Planning Advisory Services Report 457/458 (Chicago: American Planning Association, August 1995).

Appendix I.

	Applicability to Wellhead Protection	Land Use Practice	Legal Considerations	Administrative Considerations
Transfer of Development Rights	Used to transfer development from WHPAs to locations outside WHPAs.	Community offers transfer option within zoning ordinance. Community identifies areas where development is to be transferred "from" and "to".	Accepted land-use planning tool.	Cumbersome administrative requirements. Not well-suited for small communities without significant administrative resources.
Cluster/PUD Design	Used to guide residential development outside of WHPAs. Allows for "point source" discharges that are more easily monitored.	Community offers cluster/PUD as development option within zoning ordinance. Community identifies areas where cluster/PUD is allowed (i.e., within WHPAs).	Well-accepted option for residential land development.	Slightly more complicated to administer than traditional "grid" subdivision. Enforcement/inspection requirements are similar to "grid" subdivision.
Growth Controls/Timing	Used to time the occurrence of development within WHPAs. Allows communities the opportunity to plan for wellhead delineation and protection.	Community imposes growth controls in the form of building caps, subdivision phasing or other limitation tied to planning concerns.	Well-accepted option for communities facing development pressures within sensitive resource areas. Growth controls may be challenged if they are imposed without a rational connection to the resource being protected.	Generally complicated administrative process. Requires administrative staff to issue permits and enforce growth control ordinances.
Performance Standards	Used to regulate development within WHPAs by enforcing pre-determined standards for water quality. Allows for aggressive protection of WHPAs by limiting development within WHPAs to an accepted level.	Community identifies WHPAs and establishes "thresholds" for water quality.	Adoption of specific WHPAs performance standards requires sound technical support. Performance standards must be enforced on a case-by-case basis.	Complex administrative requirements to evaluate impacts of land development within WHPAs.
Regulatory: Subdivision Control				
Drainage Requirements	Used to ensure that subdivision road drainage is directed outside of WHPAs. Used to employ advanced engineering designs of subdivision roads within WHPAs.	Community adopts stringent subdivision rules and regulations to regulate road drainage/runoff in subdivisions within WHPAs.	Well-accepted purpose of subdivision control.	Requires moderate level of inspection and enforcement by administrative staff.

Appendix I.

	Applicability to Wellhead Protection	Land Use Practice	Legal Considerations	Administrative Considerations
Regulatory: Health Regulations				
Underground Fuel Storage Systems	Used to prohibit underground fuel storage systems (UST) within WHPAs. Used to regulate USTs within WHPAs.	Community adopts health/zoning ordinance prohibiting USTs within WHPAs. Community adopts special permit or performance standards for use of USTs within WHPAs.	Well-accepted regulatory option for local government.	Prohibition of USTs require little administrative support. Regulating USTs require moderate amounts of administrative support for inspection follow-up and enforcement.
Privately Owned Wastewater Treatment Plants (Small Sewage Treatment Plants)	Used to prohibit Small Sewage Treatment Plants (SSTP) within WHPAs.	Community adopts health/zoning ordinance prohibiting SSTPs within WHPAs. Community adopts special permit or performance standards for use of SSTPs within WHPAs.	Well-accepted regulatory option for local government.	Prohibition of SSTPs require little administrative support. Regulating SSTPs require moderate amount of administrative support for inspection follow up and enforcement.
Septic Cleaner Ban	Used to prohibit the application of certain solvent septic cleaners within WHPAs, a known groundwater contaminant.	Community adopts health/zoning ordinance prohibiting the use of septic cleaners containing 1, 1, 1-trichloroethane or other solvent compounds within WHPAs.	Well-accepted method of protecting groundwater quality.	Difficult regulation to enforce even with sufficient administrative support.
Septic System Upgrades	Used to require periodic inspection and upgrading of septic systems.	Community adopts health/zoning ordinance requiring inspection and, if necessary, upgrading of septic systems on a time basis (e.g., every 2 years) or upon title/property transfer.	Well-accepted purview of government to ensure protection of groundwater.	Significant administrative resources required for this option to be successful.
Toxic and Hazardous Material Handling Regulations	Used to ensure proper handling and disposal of toxic materials/waste.	Community adopts health/zoning ordinance requiring registration and inspection of all businesses within WHPAs using toxic/hazardous materials above certain quantities.	Well-accepted purview of government to ensure protection of groundwater.	Requires administrative support and on-site inspections.

Appendix I.

	Applicability to Wellhead Protection	Land Use Practice	Legal Considerations	Administrative Considerations
Private Well Protection	Used to protect private on-site water supply wells.	Community adopts health/zoning ordinance to require permits for new private wells and to ensure appropriate well to septic system setbacks. Also requires pump and water quality testing.	Well-accepted purview of government to ensure protection of groundwater.	Requires administrative support and review of applications.
Nonregulatory: Land Transfer and Voluntary Restrictions				
Sale/Donation	Land acquired by a community within WHPAs, either by purchase or donation. Provides broad protection to the groundwater supply.	As nonregulatory technique, communities generally work in partnership with nonprofit land conservation organizations.	There are many legal consequences of accepting land for donation or sale from the private sector, mostly involving liability.	There are few administrative requirements involve in accepting donations or sales of land from the private sector. Administrative requirements for maintenance of land accepted or purchased may be substantial, particularly if the community does not have a program for open space maintenance.
Conservation Easements	Can be used to limit development within WHPAs.	Similar to sales/donations, conservation easements are generally obtained with the assistance of nonprofit land conservation organization.	Same as above.	Same as above.
Limited Development	As the title implies, this technique limits development of portions of a land parcel outside of WHPAs.	Land developers work with community as part of a cluster/PUD to develop limited portions of a site and restrict other portions, particularly those within WHPAs.	Similar to those noted in cluster/PUD under zoning.	Similar to those noted in cluster/PUD under zoning.

Appendix I.

	Applicability to Wellhead Protection	Land Use Practice	Legal Considerations	Administrative Considerations
Monitoring	Used to monitor groundwater quality within WHPAs.	Communities establish groundwater monitoring program within WHPAs. Communities require developers within WHPAs to monitor groundwater quality down gradient from their development.	Accepted method of ensuring groundwater quality.	Requires moderate administrative staffing to ensure routine sampling and response if sampling indicates contamination.
Contingency Plans	Used to ensure appropriate response in cases of contaminant release or other emergencies within WHPAs.	Community prepares a contingency plan involving wide range of municipal/county officials.	None.	Requires significant up-front planning to anticipate and be prepared for emergencies.
Hazardous Waste Collection	Used to reduce accumulation of hazardous materials within WHPAs and the community at large.	Communities, in cooperation with the state, regional planning commission, or other entity, sponsor a "hazardous waste collection day" several times per year.	There are several legal issues raised by the collection, transport, and disposal of hazardous waste.	Hazardous waste collection programs are generally sponsored by government agencies, but administered by a private contractor.
Public Education	Used to inform community residents of the connection between land use within WHPAs and drinking water quality.	Communities can employ a variety of public education techniques ranging from brochures detailing their WHPAs program, to seminars, to involvement in events such as hazardous waste collection days.	No outstanding legal considerations.	Requires some degree of administrative support for programs, such as brochure mailing, to more intensive support for seminars and hazardous waste collection days.

Appendix I.

	Applicability to Wellhead Protection	Land Use Practice	Legal Considerations	Administrative Considerations
Legislative:				
Regional WHPA Districts	Used to protect regional aquifer systems by establishing new legislative districts that often transcend existing corporate boundaries.	Requires state legislative action to create a new legislative authority.	Well-accepted method of protecting regional groundwater resources.	Administrative requirements will vary depending on the goal of the regional district. Mapping of the regional WHPAs requires moderate administrative support, while creating land use controls within the WHPAs will require significant administrative personnel and support.
Land Banking	Used to acquire and protect land within WHPAs.	Land banks are usually accomplished with a transfer tax established by state government empowering local government to impose a tax on the transfer of land from one party to another.	Land banks can be subject to legal challenge as an unjust tax, but have been accepted as a legitimate method of raising revenue for resource protection.	Land banks require significant administrative support if they are to function effectively.

Appendix J

Potential and Known Source Hazards, Controls, Assessment and Management (Form IV-1)

From Form III-1; ('Source Identification Form') for this Site/Address:

City/Town _____ Well Name _____
EPA PWS Name and ID# _____ WHPA Zone # (1,2,3) _____

Form Completed By _____ Site Name/Address _____
Date _____

Name and describe the potential or known source and the source management strategy used to reduce or eliminate the risk of contamination from this source. Highlight each known, or existing source where a release has been identified, or if the site is listed on one of WDEQ's contaminated site databases. For sites/sources listed on one of WDEQ's databases, the management strategy will be *"State Agency Oversight"*. For sites where a release has been identified but the site is not listed on one of WDEQ's databases, list the strategy as "?". Include the implementation date, or proposed implementation date for the management strategy. File one form for each site or address identified on the Source Inventory List.

Example:

Potential Source #:	#1
Priority Rank #:	#5 (or Medium)
Potential Source Type:	Abandoned Well
Strategy:	Contact property owner to request that well be properly plugged and abandoned. Follow up with contact or visit to confirm plugging.
Implementation Date:	July, 1996.

Potential Source #__: Priority Rank # ___. Potential Source Type: _____.
Strategy: _____
_____
_____
_____
Implementation Date: _____
Potential Source #__: Priority Rank # ___. Potential Source Type: _____.
Strategy: _____
_____
_____
_____
Implementation Date: _____
Potential Source #__: Priority Rank # ___. Potential Source Type: _____.
Strategy: _____
_____
_____
_____

(Continued on Back)

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Potential Source #__: Priority Rank # ___. Potential Source Type: _____.
Strategy: _____
_____
_____
_____
Implementation Date: _____
Potential Source #__: Priority Rank # ___. Potential Source Type: _____.
Strategy: _____
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Implementation Date: _____
Potential Source #__: Priority Rank # ___. Potential Source Type: _____.
Strategy: _____
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Implementation Date: _____
Potential Source #__: Priority Rank # ___. Potential Source Type: _____.
Strategy: _____
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Implementation Date: _____
Potential Source #__: Priority Rank # ___. Potential Source Type: _____.
Strategy: _____
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Implementation Date: _____
Potential Source #__: Priority Rank # ___. Potential Source Type: _____.
Strategy: _____
_____
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_____
Implementation Date: _____

Appendix K

WELLHEAD PROTECTION
1991 Public Education and Information Meetings

Cheyenne:	June 25
Wheatland:	June 26
Torrington:	June 27
Sundance:	July 1
Powell:	July 9
Worland:	July 10
Casper:	July 11
Riverton:	July 16
Rawlins:	July 17
Jackson:	July 18
Evanston:	August 15

Appendix K

Wellhead Protection Questionnaire

The following questions relate to issues associated with groundwater contamination, and the protection of Public Water System (PWS) drinking water supply wells and aquifers form contamination. The purpose of this survey is to help the Wyoming Department of Environmental Quality to better define the public's need and /or desire for wellhead protection, as well as preference for alternative methods to be considered if a Wellhead Protection Program is developed in Wyoming. Questions were prepared by staff from the Department of Environmental Quality's Water Quality Division with assistance from the Wyoming Water Research Center, University of Wyoming, and the EPA.

1. Please name the county in which you reside_____

2. Do you reside inside the city limits? YES NO

   If you answered yes to this question, please name the town/city in which you reside: _____

3. Please indicate the type of water supply from which you currently derive your drinking water:

   _____ Individual private well
   _____ Municipal (city) water supply
   _____ Non-municipal (water and sewer district, subdivision, trailer park) water supply
   _____ Unknown
   _____ Other (please list): _____

4. Do you feel that your community drinking water supply is in danger of contamination from

   a. Existing groundwater contamination YES NO
   b. Future groundwater contamination YES NO

5. Please indicate the source(s) of groundwater contamination which you believe have the potential to contaminate community drinking water sources (aquifers) and/or supplies (wells).

   _____ Point sources (i.e., underground storage tanks, above ground storage tanks, municipal landfills, hazardous waste sites, septic tanks and drain fields, leaky sewer lines, abandoned wells, feedlots)

   _____ Non-point sources (i.e., land application of waste, pesticide and fertilizer application, mining activities, construction activities, road salting)

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6. Do you feel that your community should protect its public drinking water supply wells and/or aquifers from potentially hazardous or toxic contamination?

YES NO

7. Do you feel that your community needs to protect its drinking water supply wells and/or aquifers from potentially hazardous or toxic contamination?

YES NO

8. Should a Wellhead Protection Program be established in your community?

YES NO

9. Given the importance of groundwater supplies for drinking water, should the State impose the implementation of a Wellhead Protection Program if communities do not wish to participate?

YES NO

If you answered yes to this question, please indicate which community(ies) should be required to participate.

____ My community
____ All communities
____ Only communities with contaminated public drinking water wells
____ The state should not impose a Wellhead Protection Program on any community

10. For those communities that want a Wellhead Protection Program, should the State assist them in developing Wellhead Protection Programs?

YES NO

If you answered yes to this question, please indicate the form(s) of assistance they should receive.

____ Technical assistance
____ Financial assistance
____ Education/information aids (fact sheets, guidance documents, etc.)
____ Other (please list): _____

11. If technical assistance is requested, additional State funding would be necessary to provide technical staff to handle the increased work load. Would you support the use of additional State funding for technical staff?

YES NO

12. Of those listed below, who should pay the costs associated with implementing a Wellhead Protection Program in those communities that want such a program?

    ____ The water user
    ____ The local city/county government
    ____ The State

13. In many instances, funding for treatment or replacement of contaminated drinking water supplies is inadequate or unavailable. At what level of government should new funding be developed to provide for treatment or replacement of contaminated drinking water supply(ies)?

    ____ The municipal water user should provide for treatment, or an alternative source of safe drinking water
    ____ The local city /county government should provide for treatment, or an alternative source of safe drinking water
    ____ The State should provide for treatment, or an alternative source of safe drinking water
    ____ Other (please list): _____

14. In many instances, funding for investigation and clean-up of groundwater contamination is inadequate or unavailable. If your community's drinking water supply well(s) and/or aquifer is contaminated by hazardous or toxic pollution, who should be responsible for paying to restore (clean-up) the groundwater?

    ____ The person(s) responsible should pay for restoration of the aquifer's water to its natural quality
    ____ The municipal water user should pay for restoration of the aquifer's water to its natural quality
    ____ The local city /county government should pay for restoration of the aquifer's water to its natural quality
    ____ The State should pay for restoration of the aquifer's water to its natural quality
    ____ Other (please list): _____

15. Which of the following management approaches seem reasonable to implement for protection of drinking water aquifers and wells?

____ **REGULATORY**
- ____ Permit programs
- ____ Enforcement
- ____ Zoning ordinances
  - ____ Land use control (to protect future well sites)
  - ____ Performance controls
  - ____ Operating controls

____ **NON-REGULATORY**
- ____ Best Management Practices (BMP's)
- ____ Public education
- ____ Planning
- ____ Land acquisition
- ____ Capital improvements
- ____ Environmental audits
- ____ Household hazardous waste collection
- ____ Abandon wells (which have been improperly constructed)

16. Who should do the delineations for the Wellhead Protection Areas in the community?

- ____ The public water systems operator
- ____ The local city/county government
- ____ The State
- ____ Other (please list): _____

17. Who should pay for the delineations of the Wellhead Protection Areas?

- ____ The water user
- ____ The local city/county government
- ____ The State
- ____ Other (please list): _____

18. Who should perform the contaminant source inventory in the community?

- ____ The public water systems operator
- ____ The local city/county government
- ____ The State
- ____ Other (please list): _____

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19. Who should pay for the contaminant source inventory in the community?

____ The water user
____ The local city/county government
____ The State
____ Other (please list): _____

Additional Comments

_____

_____

_____

_____

_____

_____

_____

_____

_____

Thank you for taking the time to complete this questionnaire. Results from this survey will be available form the Department of Environmental Quality's Water Quality Division at a future date.

Appendix K

Results from the Wellhead Protection Survey

1. Questionnaire responses by county of residence:

Natrona	17	Big Horn	4
Teton	12	Crook	3
Fremont	10	Hot Springs	3
Park	8	Lincoln	3
Platte	8	Niobrara	3
Carbon	7	Sweetwater	3
Washakie	7	Albany	2
Unita	6	Laramie	2
Converse	5	Sublette	1
Goshen	5	Weston	1

2. Residence is or is not within city limits:

	Number	Percent
(Y)	60	56.6
(N)	46	43.4
Total	106	100.0

City/Town of Residence:

Casper	12	Edgerton	1
Powell	5	Gillette	1
Rawlins	5	Glendo	1
Glenrock	4	Jeffery City	1
Jackson	4	Laramie	1
Evanston	3	Lusk	1
Riverton	3	Medicine Bow	1
Wheatland	3	Newcastle	1
Worland	3	Opal	1
Cody	2	Sundance	1
Shoshoni	2	Thermopolis	1
Torrington	2	Wright	1
Cheyenne	1	Yoder	1
Chugwater	1		

3. Type of water supply from which you currently derive your drinking water:

	Number	Percent
Individual private well	30	26.5
Municipal (city) water supply	72	63.7
Non-municipal (water and sewer district subdivision trailer park) water supply	8	7.1
Unknown	0	0.0
Other	3	2.7
Total	113	100.0

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4. Do you feel that your community drinking water supply is in danger of contamination from

a. Existing groundwater contamination

	Number	Percent
(Y)	38	40.4
(N)	56	59.6
Total	94	100.0

b. Future groundwater contamination

	Number	Percent
(Y)	61	68.5
(N)	28	31.5
Total	89	100.0

5. Source(s) of groundwater contamination which you believe have the potential to contaminate community drinking water sources (aquifers) and/or supplies (wells):

	Number	Percent
Point sources	71	49.3
Non-point sources	73	50.7
Total	144	100.0

6. Community should protect its public drinking water supply wells and/or aquifers from potentially hazardous or toxic contamination:

	Number	Percent
(Y)	106	100.0
(N)	0	0
Total	106	100.0

7. Community needs to protect its drinking water supply wells and/or aquifers from potentially hazardous or toxic contamination:

	Number	Percent
(Y)	97	97
(N)	3	3
Total	100	100.0

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8. A Wellhead Protection Program should be established in your community:

	Number	Percent
(Y)	92	90.2
(N)	10	9.8
Total	102	100.0

9. State should impose a Wellhead Protection Program even if communities do not wish to participate:

	Number	Percent
(Y)	80	76.9
(N)	24	23.1
Total	104	100.0

If yes, communities that should be required to participate are:

	Number	Percent
My community	3	3.8
All communities	69	86.4
Only communities with contaminated public drinking water wells	7	8.8
The state should not impose a Wellhead Protection Program on any community	4	5.0
Total	83	100.0

10. The State should assist those communities who want to develop a Wellhead Protection Programs:

	Number	Percent
(Y)	103	98.1
(N)	2	1.9
Total	105	100.0

If yes, the form(s) of assistance received:

	Number	Percent
Technical assistance	92	89.3
Financial assistance	75	72.8
Education/information aids	95	92.2
Other	5	4.9
Total	267	259.2

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11. Do you support the use of additional State funding for technical staff for the Wellhead Protection Program:

	Number	Percent
(Y)	95	93.1
(N)	7	6.9
Total	102	100.0

12. Who should pay the costs associated with implementing a Wellhead Protection Program for those communities who want the program:

	Number	Percent
The water user	56	32.4
The local city/county government	63	36.4
The State	54	31.2
Total	173	100.0

13. Level of government that should develop new funding to provide for treatment of contaminated drinking water supply(ies):

	Number	Percent
The municipal water user	35	21.4
The local city/county government	57	35.1
The State	49	30.1
Other	22	13.4
Total	163	100.0

14. If the groundwater supply becomes or is contaminated, the responsible party to provide funds to restore (clean-up) the groundwater supply should be:

	Number	Percent
The person(s) responsible	80	45.1
The municipal water user	19	11.0
The local city/county government	23	13.0
The State	33	18.5
Other	22	12.4
Total	177	100.0

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15. Reasonable management approaches to implement for protection of drinking water aquifers and wells:

REGULATORY	Number	Percent
Permit programs	64	37.8
Enforcement	43	25.5
Zoning ordinances	62	36.7
Total	169	100.0
Zoning ordinances	Number	Percent
Land use control	54	87.1
Performance controls	36	58.1
Operating controls	34	54.8
Total	124	200.0

NON-REGULATORY	Number	Percent
Best Management Practices (BMP's)	70	17.0
Public education	80	19.4
Planning	66	16.0
Land acquisition	30	7.3
Capital improvements	30	7.3
Environmental audits	41	9.9
Household hazardous waste collection	50	12.1
Abandon wells (which have been improperly constructed)	45	11.0
Total	412	100.0

16. Person responsible for doing the Wellhead delineations for the Wellhead Protection Areas in the community:

	Number	Percent
The public water systems operator	31	22.8
The local city/county government	59	43.4
The State	34	25.0
Other	12	8.8
Total	136	100.0

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17. Person responsible to pay for the delineations:

	Number	Percent
The water user	50	31.3
The local city/county government	64	40.0
The State	37	23.1
Other	9	5.6
Total	160	100.0

18. Person responsible to perform the contaminant source inventory in the community?

	Number	Percent
The public water systems operator	35	23.0
The local city/county government	73	48.0
The State	36	23.7
Other	8	5.3
Total	152	100.0

19. Person responsible to pay for the contaminant source inventory in the community?

	Number	Percent
The water user	22	15.2
The local city/county government	70	48.3
The State	44	30.3
Other	9	6.2
Total	145	100.0

Appendix L

Sample Wellhead Protection Ordinance Provisions[1]

by

Sanjay Jeer, Senior Research Associate, APA

The provisions listed below are basic components for most wellhead protection ordinances. In deciding whether to include any of these provisions, you must answer two questions:

1) **Are these provisions permitted under your State enabling legislation?** Not all provisions are applicable in all states. Moreover, some states' enabling legislation allows such provisions to be part of the health or building codes instead of the zoning code, especially those that pertain to continuous compliance, monitoring, and emergency response. All provisions used in the wellhead protection ordinance must be permitted through enabling legislation or municipal charter.

2) **Are these provisions appropriate in the wellhead protection ordinance portion of the zoning code?** Often communities have general code provisions with overlapping intent that could be referenced in the wellhead provisions of the ordinance. Typically, such provisions are found in other groundwater or aquifer-protection-related standards. Cross-referencing such general provisions in the wellhead section of the ordinance may be sufficient if they are appropriate to the wellhead protection areas.

The provisions are organized into sections that are found in most zoning ordinances. Each section contains a statement of purpose followed by applicable notes. Where useful, a summary of key elements is also provided. Sample language is provided and is taken, wherever possible, from ordinances presently in use. These sample provisions are from zoning ordinances or special ordinances and tribal regulations that are similar to zoning enforcement and authority. They do not include wellhead protection standards that local governments typically maintain in other regulations, such as health regulations, or building and construction codes.

Note that these provisions are provided for illustration only and may be inappropriate or require significant modification to suit local needs.

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1 This is Appendix D of *A Guide to Wellhead Protection*. Reprinted with permission from *A Guide to Wellhead Protection* by Jon Witten and Scott Horsley with Sanjay Jeer and Erin K. Flanagan, Planning Advisory Services Report 457/458 (Chicago: American Planning Association, August 1995).

Appendix L

1. Title

Purpose: To give the ordinance a brief descriptive title.

Notes: The title should be specific to the scope of applicability (e.g., use Wellhead Protection District for a regular district or Wellhead Protection Overlay District for an overlay district). If wellhead protection is incorporated into an overall groundwater or aquifer protection district, the title sound reflect a general designation, such as Groundwater Protection or Aquifer Protection District, and make clear how the specific ordinance related to the overall plan.

If there are separate sets of regulations for the wellfields and the zone of contribution for the zone of recharge), use appropriate terms. For example, use Wellhead Operation District for wellfields, and Wellhead Protection District for the zone of contribution. Such distinctions should also be made in cases where the wellhead protection ordinance is not part of the zoning ordinance. Some of the common titles for wellhead protection provisions are:

Wellhead Protection District
[Cinton, Maine, Zoning Ordinance, 1993]

Wellhead Operation District (WO); and Well Field Protection Overlay District (WP)
[City of Dayton, Ohio, Zoning Ordinance, Sections 150.600 and 150.610, 1988]

Aquifer Protection District
[Town of Southington, Connecticut, Zoning Ordinance, Section 17, 1980]

Public Wellhead Recharge District
[Nantucket, Massachusetts, Zoning Ordinance, Section 139-12 B. 1986]

South Tacoma Groundwater Protection District
[Tacoma, Washington, Zoning Ordinance, Chapter 13.09. 1988]

For overlay-type zoning districts:

Water Source Protection Overlay District
[Minnehaha County, South Dakota, Zoning Ordinance, Article 11. 1991]

Aquifer Sensitive Area Overlay Zone
[(Spokane County, Washington, Zoning Ordinance, Section 4.16A, 1983]

Appendix L

2. Purpose and Intent

Purpose: To set forth the goals and objectives to be achieved through this ordinance.

Key Issues:

- Protection of public health, welfare, and safety
- Protection of groundwater resources from contamination
- Protection of groundwater resources from excessive extraction
- Management of land-use activities that store, handle, or produce regulated substances
- Encouragement of the use of best management practices (regulatory and nonregulatory) Protection of future groundwater sources of drinking water
- Recognition of local government responsibility in protection groundwater resources
- Encouragement for municipalities to work with neighboring communities for adequate protection of resource areas extending into other jurisdictions

Notes: In addition to stating public health, welfare, and safety concerns, include any special circumstances that are of particular importance to the community (e.g., the well or wellfield being the only source of public drinking water for the community?. The goals and objectives should be clearly stated and quantifiable, if possible. It is also necessary to make it clear if the ordinance applies to both public and private wells.

> *The purpose of the Wellhead Protection Ordinance is to protect the public, municipal water supply for the town of Norway from land uses which pose a threat to the quality and quantity of the groundwater being extracted from the Norway municipal well(s).*
> **[Town of Norway, Maine, Wellhead Protection Management Plan, October 1993]**

Provide separate purpose and intent statements for the resource or protection areas being addressed in the ordinance, such as the immediate area surrounding wells, or wellfields and the recharge area (or zone of influence) if there are separate zoning district for each zone. For example, the City of Dayton, Ohio, has one zoning district (Well Head Operation District) for the actual location of wellfields, and an overlay zoning district (Well Field Protection Overlay District) for the recharge area.

> *The WO Well Head Operation District is designed to safeguard the public health, safety, and welfare of citizens and institutions that are customers of the Dayton Water system by regulating the land use and the storage, handling, use and/or production of Regulated Substances within the zone of influence. The intent of this designation is to protect the community's potable water supply against contamination. This district will be mapped on property owned by the city at the location of any presently city-owned and operated or designated future or proposed public water supply well, recharge lagoon, or other related water facility as part of the Cit of Dayton Master Plan for Water supply and Treatment.*
> **[City of Dayton, Ohio, zoning Ordinance, Section 150.600, 1988]**

> *The WP Well field Protection Overlay District is designed to safeguard the public health, safety, and welfare of citizens and institutions that are customers of the Dayton Water system by regulating the land use and the storage, handling, use, and/or production of Regulated substances within the zone described as the land area adjacent to the existing and proposed municipal water wellfields, within the city, not included within the WQ Well Field Operation District, which lies within the one(1) year capture area, including a one*

thousand (1,000) foot strip of land outside of the direct recharge area in locations where the direct recharge area within the one(1) year capture area impinges on the aquifer boundary. The intent of this designation is to protect the community's potable water supply against contamination.

[City of Dayton, Ohio, zoning Ordinance, Section 150.610, 1988]

If there are other natural resources and geologic features (e.g. a carbonate geologic formation, lakes, and lake watershed that discharge to groundwater) that merit protection, identify them in this part of the ordinance when defining intent. Similarly, include any known threats and constraints, such as conditions inhibiting recharge capacity, land subsidence, and sinkholes.

In addition to the general goals listed in the statements of Purpose and Community Development Objectives, it is the purpose of this Article to protect a uniquely sensitive and valuable groundwater resource area, defined by a carbonate geologic formation identified in the East Marlborough township Comprehensive Plan, against land development patterns that would deplete the groundwater supply through excess demand, threaten its quality through wastewater pollution, inhibit the recharge capability of the area through exorbitant impervious surface areas, and increase the dangers of land subsidence and sinkholes.

The GP, Groundwater Protection District, shall be deemed an overlay on the application zoning district, and shall be shown on the East Marlborough Township Groundwater Protection Overlay Map. In the GP Overlay District, the following regulation shall apply, unless superseded by a more stringent regulation of the base zoning district.

[City of East Marlborough Township, Pennsylvania, Zoning Ordinance, Section 1201A, 1979]

If the aquifer or groundwater is not the only (sole) source of water supply, but a significant source of supply of the community's water needs, indicate that fact in the statement of intent.

(Note that a federal provision contained in the Safe Drinking Water Act provides for Sole source Aquifer (SSA) designation if at least 50 percent of the water delivered to the service area is dependent on reserves drawn from the SSA, provided there are no other alternative viable water sources that could supply at least 50 percent of the required water to be delivered to the service area. To qualify for such a designation and protection under the act, a community must petition EPA and meet the requirements of the Sole Source Aquifer Program. The designation permits EPA to conduct a limited review of federal financially assisted projects to determine their potential contamination threat.)

The purpose of this regulation is to safeguard public health by reducing risks of contamination of public water supply in the Town of Cheshire. Over 80 percent of Cheshire residents are served by public water supply wells which draw upon stratified drift aquifers that lie within the town boundaries, and the other 20 percent rely on private wells. In recognition of the fact that these aquifers are vulnerable to contamination from land-use activities, and that protection of Cheshire's groundwater resources is vial to ensure an adequate supply of safe, potable water, this section establishes Aquifer Protection Zones and prescribes land-use regulation within the zones.

[Town of Cheshire, Connecticut, zoning Ordinance, Section 47.1, January 1994]

Appendix L

The Brookings County Planning Commission and Board of County Commissioners recognize (1) that resident of Brookings county rely exclusively on groundwater for a safe drinking water supply and (2) that certain land uses in Brookings County can contaminate groundwater, particularly in shallow/surficial aquifers.

The purpose of the Aquifer Protection Overlay District is to protect public health and safety by minimizing contamination of the shallow/surficial aquifers of Brookings county. It is the intent to accomplish this, as much as possible, by public education and securing public cooperation.

Appropriate land-use regulations will be imposed, however, which are in addition to these imposed in the underlying zoning districts or in other county regulations. It is not the intent to grandfather in existing land uses which pose a serious threat to public health through potential contamination of public water supply wellhead areas.

[Brookings County, South Dakota, Zoning Ordinance, Section 1106, 1989]

Promote the idea of shared responsibility for groundwater protection between the business and commercial uses, residential needs, and local government authority. And seek regulatory and nonregulatory approaches to groundwater resource protection.

It is the purpose of this ordinance to promote the public health, safety, and general welfare and to minimize public and private losses due to contamination of the public water supply, to maximize groundwater protection pollution abatement control procedures, and minimize land-use restrictions that:

(1) Protect human life and health;
(2) Minimize expenditure of public money for costly pollution remediation projects;
(3) Minimize regulations on land use (for those activities that are not a threat to public water supplies);
(4) Minimize business interruptions;
(5) Minimize damage to public facilities and utilities such as water mains, sewer lines, and treatment facilities;
(6) Insure that the public is provided with safe potable water supply now and for future generation'
(7) Protect the natural resources of the State.

[City of Rockdale, Texas, General Ordinance, Section 3, 1991]

The intent and purpose of this ordinance is to safeguard the public health, safety, and welfare of the people of Volusia County, Florida, by providing for regulation of the storage, handling, use, or production of hazardous substances within zones of protection surrounding potable water supply wellfields, thereby protecting the potable water supply from contamination and other areas of Volusia County as provided herein.

[Volusia county, Florida, Zoning Ordinance, Section 701.00. draft]

This is an example of a detailed description to be used in a statement of purpose or intent.

1. *The aquifer lying under the area described in (the study of) McAllister aquifer is one of the most important sources of drinking water in Thurston County. Approximately 47,000 persons in the cities of Olympia and Lacey obtain their drinking water from*

springs fed by this aquifer. This aquifer is capable of providing water to twice these numbers and will be the major source of drinking water in Thurston county well into the future.

2. *This aquifer consists primarily of course sands and gravels, with approximately five to ten percent less permeable glacial till. These coarse sands and gravels allow relatively rapid infiltration and transmission of water and have high percolation rates. These soils are also generally poor at binding, trapping, and filtering* contaminants. Consequently, they have low potential to treat and retain pollutants.

[Thurston County, Washington, Resolution No. H3-90. 1990]

Appendix L

3. Authority and Applicability

Purpose: To establish local government (or an authorized jurisdiction's) authority and responsibility to manage and otherwise regulate wellhead protection areas, aquifers, and groundwater resources.

Key Issues:

- Refer or cite enabling legislation.
- Include references to any adopted map that defines the delineated boundaries.
- Make clear the duties and make up of any special citizen's review board or commission.
- Identify the authority and responsibility of appointed officials, such as the zoning administrator, planning director, water or public works director.
- Include a standard statement of abrogation and greater restrictions. Include a standard statement of severability.

Notes: Refer or cite the relevant federal and State enabling legislation along with local ordinances to establish the authority to regulate and the applicability of wellhead protection to protect groundwater. This section should include references to State statutes, areas of the jurisdiction where such statutes are applicable, and a general description of boundaries or reference to an adopted map of the boundaries. Contact your local government's legal counsel for identifying such statutes and legal descriptions. Legal counsels are Law Directors, Commonwealth Attorney's, Town Counsel, etc. Also contact the appropriate State environmental agency, other communities who have adopted similar ordinances, and health officials.

> *Whereas, Article 1175, Subdivision 19 of the Texas Revised Civil Statutes states in pertinent part that a city has the power to prohibit the pollution of any streams, drain, or tributaries thereof, which may constitute the source of water supply of any city and to provide policing of same as well as to provide for the protection of any watersheds...*
>
> **[City of Sweeny, Texas, General Ordinance, Section A, 1990]**

> *This Ordinance applies to all land uses and activities located or proposed within the area delineated as the Wellhead Protection Area in Norway on a map available for inspection at the office of the Norway Water District and as defined in the definitions section of the ordinance. The Wellhead Protection Area consists of WHPA 1, WHPA 2, and WHPA 3, described below, for the Norway municipal well(s).*
>
> **[Town of Norway, Maine, Wellhead Protection Ordinance, Section B, 1993]**

When special committees are appointed to review provisions and make recommendations to the planning commission or the elected body, a reference to their role and authority should also be included here. Describe the composition of the body and its role in the review, revision, and interpretation of wellhead protection provisions of the zoning ordinance.

> *(a) A Resource Protection Area Technical Advisory Committee ("RPATAC") is hereby established in the New Castle county Department of Planning composed of one (1) representative from each of the following:*

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Chemical Industry
Consulting Engineers Council
DNREC
Delaware Department of Health and Social Services, Division of Public Health
Delaware Geological Survey
New Castle County Chamber of Commerce
New Castle County Department of Planning
New Castle County Department of Public Works
Water Company Representative
Water Resources Agency of New Castle County

The members shall be appointed by the County Executive. The members shall be appointed to four (4) year terms, except that initially four (4) members shall be appointed for a two (2) year term, three (3) members shall be appointed for a three (3) year term; and three(3) members shall be appointed for a four (4) year term. They may be reappointed and shall serve until their successor is appointed. The chairman shall be designated by the County Executive.

(b) the purposes and duties of the RPATAC are to:

(1) Provide technical support and recommendations to the Department of Planning concerning the technical definition and criteria of any Resource Protection Area as depicted on the three-map series designated in Section 23-123.

(2) Advise the Department of Planning when the RPATAC determines that performance standards should be amended.

(3) Provide technical support and recommendations to the Board of Adjustment concerning any application made to that Board.

(4) Advise the Department of Planning when the RPATAC determines that this Article or any regulations promulgated pursuant to this Article should be amended.

(5) Assist the Department of Planning as requested.

[New Castle County, Delaware, Zoning Ordinance, Section 23-138 and 23-139, proposed]

A committee shall be established to assist in the interpretation of and/or revision of boundaries established in this article, the review of development plans within wellhead resources and recharge protection areas, and other related matters that may arise in the administration of this article. The committee shall consist of representatives from the Newark Planning and Water and Waste Water Departments, the Delaware Geological Survey, the Delaware Department of Natural Resources and Environmental Control, the Soil Conservation Service, and the Water Resources Agency for New Castle County. The committee shall be chaired by the Newark Director of Water and Waste Water and shall be convened by the director when, in the director's opinion, technical advice is necessary for the administration of this article as described herein. The committee shall be advisory only; all final determinations shall be made by the Water and Waste Water Director.

[City of Newark, Delaware, Zoning Ordinance, Section 30-53.d, 1991]

The City of Rockdale's Water and Sewer Superintendent is hereby appointed the wellhead protection area administrator to administer and implement the provisions of this ordinance and other appropriate sections of (Wellhead Protection Ordinance) of the Texas Water Code.

[City of Rockdale, Texas, Wellhead Protection Ordinance, Article 4, Section 1, 1991]

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A standard statement of responsibility of appointed local officials, such as the Planning Director, the Zoning Administrator, and other officials should be included and or amended as necessary.

> *The Board of Adjustment shall not consider any application for a variance from the provisions of this Article until the RPATAC (Resource Protection Area Technical Advisory Committee) has had an opportunity to review the application and make a written recommendation to the Board of Adjustment. Any application for a variance from this Article shall be transmitted to the RPATAC, which shall have forty-five (45) working days from the filing of the application to review and issue its recommendations. The application shall be advertised for public hearing for the next regularly scheduled Board of Adjustment meeting following the expiration of the forty-five (45) day -period.*
>
> **[New Castle County, Delaware, Zoning Ordinance, Section 23-138 and 23-139, proposed]**

These are some additional standard statements pertaining to the authority and applicability that are not necessary if such responsibilities are defined in other parts of the zoning ordinance.

> *Nothing contained in (the Wellhead Protection sections of the zoning ordinance shall be construed so as to interfere with the duties and powers of the Director of Water as set forth in Section 50.42 of the R.C.G.O.*
>
> **[City of Dayton, Ohio, Zoning Ordinance, Section 53.01.B(3), 1988]**

> *It shall be the responsibility of any person owning real property and/or owning or operating a business within the City of Dayton corporate limits to make a determination of the applicability of (Well Head and Well field Protection districts) as it pertains to the property and/or business under his ownership or operation, and his failure to do so shall not excuse any violations of said sections.*
>
> **[City of Dayton, Ohio, Zoning Ordinance, Section 53.01.I, 1988]**

A standard statement of abrogation and greater restrictions is appropriate at the end of this section of the ordinance, if none exists in the zoning ordinance.

> *It is not intended by this Article to repeal, abrogate, or impair any existing easements, covenants, or deed restrictions. However, where this Article imposes greater restrictions, the provisions of this Article shall prevail.*
>
> **[City of East Marlborough Township, Pennsylvania, Zoning Ordinance, Section 1204A.5, 1979]**

> *Nothing contained in (the Wellhead Protection Ordinance) shall be construed so as to interfere with any existing or future lawful requirements that may be, or heretofore were, imposed by any other public body authorized to enact sanitary, health, or water pollution abatement restrictions so long as such requirements are consistent with, or more stringent than, the stated purpose of this ordinance.*
>
> **[City of Dayton, Ohio, Zoning Ordinance, Section 53.01.B(2), 1988]**

Often, zoning ordinances include a severability clause. If the courts strike down part of an ordinance, a severability clause allows the community to continue enforcing other portions of this ordinance without invalidating the whole. Although this is a standard clause that is usually put in a general provisions section of the zoning ordinance, making

it applicable to the entire zoning ordinance, it is also repeated in most major chapters or articles of the ordinance.

> *Should any part or provision of this ordinance be declared by a court of competent jurisdiction to be invalid, the same shall not affect the validity of the ordinance as a whole or any part thereof other than the part held to be invalid.*
>
> **[Authors' recommended language]**

Communities that have experienced incidents of contamination and significant violations of the provisions of their ordinance have sometimes chosen to include statements of injunctive relief. Although the right to file for such relief in courts is available whether or not such a statement is explicitly stated in the ordinance, reiterating such rights in the ordinance acts as an added deterrence.

> *If any person who engages in nonresidential activities stores, handles, uses, and/or produces toxic substances listed in Table 1 (Toxic Substances List) within the well field zones of influence, as indicated on the Zone of Influence maps, without having obtained a permit as provided for herein or continues to operate in violation of the provisions of this ordinance, then Broward County may file an action for injunctive relief in the circuit court...*
>
> **[Broward County, Florida, Well Field Protection Ordinance, Section 11.01, 1989]**

Appendix L

4. Extent and Designations

Purpose: To establish the physical boundaries or limits of wellhead protection districts, aquifers, or groundwater resource areas that are addressed in this ordinance.

Key Issues:

- The extent and delineation of the boundaries should correspond t the study methodology and findings (remember, challenges to wellhead protection are more likely to be based on the arbitrariness of delineation than on the right to establish a wellhead protection zone).
- City the methodology used to delineate wellhead protection areas (State standard, EPA recommended standard, scientific modeling, etc.)
- References to maps, map areas, and terminology used to define areas must be consistent with the study and findings.
- Include a statement of authority to modify or expand the extent and designation of the wellhead protection areas.
- If the boundaries of the wellhead protection zones cut across existing property lines or a property is contained in more than one zone, include a general statement of clarification about which provisions apply (usually those of the more restrictive zone).
- If the boundary of the wellhead protection zone extends beyond the jurisdiction, but the jurisdiction has extraterritorial rights, include or cite such authority along with any interjurisdictional agreements that affect the management of wellhead protection areas.

Notes: The method for delineating wellhead protection areas should be consistent with the State program, if there is one. If there is no State-prescribed method, the method chosen should fit the level of detail required by the hydrogeologic setting. Some of the methods suggested by EPA include arbitrary fixed radius, calculated fixed radius, simplified variable shapes, analytical method, numerical method, and hydrogeologic mapping method. (See Chapter 3 above.) Verify if there is a specific method that the EPA and your State environmental agency recommends. The more comprehensive and detailed the method of delineation, the less likelihood of legal challenges to the wellhead protection boundaries. Delineating the wellhead protection areas separate from the aquifers may be necessary even if the entire jurisdiction is found to be in the zone of influence.

There is a significant distinction between aquifer protection areas and wellhead protection areas in State statutes, administrative regulations, and local ordinances. Aquifer protection areas have been traditionally used for the past 15 to 20 years by communities to generally protect large areas that have significant groundwater reserves. Wellhead protection areas are only those portions of aquifers (and may contain nonaquifer areas also) through which contaminants are likely to reach the wells.

If an arbitrary fixed radius is used to define the extent of a wellhead protection area when a more detailed study is still in progress, include the term "interim" in the designation. Make sure that the ordinance title, the heading of this section, and maps reflect the interim designation.

For wells serving more than five hundred (500) persons and located in unconsolidated (sand and gravel) aquifers, the Wellhead Protection Area (WHPA) consists of three (3) areas (WHPA 1, WHPA 2, and WHPA 3) which are listed and their hydrologic

characteristics described below:

(1) WHPA 1: WHPA 1 extends from the wellhead to the 200-day groundwater Time-of-Travel boundary.
(2) WHPA 2: WHPA 2 extends from the outer boundary of WHPA 1 to the 1000-day Time-of-Travel boundary.
(3) WHPA 3: WHPA 3 extends from outer boundary of WHPA 2 to the watershed's groundwater divide or Zone of contribution id delineated based on technical criteria more stringent than watershed determination.

[Town of Norway, Maine, Wellhead Protection Ordinance, Section C, 1993]

Communities that already have an aquifer protection ordinance may be able to modify it to include a delineated wellhead protection area. In this case, the community will need to consider if it has the ability and the resources to use the more restrictive wellhead protection management measures over the entire aquifer protection area or just within the wellhead protection overlay zone. The same is true for communities with numerous private wells and public drinking water wells. In this case, the protection area will likely be larger than anticipated because of the interaction between the pumping wells. In some parts of the country, the wellhead protection area will be nearly as large as the aquifer protection area, in which case it may make sense to use the more intensive wellhead protection management measures over the entire area.

Boundaries for the aquifer protection zones for the Aquifer Protection Overlay District are shown on published maps entitled "Wellhead Protection Area Maps, Brookings County Shallow Aquifer Map"...(and) are hereby adopted by reference as part of this ordinance as if the maps were fully described herein.

The shallow/surficial aquifer boundary was mapped using data from the south Dakota Geological Survey and United States Geological Survey. The zone of contribution was mapped using an analytical technique outlined in the U.S. Environmental Protection Agency publication "Guidelines for Delineation of Wellhead Protection Areas, June, 1987." The Aquifer Protection Overlay District was divided into two zones.

[Brookings County, South Dakota, Zoning Ordinance, Section 1106, 1989]

Be certain to include a reference to procedures for amending the designation of aquifer protection zone boundaries. Although the definition of wellhead protection areas is inherently tied to knowing the exact location of wells, a description of the process for expanding aquifer protection boundaries should be included.

The recharge protection areas may be modified from time to time based on the recommendation of the technical advisory committee established in subsection (d) of this article and the Water Resource Protection Area map shall be revised accordingly; substantial changes in the Water Resources Protection Area Map, based on the recommendation of the technical advisory committee, shall be made by City Council by Ordinance.

[City of Newark, Delaware, Zoning Ordinance, Section 30-53.b(4), 1991]

Normally, zoning boundaries are made to coincide with parcel or site boundaries. But, when a fixed radius method is used to delineate the wellhead protection area, provisions to cover parcels that are only partly in the district may be needed. This exception also

applies when the boundary of the protection area cuts a large parcel.

In determining the location of properties within the zones depicted on the zones of influence maps, the following rules shall apply:

(1) Properties located wholly within one (1) zone reflected on the applicable zones of influence maps shall be governed by the restrictions applicable to that Zone.

(2) Properties having parts lying within more than one (1) zone as reflected on the applicable zones of influence maps shall be governed by the restrictions applicable to the zone in which the part of the property is located

(3) Where a travel-time contour which delineates the boundary between two zones of influence passes through a building, the entire building shall be considered to be in that zone in which more than fifty (50) percent of the floor space of the building is situated as of August 28, 1986.

[Broward County, Florida, General Ordinance, Section 27-381, 1984; 1989]

Appendix L

5. Use Regulations

Permitted Uses

Purpose: To identify the types of uses and activities allowed by right.

Notes: The only uses permitted by right in wellfield areas are those that are directly related to the operation of the wellfields. However, in some cases, single-family and passive recreational uses are allowed by right. In an overlay-type district, permitted uses are those that are allowed by right in the underlying zoning district.

> *Municipal water supply and treatment facilities in accordance with the City of Dayton Master Plan for Water Supply and Treatment.*
>
> **[City of Dayton, Ohio, Zoning Ordinance, Section 150.601(A), 1988]**

> *The permitted uses, bulk and yard regulations within the* WP Well *Field Protection Overlay District shall be those of the underlying zoning district.*
>
> **[City of Dayton, Ohio, Zoning Ordinance, Section 150.611, 1988]**

Prohibited Uses

Purpose: To identify prohibited uses and activities. Such prohibited uses and activities remain prohibited in an overlay district even if they are allowed by right in the underlying zoning district.

Notes: The primary reason that a use should be prohibited is tied to the threat of contamination of groundwater by that use. Note that the criteria for prohibition should be based on the association of known contaminants with uses. Traditionally, State wellhead protection programs and local ordinances associated land-use activities with contaminants, but the emphasis in the ordinance should be on the contaminants and not the use or activity. If the threat of contamination can be adequately mitigated, some uses may be allowed through other zoning provisions, such as conditional use permits, special exception processes, or a variance procedure. In the case of an overlay district, uses prohibited in the underlying zone are also prohibited in the overlay zone.

Contaminants can be grouped under the following major categories:

- Inorganic compounds (e.g., nitrogen and phosphorus nutrients, heavy metals, sodium, and chloride)
- Viral or bacterial contaminants (e.g., pathogens)
- Organic compounds (e.g., petroleum- and hydrocarbon-based projects, PCBs, pesticides, and other volatile and semi-volatile compounds, such as benzene, napthalenes and phenols)

An important component of the specifications of the prohibited uses must include flexibility for the implementing authority to determine, and document when necessary, the right to modify this section as information on contaminants or land-use activities that might pose a threat to groundwater quality becomes available. In determining which contaminants are

subject to this ordinance, the implementing authority may obtain appropriate lists and confer with State and federal environmental and health agencies.

Sanitary landfills, landfills composed of demolition debris, and dry wells are prohibited uses in the "WP" Well Field Protection District.

[City of Harrison, Ohio, Zoning Ordinance, Section 2707, 1989]

The following uses are prohibited in the Columbia South Shore Plan District;

(1) Manufacturing and production of hazardous materials, excluding production for on-site usage only. These materials include:

a) Any hazardous substance or hazardous waste as listed in the following federal regulations:

(1) Superfund Amendments and Reauthorization Act (SARA) of 1986 Section 302 Extremely Hazardous Substances List (40 C.F.R. 300 App. A and B);

(2) Comprehensive Environmental Response Compensation and Liability Act superfund (CERCLA) of 1980. Hazardous Substances List (40 C.F.R. 302, Table 203.4);

(3) SARA of 1986, Section 313, Toxic Chemicals List (40 C.F.R. Section 372.45); and

(4) Resource Conservation and Recovery Act (RCRA) of 1976 and 1984 Amendments, Hazardous Wastes Lists (P and U Categories) (40 C.F.R. Section 261.33(e) and (f).

Note: The lists reverenced in Section B.1.a. are summarized in the Title III List of Lists - Chemicals Subject to Reporting Under Title III of the Superfund Amendments and Reauthorization Action (SARA) of 1986, published July 1987, U.S. EPA.

b) Nuclear or radioactive materials or wastes.

(2) The following specific uses are prohibited:

a) Bulk plans for hazardous materials as defined in Subsection 33.455.125.C. including petroleum refining.

b) Permanent storage or disposal of hazardous wastes (as defined under the Federal Resource Conservation and Recovery Act, Subpart D, 40 CFR 261.30; 261.31; 261.32; 261.33), industrial or municipal sludge, or radioactive materials, including solid waste landfills.

c) Collection and transfer facilities for hazardous wastes, solid wastes that contain hazardous materials from off-site sources, and radioactive materials;

d) Wood-preserving operations using formulations of Chrome-Copper-Arsenate (CCC), pentachlorophenol (PENTA), and creosote and related chemicals;

e) Battery recycling and reprocessing;

f) Retain gas stations and truck stops;

g) Agricultural application of halogenated volatile liquid organic pesticides (e.g., ethylene dibromide (EDB) and dibromochloropropane (DBCP), related chemicals and their commercial formulations);

h) Processing, reprocessing, and storage (and disposal) of PCB containing oils;

i) Manufacturing and production of paving, roofing, and other construction materials, using asphaltic- and petroleum-based coating and preserving materials; and

j) Primary and secondary metal industries that manufacture, produce, smelt, or refine ferrous and non-ferrous metals.

[City of Portland, Oregon, Zoning Ordinance, Section 22.705.040.B, 1988]

It is a good idea to include language indicating that the use lists are not exhaustive and that information pertaining to changing technology and activities will require periodic evaluation of this list and the advice of outside experts to assess risks associated with uses not included in the ordinance.

(3) Use List Not Exhaustive: The uses prohibited by this district represent the State of present knowledge and most common description of said uses. As other polluting uses are discovered, or other terms of description become necessary, it is the intention to add them to the list of uses prohibited by this district. To screen for such other uses or terms for uses, no use shall be permitted in this district without first submitting its building, site, and operational plans for Planning Commission review and approval under Section 17.05 of this ordinance.

(4) Changing Technology: The uses prohibited by this district are prohibited based upon the combined pollution experience of many individual uses, and the technology generally employed by that class of uses, which technology causes the uses as a class to be groundwater pollution risks. As the technology of identified use classes changes to non-risk materials or methods, upon petition from such a use, and after conferring with expert geological and other opinion, it is the intention to delete from the prohibited list or allow conditionally, uses which demonstrate convincingly that they no longer pose a pollution hazard.

[Town of Weston, Wisconsin, Zoning Ordinance, Wellhead Protection District, Section 17.11-14. 1993]

Conditional Uses and Special Uses

Purpose: To set forth additional conditions and standards for some uses in the wellhead protection zone.

Notes: Conditional and special uses require additional standards be provided in the wellhead protection ordinance. In an overlay protection-type zoning district, if a proposed use is deemed a conditional use in the underlying zoning district, it must conform to both the provisions in the overlay district and the provisions of the underlying zoning district. As the conditional and special use applications are typically reviewed by the Board of Zoning Appeals or a similar body independent of the Planning Commission (e.g., any special body created to review applications for uses in wellhead protection areas), the uses that will be subjected to such additional review will have to be specifically identified. Zoning ordinances often contain a separate chapter for the submission and review requirements for conditional uses. But the specific uses in wellhead protection zones that trigger review may also be included here.

The following standards shall be applicable to any conditional uses permitted pursuant to the Article:

(1) The peak rate of stormwater runoff shall not exceed the pre-development peak rate. Stormwater runoff volume shall not exceed the pre-development volume for the duration of the pre-development stormwater runoff hydrograph.

(2) The quantity and quality of groundwater recharge shall be maintained at pre-development levels.

(3) In order to establish the pre-development standards required by subparagraphs (1) and (2) above, a study shall be prepared under the supervision of a Delaware registered professional geologist or engineer trained and experienced in hydrogeology. The report of the study shall be submitted to the New Castle County Departments of Planning and Public Works, and the Water Resources Agency for New Castle County.

(4) All development shall be maintained at a minimum sixty (60) day horizontal time of travel from any public water supply well as established by the on-site hydrogeologic study required by subparagraph (3) above.

(5) To assure that the quality of groundwater recharge shall be maintained, a groundwater monitoring program shall be established as part of the report prepared pursuant to subparagraph (3) above. The program shall establish the number of wells to be installed, s well as the duration and frequency regarding the monitoring of the wells to be installed. All laboratory test results shall be submitted to New Castle County in order to assure the County that satisfactory water quality is maintained.

[New Castle County, Delaware, Zoning Ordinance, Section 23-133 (a), proposed]

Commercial and industrial uses are permitted when allowed in the underlying zone subject to the procedures and restrictions in the underlying zone and subject to the following additional limitations and restrictions:

(1) New commercial and industrial uses or changes I use or the enlargement and alteration of commercial and industrial uses existing as of the effective date of this ordinance and permitted outright in the underlying zone are permitted outright in the WPA when no chemicals or other products are used, produced by, or commonly associated with the activity which, in the event of introduction of a large quantity thereof into the groundwater, might cause, materially contribute to, or create a material risk of any adverse effect upon the city of Enterprise municipal water source.

(2) A new commercial or industrial use or change in use not permitted outright under subparagraph 1 above may be permitted by the Commission after issuance of a special use permit, following public hearing, upon a finding that the proposed use, considering the quantity and character of the chemical or other product, the methods of use, and the distance from the city of Enterprise municipal water source, would not have an adverse effect upon the city of Enterprise municipal water source in ;the event of a major spill, improper storage and ;handling, or improper disposal of said chemical or other product. If said use is permitted outright in the underlying zone, review by the Commission shall be limited to the determination of whether the standard contained in this subparagraph is met. Conditions may be imposed upon the permit by the Commission to insure protection of the city of Enterprise municipal water source.

[Wallowa County, Oregon, Zoning Ordinance, Section 24.090.1, 1988]

Include the following utilities to the definition of special uses.

(A) Public utility uses as follows:

(1) Electric and Telephone substations

(2) Gas Regulator and meter station buildings

(3) Police and fire stations that do not contain maintenance facilities)

(4) Electric transmission towers and structures (not related to oil storage and disposal)

(B) Radio, Television, or other transmission towers or masts, and the usual accessory buildings, only after their height and location have been approved by the government

agency charged with the responsibility for maintaining air safety and provided there is a yard area with a radius of half the height of the tower or mast.

[City of Dayton, Ohio, Zoning Ordinance, Section 150.602, 1988]

Sewage disposal systems are generally governed by a more stringent set of health code regulations. However, allowing such systems as part of the utilities may be subject to zoning provisions provided in the wellhead protection ordinance.

I. the designed sewage flow is no greater than 450 gallons per five acres per day, and
ii. the waste entering the on-site system is equivalent in quality to typical residential waste.

[Thurston County, Washington, Resolution No. H3-90, Section 30(d), 1990]

Excavation, mineral extraction, borrow pits and other uses, when permitted under conditional uses, impose conditions that include the following:

The *excavation, extraction, mining or processing of sand, gravel and limestone from the earth for resale shall remain as conditional uses in the WP Well Field Protection Overlay District subject to BZA approval of an excavation and facilities plan that includes, but is not limited to:*

(1) an existing site plan with topographic detail at two-foot contour intervals, all planimetric information, depth to groundwater and floodplain characteristics, where applicable
(2) the proposed extent and depth of excavations
(3) slope angle of excavation walls (any final slopes shall be at the angle of repose for the remaining material)
(4) use and disposition of the spoil and/or overburden materials from the excavations including a landscaping and vegetation plan to stabilize any disturbed material
(5) surface drainage plan
(a) drainage into on-site excavations from proximate off-site transportation facilities, such as roadways and roadbeds, and off-site watercourses is prohibited unless the applicant provides a plan which otherwise protects the excavations from off-site waterborne regulated substances.
(b) the final on-site grading shall minimize all surface drainage into the excavations.
(6) a post-excavation and operation land-use plan
(7) a security plan (unauthorized access shall be strictly prohibited as long as any excavations remain on site)

[City of Dayton, Ohio, Zoning Ordinance, Section 150.612(C),1988]

The *following uses are those industrial operations which normally produce noise, glare, air pollution fire hazards or safety hazards; such uses may only be permitted upon the granting of a special exception by the Zoning Board of Appeals, subject to such standards or conditions as are imposed by said Board and conditional to compliance with the provisions of Section 9:*

(A) Plants generating power, disposing of sewage and/or garbage
(B) The cooking, distillation, processing, and incineration of animal or vegetable products including, but not limited to, brewery, distillery, slaughterhouse, fat rendering, soap manufacture, tannery, paper manufacture, wool-scouring and cleaning, cotton textile sizing, scouring, bleaching, dyeing, and similar operations.

(C) The production of corrosive and noxious chemicals including, but not limited to, acids, acetylene gas, ammonia, chlorine, bleaching compound

(D) The production, processing, and storage of coal, coal tar, petroleum, and asphalt products including, but not limited to, coke manufacture, illuminating gas production, petroleum refining, bulk, gasoline and petroleum products storage, asphalt products, linoleum manufacture oil cloth manufacture, roofing material manufacture

(E) The processing or washing of earth materials including batching plants

(F) The use of hammer mills, ball mills, rolling mills, or drop forges in any industrial process

(G) Accessory uses in accordance with the provisions of Section 2-01A.

[City of Southington, Connecticut, Zoning Ordinance, Section 5-02.3, 1980]

Some industries have developed advances pollution control and waste management techniques that may lessen the level or chance of pollution from their activities. In recognizing such innovative approaches, the conditional use process is applied to review proposed uses that would otherwise be prohibited.

Water Quality Impact Reviews. The uses listed below traditionally utilize solvents and other hazardous materials. However, it is recognized that changes in operational and containment process technology may be proposed. These uses are not allowed unless approval is granted.

(1) The uses are as follows:

a) Furniture stripping or refinishing;

b) Exterior and vehicle salvage, drum recycling and cleaning, commercial truck or rail tanker cleaning operations;

c) Industrial and commercial dry cleaning plants;

d) Rolling, drawing, extruding, casting, forging and heat treating of ferrous and non-ferrous metals;

e) Industrial electroplating, plating, anodizing and coloring of ferrous and non-ferrous metals; and

f) Other similar uses as may be determined by the Planning Director to pose a high potential risk to the ground and surface water resources. The applicant will be notified of any such determination within ten working days after the pre-application conference.

[City of Portland, Oregon, Zoning Ordinance, Section 33.705.040.C, 1988]

Special Exceptions and Limited Exclusions

Purpose: To set forth the types of uses that may be excluded from the provisions of the permitted, prohibited, and conditional use sections.

Key Issues:

- Set maximum limits on the amount of cleaning agents and household chemicals.
- Define temporary storage of construction material.
- Permit transportation of hazardous materials on roads in the wellhead protection areas.
- Allow office and business supplies for administrative functions. Include public utility functions associated with electric, telephone, and gas substations that are excluded.
- Exclude family subdivisions of residential parcels that have adequate public sewer and stormwater drains.
- Exclude fire, police, and public safety functions that do not use, store, or dispose hazardous materials, generate sewer, or otherwise violate the prohibited use provisions of this ordinance.

- Exclude repair and maintenance of working wells.

Notes: Special exceptions and limited exclusions provide for mechanisms to handle uses and activities that are unique and incidental to other uses. For example, the transportation of hazardous materials on roads in a wellhead protection overlay zone may be excluded from the governance of this ordinance. The use of household products containing hazardous substances by facilities in the wellhead protection area also needs to be addressed. While limited exclusions are normally exempt from administrative review, special exceptions require an application and demonstration of compliance with the provisions of the ordinance. As is true for regulating special and nonconforming uses, some zoning ordinances have specific sections describing submittal and review requirements governing the special exception process. But the criteria for determining the relief through a special exception should be included here.

Limited exclusions from the provisions of (Permitted and Prohibited Uses Section), are authorized for:

(A) Non-Routine Maintenance or Repair of Property or Equipment: The use, storage, handling, and/or production of Regulated substances under this exclusion shall be limited to:

(1) The aggregate of Regulated substances in use, storage, handling, and/or production may not exceed fifty (50) gallons or four hundred (400) pounds at any time.

(2) The total use, storage, handling, and/or production of Regulated Substances may not exceed one hundred (100) gallons or eight hundred (800) pounds in any twelve (12) month period.

(B) Medical and Research Laboratory Uses: Excluded Regulated Substances shall be stored, handled, or used in containers not to exceed five (5) gallons or forty (40) pounds of each substance and the aggregate inventory of Regulated Substances shall not exceed two hundred and fifty (250) gallons or two thousand (2000) pounds.

(C) Cleaning Agents: Excluded Regulated substances which are cleaning agents shall be packaged for personal or household use or be present in the same form and concentration as a product packaged for use by the general public. The aggregate inventory of such cleaning agents shall not exceed one hundred (100) gallons or eight hundred (800) pounds at any time. In no case shall Regulated Substances claimed under this exclusion include hydrocarbon or halogenated gydrocarbon solvents.

(D) Construction Materials; Regulated substances associated with construction for which a permit has been issued, paving or the pouring of concrete shall be excluded from regulation while present on the construction site provided such regulated substances do not pose a real and present danger of contaminating surface and/or groundwater.

(E) Office Supplies: Office supplies that are used solely for the operation of on-site administrative offices, provided such supplies are prepackaged in a form ready for use.

[City of Harrison, Ohio, Zoning Ordinance, Section 2708.02, 1989]

(a) Exemption for Public Utilities: Public utilities shall be exempt from zone 1 and zone 2 prohibitions as set forth in section (on prohibited uses). However, all such utilities in zone 1 and zone 2 shall comply with all provisions of section 27-379(b)(2) through (4). The license exemption set forth in subsection (h) of this section for regulated substances contained in storage tanks and licensed under article X of this chapter shall apply. However, compliance in zone 1 and zone 2 with the requirements set forth in article X of this chapter shall be completed by August 28, 1988.

(b) Exemption for Continuous Transit: the transportation of any regulated substances

through zone 1 shall be allowed provided the transporting vehicle is in continuous transit.

(c) *Exemption for Vehicular Fuel and Lubricant Use: the use of any regulated substances solely as fuel in a vehicle fuel tank or as lubricant in a vehicle shall be exempt from the provisions of this article.*

(d) *Exemption for Use of Certain Regulated substances: The use of certain of the regulated substances such as pesticides, herbicides and fungicides in recreational, agricultural, pest control and aquatic weed control activities shall be allowed provided that:*

(1) *In all zones, the use is in strict conformity with the use requirements as set forth in the substances EPA registries and as indicated on the containers in which the substances are sold; and*

(2) *In all zones, the sue is in strict conformity with the requirements as set forth in chapters 482 and 487, Florida Statues, and chapters 5E-2 and 5E-9 Florida Administrative Code.*

(3) *In a zone 1, the use of any of the regulated substances shall be flagged in the records of the certified operator supervising* the *use. The certified operator shall provide specific notification in writing to the applicators under his or her supervision that they are working at a site located in a zone 1 for which particular care is required. Records shall be kept of the date and amount of regulated substances used at each location.*

(4) *In a zone 1, the regulated substances shall not be handled during use in a quantity exceeding seven hundred (700) gallons of formulation.*

(5) *All nonresidential uses of regulated substances in zone 1 and zone 2 shall comply with all the provisions of section 27-379(b). The use of regulated substances on nonresidential landscape areas smaller than five thousand (5,000) square feet shall be exempted from the provisions of this article, However, commercial or government services in all zones shall not be required to obtain individual licenses for every site at which they use the regulated substances, and these services shall be exempt from the provisions of this article with regard to the sites they serve provided the use is in accordance with (1), (2), (3), and (4) above. However, all records for such sites as required by chapter 482. Florida States, and chapter 10D-55, Florida Administrative code, shall be available for inspection by the county.*

[Broward County, Florida, General Ordinance, Section 27-380,1984; 1989]

The following activities or uses are exempt from the provision of this Article:

(1) *The transportation of any hazardous substance through either or both the Primary or Secondary Well field Protection zone, provided the transporting vehicle is in transit.*

(2) *Agricultural uses, including mosquiteo control, except that said uses shall comply with Chapter 487.011, et seq., the Florida Pesticide Law and the Florida Pesticide Application Act of 1974 and Rule 5E 2.001 et seq., and Rule 5E-9.001, et seq., Florida Administrative code.*

(3) *The use of any hazardous substance solely as fuel in a vehicle fuel tank or as a lubricant in a vehicle.*

(4) *Fire, police, emergency medical services, emergency management center facilities and public utilities of this Article.*

(5) *Retail sales establishments that store and handle hazardous substances for resale in their original unopened containers.*

(6) Office uses, except for the storage, handling or use of hazardous substances as provided for in applicable administrative codes.
(7) Repairing or maintaining any existing facility of improvement on lands within the Primary or Secondary Well Field Protection Zone.
(8) Storage tanks which are constructed and operated in accordance with the storage tank regulations as set forth in Chapter 17-61, Florida Administrative Code.
(9) Geotechnical borings.
(10) Residential activities.
(11) Public utility emergency generating facilities except that permanently installed fuel storage facilities exempted under Chapter 17-61, Florida Administrative Code, shall have secondary containment.
(12) Provided, however, that a local government may at its option delete in whole or in part, any of the above described exemptions, but in no case shall the local government include any additional exemptions in its ordinance adopted pursuant to this Article unless otherwise approved by the County Council.

[Volusia County, Florida, Zoning Ordinance, Section 7606.00. Draft]

Public utilities, in some wellhead protection ordinances, are treated as special exception uses when conditions or standards are not included in the ordinance. Although this allows greater flexibility in development reviews, it should be noted that, for consistency and expedition, some basic conditions or standards will have to be eventually included in the wellhead protection ordinance.

(A) Public utility uses as follows:
(1) Electric and telephone substations
(2) Gas regulator and meter station buildings
(3) Electric and communication transmission towers and structures

[City of Huber Heights, Ohio, Zoning Ordinance, Section 36.04, 1990]

Although there are few uses that are not prohibited in the wellhead protection overlay district and are either a conditional or special use in the underlying district, include a standard statement of "subject to approval" based on the performance standards of the wellhead protection ordinance. This reinforces the applicability of performance standards of both the underlying zoning district and the wellhead protection overlay district.

All special exceptions allowed in underlying districts may be approved by the board of Adjustment provided they can meet Performance Standards outlined for the Aquifer Protection Overlay Zones.

[Brookings County, South Dakota, Zoning Ordinance, Section 1106, 1989]

Family subdivisions (or minor subdivisions) are also commonly excluded from further administrative reviews provided they meet some distance and size requirements. The definition of a family or minor subdivision is provided in the subdivision regulations; such subdivisions are generally five parcels or less in residentially zoned areas.

Excluded developments: There shall be excluded from the procedures and requirements of this section all residential minor partition applications if the site thereof is more than 1320 feet from the exterior boundary of the city of Enterprise municipal water source, provided the residential use is permitted [by right] in the underlying zone and none of the parcels is less than five acres in size. All other partitions and subdivisions shall be subject to review under the procedures of this section.

Appendix L

[Wallowa County, Oregon, Zoning Ordinance, Section 24.090.1. 1988]

Nonconforming Uses

Purpose: To set forth provisions for existing uses that do not conform to the wellhead protection standards.

Key Issues:

- Identifying nonconforming uses that were existing on the date of adoption of the wellhead protection ordinance and are permitted by right, by special exception, or by conditions.
- Making sure that it is understood that prohibited uses are excluded from obtaining relief under this section.
- Setting a limit for the expansion of nonconforming uses; beyond that limit, a nonconforming use will be treated as new use and will be subject to a complete review.

Notes: Typically, nonconforming uses in wellhead protection areas are either permitted, special exception, and conditional uses that were conforming before the designation of the wellhead protection area. Such uses are commonly nonconforming due to violations of the new lot size or minimum yard requirements set by the new district. These provisions should also set limits for expansion of a nonconforming use before it must become conforming. Under certain circumstances (e.g., discontinuation of use, destruction of a use by fire or flood, etc.), a nonconforming use may be required to become a conforming use.

The issue of nonconforming uses is probably one of the most contentious aspects of local zoning. In crafting appropriate safeguards in the wellhead protection ordinance, ensure that there is general conformity with the nonconforming sections of other parts of the zoning ordinance. Any deviation from established standards or precedents has to be associated with a substantially justifiable claim. Almost all courts have generally looked at nonconforming uses as uses that have a right to continue, at least for a time, as they were on the date of adoption of the more restrictive zoning ordinance--provided there is no substantial change. The debate is primarily about issues related to defining the time limit and what constitutes substantial change. These definitions vary from state to state and sometimes also within a state. Inclusion of any stricter nonconforming standards in the wellhead protection ordinance will have to be justified. Note that protection of nonconforming uses does not extend to the continuation of any prohibited use.

The samples provided here are very specific to the local conditions and precedents. Some of the standards for expansion and time limits may have very limited, if any, relevance outside the jurisdiction from which the example is cited.

If a non-conforming use of any land, building, or structure is discontinued for six (6) months or more, any further use shall be in conformity to this District.

[City of Huber Heights, Ohio, Zoning Ordinance, Section 36.06, 1990]

Non-conforming uses may continue in this District in the form in which they exist at the time of the adoption of this Ordinance. Any change of title or right to possession shall not affect such continuation of an existing use. Whenever a non-conforming use has been abandoned for a period of one (1) year, such use shall not thereafter be re-established and

any future use shall only be in compliance with the provisions of this Chapter. In the event such non-conforming use shall pose a direct hazard to the public water supply, New Castle County may take any action permitted by law to abate the hazard.

[New Castle County, Delaware, Zoning Ordinance, Section 23-137, proposed]

Expansion of up to 25% of land uses or activities previously existing at the time of adoption of the Ordinance and which do not conform to the Wellhead Protection Area Table is allowed, provided that

Best Management Practices (Section I of this Ordinance) are followed.

The addition or expansion does not increase the non-conformity of the use or activity.

The expansion of the non-conforming use may not be for the purpose of changing that use to another non-conforming use unless the applicant can demonstrate that the new use poses a lesser threat to groundwater than the current use.

Expansion of greater than 25% of such existing uses is treated as a new use (i.e., it is permitted, prohibited, or subject to Site Plan Review as per the Wellhead Protection Area Table.

[Town of Norway, Maine, Wellhead Protection Ordinance, Section D (1b), 1993]

This is an example of a description of nonconforming use definitions and procedures for evaluation. In lieu of restating the procedures, references to nonconforming portions of the zoning ordinance can be made, if such standards exists.

Enlargement of, or alteration of a commercial or industrial use existing as of the effective date of this ordinance, or the addition of a process or ancillary facility in conjunction with a use existing as of the effective date of this ordinance, not permitted outright under subparagraph I [Section 24.050.(1)] above, may be permitted in the WPA upon issuance of a special use permit and upon finding the proposed enlargement or expansion of the use, considering the quantities and character of the chemical or other product, the method of use, and the distance from the city of Enterprise water source, would not have an adverse effect, materially contribute to an adverse effect, or create a material risk of an adverse effect, upon the city of Enterprise municipal water source, and after consideration of any impoundment or other mitigating measures imposed by State and federal law, this ordinance, the Planning Director, or the Commission. Upon receipt of an application to enlarge or alter an existing commercial or industrial use or to add a process or ancillary facility in conjunction with a pre-existing use, said permit not reviewable under the provisions of subparagraph 1 [Section 24.050.(1)] above, the Director shall notify the city and, prior to scheduling a public hearing before the Commission, shall arrange a conference to be attended by the applicant, the city's representative, and the Director. The purpose of the conference shall be to review the application, the nature of the processes and chemicals, and the impoundment and other mitigating measures to be employed by the applicant to comply with the standards of this subparagraph. If, following the conference, the city and the applicant are in agreement, the application meets the burden of proof set forth in this subparagraph, the director shall proceed to review and issue the special use permit under the procedures set forth in Section 24.0801.

If, following the conference, the city and the applicant cannot reach agreement as to the compliance of the application to the standards set forth in the subparagraph, the Director shall schedule a public hearing before the Commission as required by Section 24.0801. Failure to conduct the conference within 45 days of the date of the application's submission shall require the Director to schedule the hearing before the Commission. If the proposed use or development is permitted outright in the underlying zone, review by the Director or Commission shall be limited to determination of the application's compliance with the standards set forth in this subparagraph. In the event the proposed use complies with federal and State laws and regulations, the city of Enterprise, or other opponent, shall have the burden of coming forth with evidence sufficient to provide a reasonable basis for concluding that said State and federal laws and regulations are inadequate to assure compliance with the standards set forth in this subparagraph upon presentation of such evidence the burden shall shift to the Director or Commission which insures the protection of the city of Enterprise municipal water source.

[Wallowa County, Oregon, Zoning Ordinance, Section 24.050.(3), 1988]

Variances

Purpose: To set forth the guidelines for providing variances from the strict interpretation of the provisions of the wellhead protection ordinance.

Key Issues:

- Ensure variance approval cannot be used to relax any standards for prohibited or special uses (or to provide a right to pollute).
- Variances are seen as loopholes; therefore, minimize reasons for an applicant to justify unnecessary hardship.
- Do not include more restrictive criteria to define when variances may be granted; that constitutes a derogation of the enabling statutes.

Notes: Although variances can be obtained for any of the provisions of any ordinance, the typical purpose for variances in wellhead protection ordinance provisions is to provide relief in setback or performance standards if a substantial hardship can be demonstrated under a strict interpretation of the ordinance. For instance, a strict application of setback or lot size standards may deprive the property of privileges or safety enjoyed by other similarly located parcels. Variance procedures, like those employed for special uses and conditional uses, require a separate application and review process that involves final adjudication by the Board of Zoning Appeals.

Since the power to grant variances by the zoning board comes directly from an explicit statutory authorization, courts have held that a local ordinance may not change the variance powers granted to the board. Zoning ordinances sometimes do, and courts have voided such ordinances. In effect, from an applicant's point of view, a more restrictive standard may not be invoked to hinder an attempt to obtain a variance. Historically, a number of states and local governments have held that variance powers involve a usurpation of legislative power by the board of appeals.

The debate revolves around the usual standard for granting variances--practical difficulty and unnecessary hardship. Defining criteria in the ordinance for all such unique circumstances is nearly impossible. However, in the context of wellhead protection,

address the issues related to contamination and the risk of contamination of drinking water supplies if variances are granted. One way to do this might be to require documentation, verification, and adequate guarantees that a variance will not result in an increase in risk in contamination.

(1) The Appeal Board as established by the community shall hear and render judgment on requests for variances from the requirements of this ordinance.

(2) The Appeal Board shall hear and render judgment on an appeal only when it is alleged there is an error in any requirement, decision, or determination made by the Wellhead Protection Area Administrator in the enforcement or administration of this ordinance.

(3) Any person or persons aggrieved by the decision of the Appeal Board may appeal such decision in the courts of competent jurisdiction.

(4) No variance may be requested nor granted as a means to circumvent the intentions of this ordinance or as a remedy for a violation of this ordinance (i.e., a variance cannot be issued after the fact).

(5) The Wellhead Protection Area Administrator shall maintain a record of all actions involving an appeal.

(6) Upon consideration of the intent of this ordinance, the Appeal Board may attach such conditions to the granting of variances as it deems necessary to further the purpose and objectives of this ordinance.

(7) Prerequisites for granting variances:

(a) Variances shall only be issued upon a determination that the variance is the minimum necessary considering the potential threat of contamination of the PWS well and aquifer, to afford relief.

(b) Variances shall only be issued upon: (I) showing a good and sufficient cause; (ii) a determination that failure to grant a variance would result in exceptional hardship to the applicant; and (iii) a determination that the granting of a variance will not result in additional threats to the public safety, extraordinary public expense, create nuisances, cause fraud on or victimization of the public or conflict with existing local laws or ordinances.

(c) Any applicant to whom a variance is granted shall be given written notice that the activity receiving this variance will decrease the travel time for potential contaminants to reach the PWS well and that any and all liability of a contamination event as a result of this activity receiving the variance is on the variance holder. Furthermore, the City, its offices, and services, as well as its employees, are released from any responsibility and liability for any damages and/or contamination events due to activity receiving the variance.

(8) Variances may be issued by a community for new development necessary for the conduct of the functionally dependent use provided that: (I) the criteria outlined in Article 4, Section D(1)-(8) are met; and (ii) the development is protected by methods that minimize the risk of a contamination and creates no additional threats to public safety.

[City of Sweeny, Texas, General Ordinance, Section D, 1990]

Variance to a regulation or restriction enacted through the WPA which affects a use or development permitted by or unregulated within the underlying zone may be permitted by the Commission, following public hearing, provided the requested variance:

(1) Relates solely to a regulation or restriction of the WPA and is not a variance which can be heard pursuant to the provisions of Article 8.

Appendix L

(2) The variance is the minimum variance necessary to alleviate a hardship on the property owner related to the use and enjoyment of the property caused by the regulation or restriction as enacted within the WPA.

(3) The Commission finds the variance will not cause, materially contribute to, or create a material risk of any adverse effect upon the city of Enterprise municipal water source under reasonably possible hydrologic or geologic conditions.

[Wallowa County, Oregon, Zoning Ordinance, Section 24.075, 1988]

(a) The Planning Commission may grant a variance from the terms of this Article only [when], because of special circumstances applicable to the property involved, a strict application deprives such property of privileges or safety enjoyed by other similarly situated property with similarly timed development.

...[T]he variance permitted shall be the minimum departure from the terms of this Article necessary to avoid such deprivation of privileges enjoyed by such other property to facilitate a reasonable use, and which will not create significant probabilities of harmful environmental consequences. The Planning Commission may not grant a variance if it would provide the applicant with any special privileges not enjoyed by other similarly situated property with similarly timed development, or if based on a special or unique condition which was created as a result of the method by which a person voluntarily subdivides land after the effective date of this ordinance.

(b) The Planning Commission may grant a variance [if the regulations require] an unrealistic and unwarranted taking or an undue hardship. However, no such variance may be granted if the condition was created as a result of the method by which a person involuntarily subdivides land after the effective date of this ordinance. The granting or denial of this variance may be appealed to the City Council by any citizen.

[City of Austin, Texas, General Ordinance, Section 107.1, 1981]

Appendix L

6. Performance Standards

Purpose: To set forth standards that, if violated, will trigger an additional review for a proposed use in the wellhead protection area.

Key Issues:

- Specify maximum limits for materials with known contaminants for residential and other incidental uses.
- Limit lot size, setback, or buffer changes.
- Specify standards for determining whether review of expansion or alteration proposals for existing commercial and industrial uses is necessary.

Notes: Standards pertain to the size and quantity or volume of materials with known contaminants. These include standards for using regulated materials in small quantities for maintenance or repair of wells. Standards for residential use and storage of fuel in wellhead protection areas are specified here. Other standards, such as minimum lot size, modified setback requirements, etc., that are different from any of the underlying zoning districts are included here.

(A) Use of Regulated Substances in conjunction with municipal water supply and treatment activities shall not be restricted by this chapter.

(B) Use of Regulated Substances in conjunction with public parks, playgrounds, golf courses, and community centers shall be in accordance with the City of Dayton Park and Recreation Management Plan for maintenance of Sensitive Areas.

(C) Use of Regulated Substances in conjunction with conditional uses in this district shall be limited to:

(I) The aggregate of Required Substances in use may not exceed twenty (20) gallons or one hundred and sixty (160) pounds at any time.

(2) The total use of Regulated Substances may not exceed fifty (50) gallons or four hundred (400) pounds in any twelve (12) month period.

(D) A limited exclusion from the provisions of 150.603(C) is authorized for non-routine maintenance or repair of property or equipment. The use of Regulated Substances under this exclusion shall be limited to:

(1) The aggregate of Regulated Substances in use may not exceed fifty (50) gallons or four hundred (400) pounds at any time.

(2) The total use of Regulated Substances may not exceed one hundred (100) gallons or eight hundred (800) pounds in any twelve (12) month period.

(E) Storage of Regulated Substances in conjunction with municipal water supply and treatment activities shall not be restricted by this chapter.

(F) Storage of fuel and lubricants for vehicle operations in conjunction with permitted and conditional uses in this district shall be in underground tanks placed above the floor surface of a below-grade vault. Said vault shall allow access for physical inspection of the tank for leakage and the interior of the vault shall be continuously monitored and alarmed to provide for automatic and immediate detection of any release from the tank.

(G) Notwithstanding other provisions of this chapter, non-conforming uses in this district presently utilizing underground storage tanks for fuel and lubricants for vehicle operations shall be permitted to replace existing tanks with those constructed as per the specifications of 150.603(F) above and not exceeding the capacity of existing tanks. Replacement of underground tanks for Regulated Substances other than fuel

and lubricants for vehicle operations is not permitted.

(H) Storage of Regulated Substances other than fuel and lubricants for vehicle operations in conjunction with permitted and conditional uses in this district is prohibited.

(I) As part of the findings required under Section 150.424(D), the Zoning Administrator shall utilize the Hazard Potential Ranking System, Section 150.620 to assist in the determination of intensity of use within this district. No substitutions of a non-conforming use shall be permitted which result in an increase of the Hazard Potential Ranking on a parcel within this district.

(J) All uses within this district shall be connected to the public wastewater disposal system.

[City of Dayton, Ohio, Zoning Ordinance, Section 150.603. 1988]

(1) The lot size shall be as required by other existing Norway Ordinances, including Norway's Subdivision Regulation, or State of Maine laws and regulations.

(2) The percentage of the lot which can be covered by impermeable surfaces, including parking areas, shall be limited as presented in the following table.

WHPA	*Maximum Lot Coverage*
1	*30%*
2	*50%*
3	*50%*

[Town of Norway, Maine, Wellhead Protection Ordinance, Section E. 1993]

A gasoline station lot and/or fuel storage tanks shall not be location within two thousand five hundred (2,500) feet of any municipal water wells or other municipal water supply source.

[City of Oswego, New York, Zoning Ordinance, Section 125-50 (2), 1985]

No storage of potatoes or other putrescible crops which are likely to ferment or rot are permitted within 1,000 feet of the diversion point for any of the city of Enterprise Springs, as marked upon the ground by the city. Beyond 1,000 feet, storage of potatoes or other putrescible crops likely to ferment or rot is permitted if stored in silos or other storage facility adequate to insure there will be no leaching into the groundwater.

[Wallowa County, Oregon, Zoning Ordinance, Section 24.025. 1988]

Well spacing requirements are commonly dependent on geologic conditions, demand for water from the aquifer, and other local conditions. Specification of such standards may be included in the zoning ordinance under perofrmance standards if excessive drawing of well water from an aquifer is a concern.

All well locations described in applications for a permit to appropriate water for beneficial use, other than domestic, which propose the diversion or withdrawal of water from the unconsolidated aquifer, commonly described as the Ogallala aquifer, or an alluvial aquifer, or both, shall be placed so that spacing between that well and all other nondomestic wells with a diversion rate of 51 gallons per minute or more meets the following well spacing requirements.

(1) The minimum spacing of wells with a diversion rate of from 51 to 400 gallons per minute shall be 1,300 feet.

(2) The minimum spacing of wells iwth a diversion rate in excess of 400 gallons per minute shall be 2,300 feet.

[Southwest Kansas Groundwater Management District No. 3, Kansas, General Ordinance, Section 5-23.3.(a), 1981]

Appendix L

7. Site Plan Submission and Administrative Requirements

Purpose: To set the application requirements for content, format, and supporting documentation (e.g., such as maps and plans) for site plans for uses in the wellhead protection areas.

Key Elements:

- List of hazardous, toxic, and other regulated materials
- Location of existing wells and public water supply systems
- Location of significant geologic and natural features
- Fees, funding, and disbursement criteria

Notes: In addition to routine site plan submission requirements, additional information about the types and volumes of all hazardous materials expected to be used at a proposed facility should be required on site plans for uses in the wellhead protection area. This information typically must describe the types of wastes a use will generate as well as the methods that will be used to dispose of such wastes. For maps and plans, the location of all existing wells within a certain distance of the property line may be required for reference. Mapping of sensitive geologic or natural resources may also be required. In addition, for stormwater runoff control and management, a separate plan may be required.

Note that, for monitoring and continuous evaluation of contaminants and risks associated with them, the requirements for reporting of hazardous materials use, storage, or disposal should be handled in other codes, outside the scope of zoning powers. These include building codes, health codes, and emergency plans. The site plan provisions in a zoning ordinance are a one-time opportunity for ensuring that development proposals comply witht he ordinance. This opportunity exists before the developments are approved. Because of turnover in land uses and tenants, what may have been approved at the site plan stage may no longer accurately reflect future risks of contamination.

The following written and mapped information shall be submitted:

Description of proposed use: type of use or activity; commercial (trades and services), industrial (manufacturing and processing); product produced: Standard Industrial Code (S.I.C.) if applicable.

A complete list of the types of volumes of all hazardous materials (including fuels) used, stored, processed, handled or disposed, other than those volumes and types associated with normal household use.

Description of types of wastes generated and method of disposal including: solid wastes, hazardous wastes, sewage and non-sewage wastewater discharges. Location of adjacent (within 200 feet of property line) private drinking water supply wells.

Location of public water supply wells within 1,000 feet.

Provisions for management of storm water runoff.

Appendix L

A site plan and building plan showing: hazardous materials loading, storage, handling and process areas; floor drains; process vents; sewage disposal; and waste storage or disposal areas.

Plans and documents containing information to show compliance with the Performance and Design Standards.

Other additional information as may be requried by reviewing agencies regarding: the proposed use, its potenital impact to water quality, hydrogeologic information, monitoring, and mitigation measures.

[Connecticut Department of Environmental Protection, *A Guide for Drafting Local Aquifer Protection Regulations.* Bureau of Water Management, Planning and Standards Division, Section VII, 1989]

Except for applicants initially electing to submit an Environmental Assessment Report as set forth in Section 917.7, all other applicants whose properties are located entirely or partially within the Carbonate Area District, as defined in Section 917.2, shall submit the following information to the township.

(1) A map, at scale no smaller than 1" = 100' indicating the location of the property and all proposed improvements thereon and their geographic relationship tot he township's Carbonate District. The applicant shall utilize the carbonate area boundaries depicted on the township's Carbonate District Map.

(2) For areas proposed for grading, construction of buildings, and other improvements, the applicant shall submit information for such areas, indicating the presence of any of the following carbonate features:

Depressions;

Fissures, lineaments, faults, or air photo fracture traces;

"Ghost Lakes" occurring after rainfall events;

Outcrops of bedrock;

Seasonal high water tables;

Sinkholes;

Soil mottling, as defined by a soil scientist;

Springs;

Surface drainage entering the ground.

Such information may be based upon field surveys and/or published data, but in either case shall be supported by an explanation of its source including the qualifications of the individuals directly responsible for preparing such information.

[City of West Whiteland Township, Pennsylvania, Zoning Ordinance, Section 917.6. 1986]

Site plans and supporting documents shall be provided and contain sufficient information to show compliance with the site development and management criteria of these regulations. All applications for a special exception in the Aquifer Protection Zone shall

include at least the following:

(a) Engineering plan prepared by a registered civil engineer showing existing and proposed contours, proposed site drainage, sanitary sewers, public water supply and hydrants, including the location of the nearest existing fire hydrant at the time of application, at a scale of not less than 1" = 40' and on 24" x 36" sheets unless a smaller scale is approved by the Director of Planning in writing.

(b) Layout plan showing the location of all buildings, parking areas, entrance and exit drives, hazardous materials/waste storage areas and facilities, loading areas, disposal facilities and containment areas at a scale of not less than 1" = 40' and on 24" x 36" sheets unless a smaller scale is approved by the Director of Planning.

(c) A building floor plan for all buildings showing the location of all storage or containment areas and facilities, process areas, and building exits. Storage areas shall be identified according to their use and material stored. The location of emergency equipment related to each storage area shall be shown. Building plans shall be at an appropriate scale on 24" x 36" sheets.

(d) Construction details shall be provided at an appropriate scale for all containment facilities, drainage facilities including detention basins, water and sewer facilities, and hydrants. Calculations, details, and profiles shall be provided for all drainage design systems. All storage and containment facilities shall be described by the type of materials stored, the quantity of the containers, and the volume of containment areas.

(e) A comprehensive description of the amount and composition of any and all hazardous materials that are manufactured, generated, stored, discharged, used, or transported on, to or from the site.

[City of Manchester, Connecticut, Zoning Ordinance, Section 21.07.02, 1988]

For new activities located in WHPA 1, or WHPA 2, or WHPA 3 and regulated by the above "Applicable Land Uses or Activities" Table, the applicant for a Site Plan Review has the burden of proof that the proposed activity will not adversely affect groundwater. All applications shall be prepared and considered as per Norway's existing Site Plan Review Ordinance and shall include written information and plan (map) information. In addition, certain land uses or activities may require Site Plan Reviews with additional information as...required by the Planning Board.

[Town of Norway, Maine, Wellhead Protection Ordinance, Section F, 1993]

An application for an Aquifer Protection Overlay Zone review shall include, in addition to the other requirements set forth in the Zoning Regulations and Subdivision and Other Land Use Regulations, the following information:

(1) The amount and composition of any hazardous materials that will be handled, stored, generated, treated, or disposed of on the property.

(2) Provisions for treatment, storage, and/or disposal of any hazardous materials. "Hazardous Materials" means hazardous materials as defined in 40 CFR 171.8 and includes those materials listed in 40 CFR 172.101, "hazardous materials table for any "hazardous substance" as defined in 40 CFR 302.4 and listed in Table 302.4, "list of hazardous substances and reportable quantities," or any" hazardous waste" as defined in Section 22a-115, CGS.

(3) Distance to nearest public or private drinking water supply well or AA streams (tributary to public drinking water supply).

(4) Whether public sanitary sewers are available or proposed at the location.

(5) Septic tank location, size, and capacity, and/or sewage lift stations, force mains, and grease traps.

(6) Expected types and amount of discharge to sewers, to the ground and to surface water.

(7) Emergency plan to detect and control hazardous materials leaks and spills, including but not limited to inspections, notification of official emergency containment and clean-up procedures.

[Town of Cheshire, Connecticut, Zoning Ordinance, Section 47.4, January 1994]

Some communities include funding costs and other revenue-related provisions as part of the wellhead protection ordinance. These provisions describe how costs associated with the administration of this ordinance along with any costs associated with emergency response and remediation measures necessary in the event of contamination will be recovered. Funding provisions include specific conditions for collection of fees, disbursement and use of funds, and details pertaining to the powers and conduct of an oversight board or committee.

(A) Establishment of the Well Field Protection Fund

(1) The Well Field Protection Fund is hereby established to remediate pollution that could affect the public water supply and/or to pay the costs of acquiring interests in property necessary to reduce the risk of pollution of the public water supply. The Well Field Protection Fund can be used only for Well Field Protection Activities within the Well Field Protection Overlay District and within the one (1) year capture zones of the well fields.

(2) The City of Dayton Water Rates shall be amended to include a Well Field Protection Charge applicable to the entire rate base. This Charge is to generate revenue for the Well Field Protection Fund.

(3) All interest and payments resulting from Well Field Protection Fund activities will be paid to the Well Field Protection Fund. All directly related administrative costs of the Well Field Protection Fund are reimbursable from the Well Field Protection Fund.

(4) Costs for Well Field Protection activities advanced from the water Fund or any other City source of funds are reimbursable from the Well Field Protection Fund.

(B) Well Field Protection Board

(1) The Well Field Protection "Board" is hereby established. The Board shall consist of the Directors of Water, Finance and Planning. The Board shall determine the Well Field Protection Charge to be part of the City of Dayton Water Rates subject to approval by the City Commission.

(2) The Board shall reduce the Well Field Protection Charge if the Well Field Protection Fund exceeds the limitations as set forth in Section 53.05(C)(1) subject to approval by the City Commission.

(3) The Board shall, subject to approval by the City Commission, develop rules, regulations, and procedures for the administration of the Well Field Protection Fund.

(C) Limitations

(1) The Well Field Protection Fund shall be limited to $10,000,000.00.

(2) Interests in private property will not be acquired with funding under the Well Field Protection Fund in order to compensate the owner for compliance with

a) a lawful order, requirement or declaration from any regulatory agency; or

b) a requirement to obtain or maintain insurance coverage.

[City of Dayton, Ohio, Zoning Ordinance, Section 53.05.1988]

Appendix L

The Board of Supervisors of East Marlborough Township specifically finds that it is equitable and in the public interest for the Township to bear a portion of the costs associated with the review field testing, and reporting procedures prescribed in Section 1205A. Hence, the costs thereof shall be borne as follows:

(A) The cost of data study and site inspection by the Township engineer and the subsequent report as specified in Section 1205A C, D, and E shall be equally divided between the Township and the landowner.

(B) The cost of any additional testing and reports as specified in Section 1205A, F, and G, shall be divided so that the Township will bear 20% of the cost and the landowner shall bear 80% of the cost.

(C) East Marlborough Township shall not be responsible or bear any of the cost of any other engineering or testing expenses and in the event that the landowner wishes to engage his own engineer, the landowner shall be responsible for all costs thereof.

[City of East Marlborough Township, Pennsylvania, Zoning Ordinance, Section 1208A, 1979]

Appendix L

8. Definitions

Purpose: To define key words used in the ordinance.

Key Issues:

- Define all major terms used while drafting the ordinance
- Use definitions from federal and State statutes, where applicable
- Modify or amend existing definitions in other local ordinances for consistency.

Notes: It should become clear which terms require definition as the ordinance is drafted. Communities have found it necessary to define terms such as well, wellhead, groundwater, etc. The following are some of the common definitions of terms and concepts found in wellhead protection ordinances. Note that not all definitions listed below are directly related to wellhead protection and may be more appropriate in other sections of the zoning ordinance. Such definitions include those related to groundwater protection (for use in other ordinances dealing with water quality) and others related to zoning administration. The sample definitions are divided into four groups:

Wellhead and Wellfield Definitions

Definitions of Geologic and Natural Forms Related to Groundwater Protection

Hazardous Materials Definitions

Other Zoning and Miscellaneous Definitions

Wellhead and Wellfield Definitions

Aquifer *A geologic formation, group of formations or part of a formation capable of storing and yielding groundwater to wells or springs.*
[Brookings County, South Dakota, Zoning Ordinance, Section 1106, 1989]

Aquifer *A permeable geologic formation, either rock or sediment, that when saturated with groundwater capable of transporting water through the formation.*
[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Conified Aquifer *Conified aquifer means (1) An Aquifer overlain and underlain by impermeable layers or (2) An aquifer in which the groundwater is under pressure greater than atmospheric pressure and which will rise in a well above the point at which it is first encountered.*
[Southwest Kansas Groundwater Management District #3, Kansas, General Ordinance, Section 5-23-1(c). 1981]

Containment Device *A device that is designed to contain an unauthorized release, retain it for cleanup and prevent released materials from penetrating into the ground.*
[City of Renton, Washington, Draft Aquifer Protection Ordinance, Section 4.F. 1991]

Drawdown Contour, one-foot *A one-foot drawdown contour is the locus of points around a well*

or well field where the free water elevation is lowered by one foot due to a specified pumping rate of the well or well field.

[Palm Beach County, Florida, Wellhead Protection Ordinance, Section 3.t. 1991]

Groundwater *The water contained within the earth's surface that has penetrated from precipitation and from infiltration by streams, ponds and lakes.*

[Wetlands Protection, A Local Government Handbook, 1991]

Groundwater Contamination *Presence of any substance, designated by the U.S. EPA or the State of Maine as a primary or secondary water quality parameter, in excess of the maximum allowable containment level (MCL).*

[Town of Norway, Maine, Wellhead Protection Ordinance, Section J.2, 1993]

Groundwater, High Seasonal *High seasonal groundwater shall mean the minimum depth at any season of the year to the upper surface of the zone of saturation, as measured from the ground surface.*

[City and County of Missoula, Montana, Subsurface Sewage Treatment and Disposal Systems Ordinance, Section XII, 1988]

Indirect Recharge Area *The area contributing water to surface water courses up gradient of the aquifer or Well field area of contribution.*

[Connecticut Department of Environmental Protection, A Guide for Drafting Local Aquifer Protection Regulations. Bureau of Water Management, Planning and Standards Division, Section III, 1988]

Leachable Material *Material, including salt and certain components of concrete, asphalt, tar, coal, etc. which is readily soluble in water and thus easily removed and transported in solution by meteoric and/or groundwater.*

[Town of Norway, Maine, Wellhead Protection Ordinance, Section J.2, 1993]

Percolation Rate *The rate at which water flows or trickles through porous soils, as determined by a percolation test.*

[City of Anchorage, Alaska, Wastewater Disposal Regulations, Section 15.65.010 V, 1990]

Permitting Pumping Capacity *Refers to the amount of water authorized by the South Florida Water Management District to be pumped from a well, expressed as gallons per day.*

[Broward County, Florida, General Ordinance, Section 27-376, 1984; 1989]

Pollutant Travel Time *Is the time required by pollutants to travel from one point to another.*

[Broward County, Florida, General Ordinance, Section 27-376, 1984; 1989]

Potable Water *Is that water that is satisfactory for drinking, culinary, and domestic purposes, meeting current state and federal drinking water standards.*

[Broward County, Florida. General Ordinance. Section 27-376. 1984: 1989]

Potable Water Supply *Any water used or intended to be used for drinking, bathing, culinary or other personal purposes.*

[Ocean County, New Jersey. Ordinance 87-1, Section 1, 1999]

Primary Recharge Area (for stratified drift aquifers) *The area overlying the aquifer and adjacent*

stratified drift in which groundwater flows directly into the aquifer. (The contact line between the stratified drift and adjacent till or bedrock is the boundary line).

[Connecticut Department of Environmental Protection, A Guide for Drafting Local Aquifer Protection Regulations, Bureau of Water Management, Planning and Standards Division. Section III. 1989]

Secondary Recharge Area *Till and bedrock areas which provide direct groundwater inflow to the primary recharge area.*

[Connecticut Department of Environmental Protection, A Guide for Drafting Local Aquifer Protection Regulations. Bureau of Water Management, Planning and Standards Division. Section III. 1989]

Shallow/Surficial Aquifer *An aquifer in which the permeable media (sand and gravel) starts at the land surface or immediately below the soil profile. The main shallow/surficial aquifer in Brookings County is the Big Sioux Aquifer.*

[Brookings County, South Dakota, Zoning Ordinance. Section 1106. 1989]

Stormwater Drainage *A sewer or other system for conveying surface runoff due to storm events and unpolluted groundwater or surface water, including that collected by cellar drains, but excluding sanitary sewage and industrial waste.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Stormwater Impoundment *Any structure designed and constructed to contain stormwater runoff.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Subsurface Disposal System *A collection of treatment tank(s), disposal area(s), holding tank(s) and pond(s), surface spray system(s), cesspool(s), well(s), surface ditch(es), alternative toilet(s), or other devices and associated piping designed to function as a unit for the purpose of disposing of wastes or wastewater on or beneath the surface of the earth.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Surface Runoff *That part of the precipitation that passes over the surface of the soil to the nearest surface stream without first passing beneath the surface.*

[City of West Whiteland Township, Pennsylvania. Zoning Ordinance. Section 917.3. 1986]

Ten-Year Time of Travel Distance *The distance that groundwater will travel in ten years. This distance is a function of the permeability and slope of the aquifer.*

[Brookings County, South Dakota, Zoning Ordinance, Section 1106, 1989]

Time of Travel Boundary *A boundary beyond which groundwater will take more than a set period of time (i.e., 200 days) to travel to a given point (i.e. a pumping well).*

[Town of Norway, Maine, Wellhead Protection Ordinance, Section J.2, 1993]

Transfer Station; Recycling Facility *Facility designed for temporary storage of discarded material intended for transfer to another location for disposal or re-use: facility which processes discarded material for reuse.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Travel Time Contour *Locus of points from which water takes an equal amount of time to reach a given destination such as a well or wellfield.*

Appendix L

[Broward County, Florida, General Ordinance. Section 27-376. 1984: 1989]

Travel Time Zones *The areas bounded by travel time contours.*
[Broward County, Florida, General Ordinance. Section 27-376. 1984: 1989]

Wastewater *Any combination of water-carried wastes from institutional, commercial, and industrial establishments, and residences together with any storm, surface water, or groundwater, as may be present.*
[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Wastewater Treatment Plant *Any arrangement of devices and structures used for treating wastewater.*
[Town of Norway, Maine, Wellhead protection Ordinance. Section J.2. 1993]

Water Supply System, Individual *An individual water supply system means a single system of piping, pumps, tanks, or other facilities utilizing a source of groundwater to supply water to a single lot.*
[Montgomery County, Maryland, Individual Water Supply and Sewage Disposal Ordinance. Section 3.2. 1988]

Watershed *Land lying adjacent to water courses and surface water bodies which creates the catchment or drainage area of such water courses and bodies; the watershed boundary is determined by connecting topographic high points surrounding such catchment or drainage areas.*
[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Well, Active *An active well is a well that has been utilized at least once I the preceding 12 months for the extraction of groundwater.*

Well, Inactive *An inactive well or standby well means a well that has not been used for a period of one year or more for the production of groundwater, but is maintained in such a condition that it could be so used, or a monitoring well maintained for such use, or a cathodic protection well maintained for such use.*

Well, Abandoned *An abandoned or unused well may be defined under one or more of the following:*

a. *A well, other than a monitoring well, which has been out of service continuously for one year or more, and does not meet the definition of a standby well.*

b. *A monitoring well from which no measurement or sample has been taken for a period of three years.*

c. *A well which is in such a state of disrepair that it cannot be made operational for its intended purpose.*

d. *A test hole or exploratory boring 24 hours after construction and testing work has been completed.*

e. *A cathodic protection well that is no longer functional for its original purpose.*

f. Any boring that cannot be satisfactorily completed as a well.

[Santa Clara County, California, Ordinance Regulating Classification, Construction and Destruction of Wells, Section 2, 1990]

Wellfield *A tract of land which contains a number of existing or proposed wells for supplying water as specified in the wellfield protection maps.*

[Broward County, Florida, General Ordinance, Section 27-376, 1984; 1989]

Wellfield Area of Contribution *Area of the aquifer where groundwater flow is diverted to a pumping well due to a lowering of the water table.*

[Connecticut Department of Environmental Protection, *A Guide for Drafting Local Aquifer Protection Regulations*. Bureau of Water Management Planning and Standards Division. Section III. 1989]

Wellfield Recharge Area *The area from which groundwater flows directly to the wellfield area of contribution.*

[Connecticut Department of Environmental Protection, *A Guide f or Drafting Local Aquifer Protection Regulations*. Bureau of Water Management, Planning and Standards Division. Section III. 1989]

Wellhead *The specific location of a well (a hole or shaft dug or drilled to obtain water) and/or any structure built over or extending over a well.*

[Town of Norway, Maine, Wellhead protection Ordinance. Section J.2. 1993]

Wellhead Protection Area *The surface and subsurface area surrounding a water well or wellfield supplying a public water system, through which contaminants are reasonable likely to move toward and reach such well or wellfield.*

[U.S.C. Safe Drinking Water Act. 1986 Amendments]

Wastewater *Wastewater or sewage means the combination of the liquid and water carried wastes from residences, commercial buildings, industrial plants and institutions.*

[City of Denver, Colorado, Industrial and Prohibited Wastewater Discharges Ordinance. Section 11-3-3 (43). 1991]

Water Table *The upper surface of a zone of saturation except where that surface is formed by an impermeable body.*

[City of West Whiteland Township, Pennsylvania, Zoning Ordinance. Section 917.3. 1986]

Zone of Contribution *The entire area around a well or wellfield that is recharging or contributing water to the well or wellfield.*

[Brookings County, South Dakota, Zoning Ordinance. Section 1106. 1989]

Zone of Contribution *The area from which groundwater flows to a pumping well.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Zones of Influence *Refers to zones delineated by isotravel time contours around existing or proposed wellfields as specified in the wellfield protection maps, as amended, approved by the Broward County Board of Commissioners, within which hazardous materials are regulated to protect the quality of the groundwater.*

Appendix L

Zone 1: The land area situated between the well(s) and the ten-day travel time contour.

Zone 2: The land area situated between the ten-day and the thirty-day travel time contours.

Zone 3: The land area situated between the thirty-day and the 210-day travel time contours, or the thirty-day and the one-foot drawdown contours, whichever is greater.

[Broward County, Florida, General Ordinance, Section 27-376, 1984; 1989]

Definitions of Geologic and Natural Forms Related to Groundwater Protection

Carbonate *A sedimentary rock formed by the organic or inorganic precipitation of mineral compounds characterized by the fundamental chemical ion CO_3, e.g., limestone and dolomite.*

[City of West Whiteland Township, Pennsylvania, Zoning Ordinance, Section 917.3. 1986]

Depression *A low place of any size on a plane surface with drainage underground or by evaporation hollow completely surrounded by higher ground and hazing no natural outlet for surface drainage.*

[City of West Whiteland Township, Pennsylvania, Zoning Ordinance. Section 917.3. 1986]

Drainage *The movement of water from an area by stream or sheet flow and removal of excess water from soil by downward flow.*

[City of West Whiteland Township. Pennsylvania. Zoning Ordinance. Section 917.3. 1986]

Fault *A surface or zone of rock fracture along which there has been noticeable movement.*

[City of West Whiteland Township, Pennsylvania, Zoning Ordinance. Section 917.3. 1986]

Fissure *An extensive crack, break, or fracture in the rock.*

[City of West Whiteland Township, Pennsylvania, Zoning Ordinance. Section 917.3. 1986]

Ghost *Lakes* *Transient surface water bodies formed in sinks after heavy precipitation, due to poor internal drainage, residual clay remaining after solution of limestone minerals, or other causes.*

[City of West Whiteland Township, Pennsylvania. Zoning Ordinance. Section 917.3. 1986]

Outcrop *The exposure of bedrock or strata projecting through the overlying cover of detritus and soil.*

[City of West Whiteland Township, Pennsylvania. Zoning Ordinance. Section 917.3. 1986]

Overland Flow *Storm water runoff that is not confined by any natural or man-made channel such as a creek, drainage ditch, storm sewer, or the like.*

[City of Austin, Texas, Zoning Ordinance. Article 1, Section 101.4(b). 1981]

Sinkhole *A funnel-shaped depression in the land surface generally in a limestone region associated with a subterranean passage developed by solution.*

[City of West Whiteland Township, Pennsylvania. Zoning Ordinance. Section 917.3. 1986]

Soil Mottling *A soil irregularly marked with spots or patches of different colors, usually indicating poor aeration or lack of good drainage.*

[City of West Whiteland Township, Pennsylvania, Zoning Ordinance, Section 917.3. 1986]

Spring *A place where, without the agency of man, water flows from rock or soil upon the land*

or into a body of surface water.

[City of West Whiteland Township, Pennsylvania. Zoning Ordinance, Section 917.3, 1986]

Stratified Drift *Predominantly sorted sediment deposited by glacial meltwater consisting of gravel, sand silt or clay in layers of similar grain size.*

[Connecticut Department of Environmental Protection, ***A Guide for Drafting Local Aquifer Protection Regulations.*** Bureau of Water Management, Planning and Standards Division, Section III. 1989]

Hazardous Materials and Related Definitions

Containment Facility, Primary *A tank, pit, container, pipe, or vessel of first containment of a liquid or chemical.*

[Brookings County, South Dakota, Zoning Ordinance, Section 1106, 1989]

Containment Facility, Secondary *A second tank, catchment pit, pipe, or vessel that limits and contains liquid or chemical leaking or leaching from a primary containment area; monitoring and recovery are required.*

[Brookings County, South Dakota, Zoning Ordinance. Section 1106. 1989]

Chemical Bulk Storage *Storage of a chemical or chemical in a container or containers larger than those intended for normal homeowner or retailer purposes. Proper, non-commercial, homeowner use of chemicals is not included.*

[Town of Norway, Maine, Wellhead protection Ordinance. Section J.2. 1993]

Chemigation *The process of applying agricultural chemicals (fertilizer or pesticides) using an irrigation system by injecting the chemicals into the water.*

[Brookings County, South Dakota, Zoning Ordinance. Section 1106. 1989]

Contaminate_*To have unwanted chemicals or bacteria mixed into a water system formerly void of such substances.*

[City and County of Missoula, Montana, Subsurface Sewage Treatment and Disposal Systems Ordinance. Section XII. 1988]

Contingency Plans *Detailed plans for control, recontainment, recovery, and clean up of hazardous materials released during fires, equipment failures, leaks, and spills.*

[Brookings County, South Dakota, Zoning Ordinance. Section 1106.1989]

Critical Material *Any liquid, semi-liquid, flowable, or water soluble solid that is listed on the most current Superfund amendments and Reauthorization Act, Title III (SARA III List of Lists published by the Office of Toxic Substances, U.S. Environmental Protection Agency, Washington, D.C., or is required by the U.S. Occupational Safety and Health Administration to have a material safety data sheet (MSDS).*

[Panhandle District #1, Coeur d'Alene, Idaho, Environmental Health Code. Section 41.1.400.02(a). 1990]

Discharge *To release by any means to the surface waters, groundwaters, surface of the ground, below ground, the air and living resources. Discharge also includes, but is not limited to, any spilling, leaking, pumping, pouring, emitting, emptying or dumping except those activities duly permitted by any state or federal agency.*

Appendix L

[Town of Owego, New York, General Ordinance, Protection of Wells. Section (b). 1985]

Fuel Oil Distributor; Fuel Oil Storage *The storage of fuel for distribution or sale. Storage of fuel oil not for domestic use (i.e., not in tanks directly connected to burners).*
[Town of Norway, Main, Wellhead Protection Ordinance. Section J.2. 1993]

Grey Water *All domestic wastewater except toilet discharge water.*
[Brookings County, South Dakota, Zoning Ordinance. Section 1106. 1989]

Hazardous Materials *A material which is defined in one or more of the following categories:*

(a) Ignitable: A gas, liquid, or solid which may cause fires through friction, absorption of moisture, or which has low flash points. Examples: white phosphorous and gasoline.

(b) Carcinogenic: A gas, liquid, or solid which is normally considered to be cancer causing or mutagenic. Examples: PCB's in some waste oils.

(c) Explosive: A reactive gas, liquid, or solid which will vigorously and energetically react uncontrollably if exposed to heal, shock, pressure, or combinations thereof. Examples: dynamite, organic peroxides, and ammonium nitrate.

(d) Highly Toxic: A gas, liquid, or solid so dangerous to man as to afford an unusual hazard to life. Examples: parathion and chlorine gas.

(e) Moderately Toxic: A gas, liquid, or solid which, through repeated exposure or in a single large dose, can be hazardous to [humans]. Example: atrazine.

(f) Corrosive: Any material, whether acid or alkaline, which will cause severe damage to human tissue, or in case of leakage might damage or destroy other containers of hazardous materials and cause the release of their contents. Examples: battery acid and phosphoric acid.
[Brookings County, South Dakota. Zoning Ordinance. Section 1106. 1989]

Hazardous Material *Any gaseous, liquid, or solid materials, or substances designated as hazardous by the U.S. Environmental Protection Agency and/or the Maine Department of Environmental Protection.*
[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Hazardous Waste *Any substance identified under Chapter 850, Identification of Hazardous Wastes, of the rules of the State of Maine, Department of Environmental Protection, effective date July 1, 1980, including revisions or amendments thereto, and any radioactive waste material, which means any solid, liquid, or gas residue, including, but not limited to, spent fuel assemblies prior to processing, remaining after the primary usefulness of the radioactive material has been exhausted, and containing nuclides that spontaneously disintegrate or exhibit ionizing radiations.*
[Town of Norway, Maine, Wellhead Protection Ordinance, Section J.2. 1993]

Heating Oil Storage (Consumptive Use) *Storage for heating of heating oil in excess of 660 gallons. Tanks with capacity between 50 gallons and 660 gallons are regulated by the Oil and Solid Fuel Board.)*

Appendix L

[Town of Norway, Maine, Wellhead Protection Ordinance, Section J.2. 1993]

Industrial Waste *Wastes resulting from the processes employed in industrial manufacturing, trade, or business establishments.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Inert Fill *Material placed on or into the ground as fill: the material will not react chemically with soil, geologic material, or groundwater that may be present at the site.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Intensive Open Space Uses *Uses of open space, such as gold courses and power lines, which have the potential, because of their duration, frequency, or nature to significantly alter the environment, particularly the groundwater quality and quantity, associated with the open space.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Junk, Salvage Yard *A yard, field, or other area used as a place of storage for:*

(1) Discarded, worn-out, or junked plumbing, heating supplies, household appliances, and furniture;

(2) Discarded, scrap and junked lumber;

(3) Old or scrap copper, brass, rope, rags, batteries, paper trash, rubber or plastic debris, waste and all scrap iron, steel, and other scrap or ferrous or nonferrous material;

(4) Used tires, discarded tires, or worn-out tires which may or may not be usable now or in the future;

(5) Town garbage dumps, waste dumps, and sanitary fills will not be considered junkyards for the purpose of this Ordinance.

(6) Three or more unserviceable, worn-out vehicles.

[Town of Norway, Maine, Wellhead Protection Ordinance, Section J.2. 1993]

Landfill *An area used for the placement of solid waste, liquid waste or other discarded material on or in the ground.*

[Town of Norway, Maine, Wellhead Protection Ordinance, Section J.2. 1993]

Leaks and Spills *Any unplanned or improper discharge of a potential contaminant, including any discharge of a hazardous material.*

[Brookings County, South Dakota. Zoning Ordinance. Section 1106. 1989]

Pesticide, Herbicide Bulk Storage *Storage of herbicides or pesticides intended for sale or intended for application on commercial premisses or intended for application on cash crops. Homeowner storage or storage related to non-commercial gardeners is not included.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Salt or Sand/Salt Piles (covered) *Storage of salt or sand/salt mix intended for municipal, commercial, or other use except for homeowner sidewalks, steps, or driveways beneath a roof or other structure capable of preventing precipitation from reaching the salt or sand/salt.*

Appendix L

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Salt or Sand/Sale Piles (uncovered) *Storage of any amount of salt or sand/salt for any purpose, without a roof or other structure capable of preventing precipitation from reaching the salt or sand salt.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Sludge *Residual material produced by water or sewer treatment processes, industrial processes, or domestic septic tools.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Sludge Utilization *The spreading of sludge on the ground or other use of sludge which might expose surface or groundwater to the sludge.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Snow Dump *A location to which snow is transported and dumped by commercial, municipal, or State snow-plowing operations.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Solid Waste *Discarded solid material with insufficient liquid content to be free flowing. This includes but is not limited to rubbish, garbage, scrap materials, junk, refuse, inert fill materials, and landscape refuse. For the purposes of this Ordinance, solid waste includes recyclable materials.*

[Town of Norway, Maine, Wellhead Protection Ordinance, Section J.2. 1993]

Spill Prevention Control and Countermeasure (SPCC) Plan *Spill Prevention Control and Countermeasure Plan as described in 40CFR, Part 112 of Federal Oil Pollution Prevention Regulations.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Underground Storage Tank *Any one or a combination of nonportable containers, excluding all pipes connected thereto, which is used to store an accumulation of toxic or hazardous substances, and the volume of which is ten percent or more beneath the surface of the ground.*

[Elkhart County, Groundwater Protection Ordinance, Section 3.P. 1988]

Other Zoning Definitions Appropriate to Wellhead Protection Ordinances

Best Management Practices *Measures contained in Soil Conservation Service South Dakota Technical Guide, either managerial or structural, that are determined to be the most effective, practical means of preventing or reducing pollution inputs from nonpoint sources to water bodies.*

[Brookings County, South Dakota, Zoning Ordinance. Section 1106. 1989]

Best Management Practices *Operational Procedures for handling, storage, and disposal of regulated substances and procedures which are designed to minimize the impact of certain activities or land uses on groundwater quality and quantity.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Conforming *A building, structure, activity, or land use which complies with the provisions of this Ordinance.*

Appendix L

[Town of Norway, Maine, Wellhead Protection Ordinance, Section J.2. 1993]

Construction *Includes building, erecting, moving, or any physical operations on the premises which are required for construction. Excavation, fill, paving, and the like shall be considered part of construction.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Construction and Commercial Equipment and Vehicle Storage *Storage of construction equipment or other commercial vehicles in excess of 30 consecutive days in which the equipment is not used.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Continuous Transit *Continuous Transit is the nonstop movement of a mobile vehicle.*

[Broward county, Florida, General Ordinance, Section 27-376, 1984; 1989]

Existing Activity *Existing activity [or use for which] a building permit or occupational license has been issued by the appropriate jurisdiction prior to the effective date of this ordinance, or for which a completed building permit or occupational license application had been filed and accepted with the appropriate jurisdiction prior to the effective date of this ordinance. All other activities or uses shall be deemed "new."*

[City of Jacksonville, Florida, Wellhead Protection Ordinance, Part VI, Section 366.603, 1991]

Gas Station, Service Station *Any place of business at which gasoline, other motor fuels, or motor oil are sold to the public for use in a motor vehicle, regardless of any other business on the premises.*

[Town of Norway, Maine, Wellhead protection Ordinance. Section J.2. 1993]

Lineament *Any line on an aerial photograph that is structurally controlled, including any alignment of separate photographic images, such as stream beds, trees, or bushes, that are so controlled. The term is widely applied to lines representing beds, mineral bandings, veins, faults, joints, disconformities, and rock boundaries.*

[City of West Whiteland Township, Pennsylvania, Zoning Ordinance, Section 917.3. 1986]

Nonconforming Use *A building, structure, use of land, or portion thereof, existing at the effective date of adoption or amendment of this Ordinance which does not conform to all applicable provisions of this Ordinance.*

[Town of Norway, Maine, Wellhead Protection Ordinance, Section J.2., 1993]

Utility Corridor *Right-of-way easement, or other corridor for transmission wires, pipes, or other facilities for conveying energy, communication signals, fuel, water, wastewater, etc. Municipal water supply distribution mains, operational, or maintenance facilities, are excluded from restrictions in the Wellhead Protection Table.*

[Town of Norway, Maine, Wellhead Protection Ordinance, Section J.2. 1993]

Appendix M

1995 COUNTY EMERGENCY MANAGEMENT COORDINATORS
(Subject to Change)

Albany County
Laramie, WY 82070
Glenn Moriz
721-5397 (wk)
745-4711 (hm)

Big Horn County
Cowley, WY 82420
Don McCracken
548-7647 (hm)

Campbell County
Gillette, WY 82716
Tom Johnson
682-5319 (wk)

Carbon County
Rawlins, WY 82301
Nick Casson
327-5333 (hm)

Converse County
Douglas, WY 82633
William Meehan, Jr.
358-6133 (hm)

Crook County
Sundance, WY 82729
Cheryl Williams
283-2390 (wk)
283-2361 (hm)

Fremont County
Riverton, WY 82501
Kim Lee
856-2374 (wk)
856-7422 (hm)

Goshen County
Torrington, WY 82240
Melvin Eaton
532-2788 (hm)

Hot Springs County
Thermopolis, WY 82443
Jerry Langbehn
864-3421 (wk)
864-5602 (hm)

Johnson County
Buffalo, WY 82834
Steve Apgar
684-9058 (wk)
684-9032 (hm)

Laramie County
Cheyenne, WY 82001
David Guille
637-6406 (wk)
638-3541 (hm)

Lincoln County
Kemmerer, WY 83101
Charles Young
877-9835 (wk)
877-6707 (hm)

Natrona County
Casper, WY 82601
Lt. Stewart Anderson
235-9205 (wk)
237-3016 (hm)

Niobrara County
Lusk, WY 82225
Kester Akers
334-3622 (wk)
334-2674 (hm)

Park County
Cody, WY 82414
Duane Sharp
587-5601 (587-2204) (wk)
587-4844 (hm)

Platte County
Wheatland, WY 82201
Jane Carlson
322-2140 (wk)
322-3018 (hm)

Sheridan County
Sheridan, WY 82801
Thomas Ringley
674-8945 (wk)
674-4812 (wk)

Sublette County
Pinedale, WY 82941
Scott Thompson
367-2284 (wk)
276-5320 (hm)

Sweetwater County
Rock Springs, WY 82
Jack Zimmerman
352-6820 (wk)
875-3564 (hm)

Teton County
Jackson, WY 83001
Jim Stone
733-3392 (wk)
733-4348 (hm)

Uinta County
Evanston, WY 82930
Brent Morris
789-1780 (wk)

Washakie County
Worland, WY 82401
Roy Johnson
347-2741 (wk)
347-4832 (hm)

Weston County
Upton, WY 82730
Vonda Rothleutner
468-2656 (wk)
468-2300 (hm)

Appendix N

SUMMARY OF EXISTING SOURCE CAPACITY AND DEMAND
(Form V-1)

EXISTING SOURCE PRODUCTION CAPACITY	Wet Year Winter (gpd)	Dry Year Winter (gpd)	Wet Year Summer (gpd)	Dry Year Summer (gpd)
(Source A)				
(Source B)				
(Source C)				
TOTAL SOURCE PRODUCTION CAPACITY (gpd)				
TOTAL SOURCE STORAGE CAPACITY (gal)				
EXISTING DEMAND (gpd)				
NUMBER OF SUPPLY DAYS IN STORAGE				

Appendix O

CONTINGENCY PLANNING TEAM ROSTER
(Form V-2)

POSITIONS	NAME	ROLE	WORK PHONE	HOME PHONE
Wyoming DEQ Herschler Bldg. Cheyenne, WY 82002		Respond/ Guidance	(307)777-7781 (24-hour)	Notify in case of hazardous substance release
National Response Center Washington, D.C.		Respond/ Guidance	(800) 424-8802 (24-hour)	Notify NRC or EPA in case of hazardous substance release
US EPA Region VIII Emergency Response Branch One Denver Place 999 18th Street, Suite 500 Denver, CO 80202		Respond/ Guidance	(303) 564-1788 (24-hour)	Notify NRC or EPA in case of hazardous substance release
County Emergency Management Coordinator (see Appendix M)		Respond/ Guidance		
Local Emergency Planning Committee		Respond/ Guidance		
Hazard Assessment Coordinator		Respond/ Guidance		
Public Relations Coordinator		Guidance		
City Engineer or Technical Consultant		Guidance		
Public Works Director		Guidance		
Asst. Public Works Director		Guidance		
Water Superintendent		Respond/ Guidance		
Assistant Water Superintendent		Respond/ Guidance		
Fire Department				

Continued on Next Page

Appendix O

Police Department		Respond		
Mayor		Guidance		
Priority water users				
Emergency Contractors (Heavy equipment, bottled water, etc.)		Respond		
News Media				

Appendix P

EMERGENCY PROBABILITY AND SEVERITY CHART
(Form V-3)

TYPE OF EMERGENCY	PROBABILITY (10-High - 1-Low)	SEVERITY (10-High - 1-Low)	REMARKS
Natural			
Drought			
Flood			
Ice & Snow Storm			
Wind			
Earthquake			
Fire			
Man-Made			
Spills/Chemical Contamination			
Sabotage			
Power Outage			
Operator Error			
Equipment Failure			
Explosion			
Vandalism			

Appendix Q
WHP Plan Submittal Checklist

	Yes	No
Does the WHP Plan Contain or Address the Following?		
1 ***Institutional Roles: (see Section I of Wyoming's Wellhead Protection Guidance Document)***		
1.1 Has a listing of members of the Wellhead Protection Management Committee, including resolutions, if any, and descriptions of public participation efforts been included in the WHP Plan?		
2 ***Delineation of the Wellhead Protection Areas: (see Section II of Wyoming's Wellhead Protection Guidance Document)***		
Have you followed the Flow Chart in Table II-1 to appropriately determine the type of flow (i.e. porous, diffuse or conduit)		
As identified in Table II-2 of *Wyoming's Wellhead Protection Guidance Document*, a Wellhead Protection Area (WHPA) shall be delineated for each PWS well:		
2.1 Zone 1 - Does the radius (i.e. 50' or 100') of Zone 1 for each well meet the requirements specified?		
2.2 Zone 2 - Has the appropriate delineation method been applied, given the *aquifer media* type and *flow* type of the aquifer supplying your well(s)? See Table II-1, II-2, Appendix D and Part IV of Appendix G.		
2.3 Zone 3 - Has the appropriate delineation method been applied, given the *aquifer media* type and *flow* type of the aquifer supplying your well(s)? See Table II-1, II-2, Appendix D and Part IV of Appendix G.		
2.3.1 Are alternative criteria or methods required due to the presence of one or more of the conditions identified in Section II - *'Special Considerations'*, or in Part IV of Appendix G?		
2.4 Have aquifer/pump tests been performed?		
2.4.1 Have any of the delineated wells been constructed with state agency funding?		
2.4.2 Has rehabilitation of existing wells or the water distribution system been performed with state agency funding?		

Appendix Q
WHP Plan Submittal Checklist

		Yes	No
2.5	*(Community PWSs Only)* Have the WHPAs been delineated and has the *'Susceptibility Assessment Form'* (Appendix F) been completed for each well?		
2.6	Do the WHPAs of the wells overlap?		
2.6.1	If 'Yes': Have the overlapping WHPAs been properly 'nested' or 'clustered' into one WHPA for the wellfield WHPAs (see Figure II-4);		
	If modeled, does computer modeling of the WHPA incorporate well interference?		
2.7	WHPA *'Delineation Report'* (see Section II):		
2.7.1	Does the report contain the required information on the following:		
	- Geologic Data?		
	- Aquifer Data?		
	- Well Data?		
	- Pump Data?		
	- WHPA Delineation Information?		
	- Map Showing Boundaries of the WHP Areas or Zones?		
	- City/County Zoning and Land Use Map?		
	- Confined Aquifer Conditions?		
	- *'Susceptibility Assessment Form'* (Appendix F) for each PWS in the WHP Plan?		

Appendix Q
WHP Plan Submittal Checklist

		Yes	No
3	***Inventory of Potential Contamination Sources: (see Section III of Wyoming's Wellhead Protection Guidance Document)***		
	Have the following steps been completed in developing an inventory of 'existing' and 'potential' contaminant sources within each WHPA?		
3.1	Indicate which of the following steps have been taken and completed for completing the contaminant source inventory:		
3.1.1	Local, state and/or federal databases have been accessed and source information for known (i.e. 'existing') sources has been included in the contaminant source inventory; 'existing' sources have been located and identified on the base map.		
3.1.2	Information has been collected on unknown (i.e. 'potential') sources and included in the contaminant source inventory; 'potential' sources have been located and identified on the base map. Indicate which method (or methods) was followed to collect information on 'potential' sources: - Mail Survey - Telephone Survey - Door-to-door Survey - Field Survey - Windshield Survey - Personal Interviews		
3.1.3	Has the accuracy and reliability of sources of information been verified?		
3.1.3.1	Indicate which method (or methods) was followed to verify information on 'existing' sources: - Mail Survey - Telephone Survey - Door-to-door Survey - Field Survey - Windshield Survey - Personal Interviews		

Appendix Q
WHP Plan Submittal Checklist

		Yes	No
3.1.3.2	Indicate which method (or methods) was followed to verify information on 'potential' sources: - Mail Survey - Telephone Survey - Door-to-door Survey - Field Survey - Windshield Survey - Personal Interviews		
3.2	Have the 'existing' and 'potential' sources within the WHP area been described by:		
3.2.1	Completing Source Identification forms (Form III-1)? -or- Other forms that contain: - Source owner/operator name and location? - Source type and WHPA 'Zone' in which it is located? - Source Priority Method and Rank?		
3.3	Has the Source Inventory <u>list</u> been completed from the Source Identification forms?		
3.3.1	Does the Source Inventory list contain the following? - Minimum information that is on the Source Identification forms which is grouped by WHPA Zones? - Description of WHPAs to which the inventory applies? - Date of Completion of Source Identification data collection and survey(s)? - Statement describing the timing of completion of the Source Identification forms with respect to WHPA delineations and identifying the status of the Source Inventory (i.e., 'Preliminary' or 'Final')? - Upon completion of the above, have Parts V and VI of the '*Susceptibility Assessment Form*' (Appendix F) been completed?		

Appendix Q
WHP Plan Submittal Checklist

		Yes	No
3.4	Have the 'existing' and 'potential' sources been ranked (prioritized) according to one (or more) of the following: - Distance or TOT to nearest public drinking water well? - 'Sensitivity' of the uppermost aquifer underlying the source? - Number of residents served by public drinking water well? - Ranking from EPA's "*Managing Ground Water Contamination Sources in Wellhead Protection Areas: A Priority Setting Approach*"?		
3.5	Have 'existing' and 'potential' contaminant source locations and information been plotted on a base map for use as an overlay on WHPA delineation maps? - Are 'existing' and 'potential' sources distinguished? - Are the souces on the map linked to the Source Inventory list by a source identification number? - Do different symbols or numbers differentiate between types of sources? - Is the Source Overlay identified as 'Preliminary' or 'Final'?		
3.6	Does the WHP Plan contain provisions for updating, refining, and expanding the source inventory information?		
3.7	Does the WHP Plan include provisions to update the Source Inventory at least every two years using the methods described in Section III?		
4	***Potential Contaminant Sources - Management Strategies: (see Section IV of Wyoming's Wellhead Protection Guidance Document)***		
4.1	Does the WHP plan describe the techniques that will be employed to manage and minimize the threats posed by the 'existing' and 'potential' contaminant sources identified in the Source Inventory?		

Appendix Q
WHP Plan Submittal Checklist

		Yes	No
4.2	Has the contaminant source priority ranking information been used to develop management strategies that are appropriate for the priority rank of the 'existing' and 'potential' contaminant sources identified within the WHPA?		
4.3	Has a 'Potential Source, Hazards, Controls, Assessment, and Management Form' (Form IV-1; Appendix J) been completed for each potential contaminant source in the 'Source Inventory List'?		
4.4	Have ordinances, Memorandum of Understanding or Agreement, land use agreements, and other source management instruments been appended to the WHP plan?		
5	***Planning for the Future - Contingency Plans and Plans for Siting New Wells: (see Section V of Wyoming's Wellhead Protection Guidance Document)***		
5.1	Has the WHP Management Committee, or its designate, addressed and included the following requirements in the Contingency Plan?		
5.1.1	Existing system conditions (Form V-1; Appendix N) and copies of maps and/or construction plans, specifications, and drawings of water distribution and storage system?		
5.1.2	Chain of command and description of individual roles and responsibilities during an emergency (Form V-2; Appendix O)?		
5.2	Emergency responses planned for 'high' probability and 'high' severity events (Form V-3; Appendix P), which includes:		
	- procedures to shut down or isolate a contaminated well?		
	- source of emergency water for drinking and other household uses as well as sources of equipment to treat, transport, and distribute water?		
	- procedures to decontaminate the distribution system and well(s)?		
	- procedures to coordinate with county and state emergency response agencies?		
	- procedures to effectively communicate with the water users?		

Appendix Q
WHP Plan Submittal Checklist

		Yes	No
	- a plan of action for siting a new permanent water supply to replace contaminated supply?		
	- sources of emergency funds and equipment, and procedures for requesting and dispersing funds and equipment?		
	5.2.1 Provisions for obtaining, distributing, and funding *temporary* alternate drinking water supplies?		
	5.2.2 Provisions for developing and financing new drinking water sources in case of long-term shortages due to contaminated supplies?		
	- An inventory of alternative water supply sources (quantity, quality, and ownership)?		
	5.2.3 A plan and schedule for updating the Contingency Plan?		
6	***Plans for Updating and Revising the WHP Plan (see Section VIII of Wyoming's Wellhead Protection Guidance Document):***		
6.1	Are there provisions to update and revise the WHP plan at least every two years?		
6.1.1	Do the provisions describe how the following will be updated and revised?		
	6.1.2 Hydrologic characteristics of producing aquifer.		
	6.1.3 Changes in the water supply, or pumping volumes.		
	6.1.4 New potential sources of contamination.		
	6.1.5 New management strategy development or implementation.		
	6.1.6 Contingency planning and emergency response.		
	6.1.7 Planning or developing new water supplies.		
6.2	Does the WHP Plan include provisions for submitting revisions (i.e., delineations, Source Inventory lists and Identification forms, 'Source Overlays', source management strategies, Contingency Plans, and plans for siting new well(s)) to WDEQ/WQD at least every two years?		
6.3	If there are no changes (as described above) in two years, are there provisions for having a representative of the local		

Appendix Q
WHP Plan Submittal Checklist

		Yes	No
	government or the manager of the PWS send a letter to WDEQ/WQD documenting that the WHP Plan was reviewed and that no changes have occurred?		
6.4	Are there provisions to have any revisions or updates amended to, or incorporated into the WHP Plan?		

Appendix R

***** FACT SHEET 1*****

Economic Benefit Potential From Implementation of a Wellhead Protection Program in Wyoming

Background:

Wellhead Protection Programs are implemented by states to assist and guide communities in the development of local Wellhead Protection Plans. These plans are designed to protect Public [drinking] Water System *(PWS)* wells from potential contamination resulting from past, present and future practices.

Wellhead Protection Plans may provide economic benefits to a community in three ways: 1) using core elements (i.e., Wellhead Delineation, Contaminant Source Inventories, Source Management Approaches, Contingency Plans) of Wellhead Protection Plans as a basis for obtaining *susceptibility [vulnerability] monitoring waivers*, potentially allowing PWSs to avoid portions of the costly monitoring currently required by EPA under the Safe Drinking Water Act (SDWA); 2) avoiding the need to install a costly system to treat contaminated drinking water, and; 3) avoiding the cost of having to replace a well due to contamination.

Use of Wellhead Protection Plans to Obtain Monitoring Waivers:

Table 1 presents estimated annual costs for Synthetic Organic Compound (SOC) and Volatile Organic Compound (VOC) monitoring tests that PWSs presently must perform to meet SDWA requirements. In the event that a community's local Wellhead Protection Plan were utilized in obtaining monitoring waivers, these costs, or a portion of them, may be eliminated (and realized as a savings).

Costs at the state level are assumed to be approximately $150,000 per bi-ennium ($75,000/yr) or $300,000 over a four year period for one Full Time Equivalent (FTE) position (plus related expenses) to administer the program. *Savings* illustrated would accrue as a result of using Wellhead Protection Plans to aid in obtaining *monitoring waivers for either or both tests.*

Table 1

*Annual Monitoring Costs Per Sample**

Method	Price
SOCs	$5,760
VOCs	900
Total	**$6,660**

* Quarterly Sampling Required

Source: Division of Drinking Water, State of Utah

Based upon Utah's experience where 1,000 PWSs saved approximately $3.8 million per year in monitoring costs, the 600 Wyoming PWSs could reasonably experience a proportional

savings of roughly $2.28 million per year or $9.12 million over a four year period[1] and the benefit/cost ratio would be 30:1, meaning that for each dollar spent by the state to administer the program, $30 in savings would be realized by communities. As illustrated in Table 3, assuming that 44% (265) of the Wyoming PWSs should qualify for monitoring waivers based upon vulnerability to contamination, as has been found in Texas where wellhead protection is likewise a *voluntary program*, savings would be roughly ***$1 million per year*** or *$4 million over a four year period* and the benefit/cost ratio would be ***13:1***.

Use of Wellhead Protection Plans to Potentially Save on Treatment Costs:

Implementation of Wellhead Protection Plans at the local level may benefit both the *Farm Loan Program* and the *Wyoming Water Development Commission* from the reduced need for emergency funding to *replace contaminated wells* or *provide for water treatment facilities*.

As an example, in 1995 the Rock Springs-Green River Joint Powers Board approached the legislature seeking state funding for a drinking water treatment plant due to site contamination. The expected cost of the proposed system is roughly *$30 million*. Since most communities do not have the financial means to fund an emergency water system improvement, it is reasonable to expect that resources will continue to be requested from state funding mechanisms if/when similar situations arise in the future.

Use of Wellhead Protection Plans to Potentially Save on Replacement Costs:

Table 2 contains a summary of potential costs associated with replacement of a contaminated drinking water supply well. When a well becomes contaminated, there are usually two options available to deal with the problem: 1) the well can be replaced, or: 2) the contaminants can be removed through treatment.

In locations where another drinking water source (aquifer) is non-existent, or prohibitively deep, treatment may be the only viable option.

Table 2
Potential Cost of Replacing Contaminated PWS Well

Item	Cost
Well Drilling	$50-150/ft $100-120/ft (avg)
Trans. Pipeline (size dependant)	$200,00/mi (low) $375,000/mi (high)
Storage Tank (maintains pressure)	$.38/gal (low) $2/gal (high)
Water Treatment	$1/gal capacity

Source: Wyoming Water Development Commission

[1] Utah's WHP program is mandatory and all groundwater based PWSs must develop and implement wellhead protection plans. The estimated $1.6 million is based upon figures from the Texas Natural Resource Conservation Commission (Water Utilities Division) where 44% of PWSs obtained monitoring waivers through its Vulnerability Assessment Program, similar to a wellhead protection program.

Appendix R

An example well of 300 feet in depth ($110 per foot) drilled 2.5 miles ($247,000 per mile) from the system intake would result in a development cost of approximately $650,500.

Summary of Potential Savings:

Table 3 illustrates the potential savings which could potentially accrue to Wyoming communities through successful use of Wellhead Protection Plans. As illustrated in Table 3, in the event that replacement of one similar well could be avoided through the implementation of a Wellhead Protection Plan, *savings to the state would amount to roughly $2 for every $1 spent* by the state to administer the program over a period of four years. As illustrated in Table 3, in the event that implementation of a Wellhead Protection Plan prevented the need for just one similar drinking water treatment plant, the *savings to the state would amount to $100 for every $1 spent* by the state to administer the program over a period of four years.

Table 3

Cost/Benefit Accruing From Implementation of Wellhead Protection Plans

Benefit (Savings)	Period	Cost	Ratio
$4 Million*	4 Yrs.	$300,000	13:1
$30 Million**	Once	$300,000	100:1
$650,000***	Once	$300,000	2:1

* Monitoring Waivers
** Treatment Plant
*** Replace Well

Source: WDEQ

whp/factsht1.doc

Appendix R

***** FACT SHEET 2 *****

Potential Economic Benefits and Cost-Avoidance to Wyoming Communities (or Public Water Systems) When Wellhead Protection Plans are Implemented

Background:

This fact sheet presents the potential economic benefits and cost savings that can be achieved when a community or its Public [drinking] Water Systems (PWSs) develop and implement local Wellhead Protection (WHP) Plans. The cost-benefit ratio is obtained by comparing the average cost of developing wellhead protection plans to EPA monitoring costs, and to the avoided costs of either providing a new drinking water supply or a water treatment system in the event that a PWS well becomes unuseable due to contamination. Implementation of Wellhead Protection Plans at the local level may benefit both the *Farm Loan Program* and the *Wyoming Water Development Commission* from the reduced need for emergency funding to *replace contaminated wells* or *provide for water treatment facilities*.

Costs of Developing and Implementing Wellhead Protection Plans:

As illustrated in Table 1, the majority of groundwater-supplied PWSs in Wyoming serve fewer than 500 people, and all but 8 serve fewer than 3300 people.

Table 1: Wyoming (Groundwater) Public Water Systems (PWSs) by Class and Size

Type (Class) of PWS[2]	Number of PWSs	Number of PWSs per Population Served					
		<100	>100 <500	>500 <1000	>1000 <3300	>3300 <10000	>10000
Community	186	81	81	6	12	4	2
Transient, Non-Community	319	232	72	8	5	2	0
Non-Transient, Non- Community	82	53	26	2	1	0	0
TOTAL	**587**	**366**	**179**	**16**	**18**	**6**	**2**

Source: Data collected from the EPA Safe Drinking Water Program Database; (1/23/96).

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2 As classified by EPA, a **'community'** water system serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents. A **'non-community'** water system may be classified as either (1) **'transient non-community'** (does not regularly serve at least 25 of the same persons over six months per year), or (2) **'non-transient non-community'** (regularly serving at least 25 of the same persons over six months per year).

Appendix R

Actual and projected costs for development of Wellhead Protection Plans are provided for two small towns (Elk Mountain, WY and Gilbert, LA) and for three small (Utah) public water systems of differing sizes in Table 2:

Table 2: Cost to Develop Wellhead Protection Plans[3]

Factors	Gilbert, LA (1994)	Elk Mountain, WY (1996)	3 Small PWSs; Utah (1995)		
Population Served	700	186	>25 <100	>100 <175	>175 <2500
Number of Wells	2	2	1 - 2	1 - 2	2 - 3
Delineation of Wellhead Protection Areas	$3347 (Incl. Contam. Source Inventory, Public I & E)	$1100 (Incl. Consultant Fees - WHPA Model)	(Calculated Fixed Radius Method)		
Contaminant Source Inventory	$36 (Overlay Map)	$250			
Management Plan	$571	$1155			
Contingency Plan/Siting New Wells	$231	$130			
Forming WHP Committee	$0	$165			
Public Information/ Education (I & E)	(See Above)	$800			
Road Signs	$231	NA			
Total WHP Development Costs (1st year)	$4416	$4790	$400	$1800	$4200
Annual Contaminant Source Inventory & Inspections	$125	$200	$25	$50	$200
Total WHP Costs (5 years)	$5041	$5790	$500	$2000	$5000

3 The costs in Table 2 have not been adjusted for inflation and are based upon the dollars in the specified year. Future cost estimates for developing wellhead protection plans should be adjusted accordingly.

Appendix R

The economic benefit (avoided cost) and (avoided) cost-benefit ratio of each of the above 'factors' is presented in Table 3:

Table 3: Potential Avoided Costs and Cost/Benefit Ratios

Factor	Total Cost (Avoided)	Population Served	WHP Costs (5 yrs)	(Avoided) Cost/ Benefit Ratio
Monitoring Costs - 5 years (SVOCs and VOCs)	$18,875 " "	<100 100 -175 175-2500	$500 $2000 $5000	38:1 9:1 4:1
Replacement Costs of New Well (300 ft. deep and 2.5 mi. from the system intake)	$650,500 " "	<100 100 -175 175-2500	$500 $2000 $5000	1300:1 325:1 130:1
Treatment Costs (Reverse Osmosis at Wellhead)	$23,600 $222,200 $505,800	<100 100-175 175-2500	$500 $2000 $5000	47:1 110:1 100:1

Avoidance of Monitoring (Sampling) Costs:

Based upon Utah's experience where 1,000 PWSs saved approximately $3.8 million per year in monitoring costs, the 600 Wyoming PWSs could reasonably experience a proportional savings of roughly $2.28 million per year. Assuming that 44% (265) of the Wyoming PWSs should qualify for monitoring waivers based upon vulnerability to contamination (as has been found in Texas, where wellhead protection is likewise a voluntary program) savings would be roughly *$1 million per year* or ***$3,775* per system, per year**.

Avoidance of Cost to Replace Drinking Water Supply:

An example well of 300 feet in depth ($110 per foot) drilled 2.5 miles ($247,000 per mile) from the system intake would result in a development cost of approximately ***$650,500***. These costs do not include the remediation costs required to remove the source of contamination and restore the groundwater as a viable drinking water source. In many cases, since the source will continue to threaten new PWS wells or existing private drinking water wells, active remediation of the groundwater is necessary. As documented in many case studies of existing PWSs across

Appendix R

Fact: ***92% of all Wyoming Public Water Systems serve fewer than 3300 people.***
Fact: ***All but 18 of Wyoming's communities have populations less than 3300 people.***

Since most Public Water Systems in Wyoming serve communities similar in size to those illustrated in Table 2 (i.e. <2500), the cost to the majority of Wyoming communities (or PWSs) to develop a Wellhead Protection Plan should approximate the costs depicted in Table 2, or roughly:

* **$500 for the 366 PWSs serving <100 people**
* **$2000 for PWSs serving between 100 and 175 people**
* **$5000 for PWSs serving between 175 and 2500 people**

As mentioned earlier, 92% of all Wyoming Public Water Systems serve fewer than 3300 people and all but 22 of Wyoming's communities have populations of less than 2500 people. The cost estimates above would therefore reasonably apply to the majority of communities (and PWSs) within the state.

Potential Economic Benefits and Cost-Avoidance to Wyoming Communities When Wellhead Protection Plans are Implemented:

Wellhead Protection Plans may provide economic benefits to a community in three ways: **1)** using core elements (i.e., Wellhead Delineation, Contaminant Source Inventories, Source Management Approaches, Contingency Plans) of Wellhead Protection Plans as a basis for obtaining *susceptibility [vulnerability] monitoring waivers*, potentially allowing PWSs to avoid portions of the costly water quality sampling currently required by EPA under the Safe Drinking Water Act (SDWA); **2)** avoiding the need to install a costly *system to treat contaminated drinking water*, and; **3)** avoiding the cost of having to *replace a well* due to contamination.

the country, the cost of remediation significantly increases the total costs of replacing a water supply. Most small PWSs need outside sources of funding to pay for drilling new wells, remediation costs, and treatment systems.

Avoidance of Cost to Treat Contaminated Drinking Water:

Estimated costs to install a relatively simple reverse osmosis treatment system at the wellhead range from as little as ***$23,000 to more than $500,000***, depending upon the volume of water required to treat. Capital costs and the 5-year operation and maintenance costs are included in these estimates. Depending on the location of the water well(s), additional water transmission lines may be needed, thereby increasing the capital costs even higher.

Summary:

The cost/benefit ratios illustrated in Table 3 demonstrate that from ***$7 to $1300 might be saved (or avoided) for every $1 spent*** by a community (or PWS) to develop a Wellhead Protection Plan. ***As illustrated in Table 3, in most cases it is the smaller communities that stand to gain the most by developing Wellhead Protection Plans.*** Very small PWSs (<100 people served) could possibly save (or avoid) as much as $1300 for every $1 spent if development and implementation of a Wellhead Protection plan prevented the contamination of one drinking water supply well. For all sizes of PWSs (or communities) illustrated in Table 3, the cost savings that might be achieved by obtaining monitoring waivers *alone* can justify the cost involved in developing the Wellhead Protection Plan.

whp'factsht2.doc

Appendix A

GROUNDWATER FLOW MODELS

Iowa State University
$400, unassembled, with instructional videotape and packet of groundwater information.
$460 fully assembled with carrying case.
Order from: SWCS Student Chapter
3212 Agronomy Hall
Iowa State University
Ames, IA 50011
515/294-3772
www.public.iastate.edu/~stu_org/swcc/

University of Nebraska
$350, includes shipping and carrying case (required if model is shipped).
$300 without case (model must be picked up). Can make some region-specific modifications.
Order from: 249 L.W. Chase Hall
University of Nebraska-Lincoln
East Campus
Lincoln, NE 68583-0726
402/472-1625

University of Wisconsin
$250 plus $10 shipping. Region-specific modifications cost extra.
Order from: Groundwater Model Project
College of Natural Resources
University of Wisconsin-Stevens Point
Stevens Point, WI 54481
715/346-4613
www.uwsp.edu/stuorg/awra/h2omodel.html

Western Michigan University
$195 plus $20 in-State shipping or $30 out-of-State shipping.
Can make some region specific modifications.
Order from Groundwater Education in Michigan
Institute for Water Resources
3327 Rood Hall
Western Michigan University
Kalamazoo, MI 49008
616/387-5502

Appendix A

The Western Group
$290 + S&H for the Standard Groundwater Simulator; $390 + S&H for the Bedrock Simulator. Includes Instructor's manual, carrying-storage case, pump and other accessories.
Order from: The Western Group, L.C.
PO Box 638
Augusta, MI 49012-0638
616-381-4355

The Groundwater Foundation
$18.95; Simple, easy and affordable.
Order from: The Groundwater Foundation
PO Box 22558
Lincoln, NE 68542-2558
800/858-4844

Groundwater Model Demonstration videotape (15 min.) Shows how to operate and maintain a groundwater model. $15.
Order from: League of Women Voters of Enid
1722 E. Maple
Enid, OK 73701
405-242-5012

whp/gwmodels.doc

Appendix B

Concern Inc.
1794 Columbia Road, NW
Washington, DC 20009
202/328-8160
Concern provides environmental information to individuals and groups and encourages them to act in their communities. Concern publishes concise reports defining key environmental issues and containing suggestions for individual and group action, organizes workshops, conferences and exhibits and undertakes other educational activities.

Environmental Defense Fund
257 Park Avenue South
New York, NY 10010
212/505-2100
A national research, education and advocacy organization, EDF has conducted research on leaking storage tanks and works on public policy issues including wetlands, restoration of the Everglades and reauthorization of the Clean Water Act. EDF has offices in seven states and the District of Columbia.

Farm-A-Syst/Home-A-Syst
Steenbock Library, Room B142
550 Babcock Drive
Madison, WI 53706
608/262-0024
Farm-A-Syst is a volunteer program to help farmers and rural residents on private wells conduct water pollution risk assessments and develop an action plan to reduce the risks identified. The program is under way in 22 states and in the planning stages in others. In fall 1993 the program started work on a Home-A-Syst program to serve nonfarm private well users in the northeast.

Freshwater Foundation
Spring Hill Center
725 County Road Six
Wayzata, MN 55391
Freshwater Foundation pursues the protection of freshwater resources through educational programs, resource management, demonstration projects and freshwater research. Since 1985 the foundation has been a partner in *U.S. Water News* (see publications).

Freshwater Institute
The Conservation Fund
P.O. Box 1746
Shepherdstown, WV 25443
304/876-2815
Freshwater Institute is a program of The Conservation Fund, a national nonprofit land and water conservation organization. The institute explores practical, innovative approaches to the protection, conservation and use of our nation's fresh water resources.

Friends of the Earth
1025 Vermont Avenue, NW, Suite 300
Washington, DC 20005
202/783-7400
FOE is an international environmental organization that works on a range of public policy issues. FOE works to protect groundwater through influencing federal legislation, providing technical assistance to local groups, and holding a biennial citizen's groundwater conference. FOE has offices in Seattle, Washington, and the District of Columbia, as well as 51 international affiliates.

Appendix B

The American Water Works Association (AWWA)
6666 Quincy Ave.,
Denver, CO 80235
303/794-7711

The AWWA has developed an award program to recognize water systems which have developed and are implementing exemplary Wellhead Protection (WHP) Programs. This program will include awards (up to three per state per year) to water systems selected by each section that has qualifying water systems.

The Urban Institute
2100 M Street, NW
Washington, DC 20037
202/833-7200

The Urban Institute is a nonprofit, nonpartisan policy research organization that works on a range of public interest issues including groundwater protection. The institute has produced "Suggestions For State and local Groundwater Protection Programs", a series of publications providing guidance on accessing information, encouraging local efforts and encouraging business and public involvement in groundwater protection. Write or call for more information.

EPA Safe Drinking Water (SDW) Hotline: (800)426-4791

The SDW Hotline is available to help State and local officials and the public understand the regulations and programs developed in response to the Safe Drinking Water Act Amendments of 1986 and 1996. For groundwater and wellhead protection issues, the Hotline can provide general information about the national program, and State and EPA Regional groundwater contacts. The Hotline also has information about the National Rural Water Association's program to assist small communities to develop local drinking protection plans.

EPA Office of Water Resource Center

The Center has a complete listing of all wellhead protection, groundwater, and drinking water publications. If the documents are available, the Resource Center will send copies to interested parties free of charge. If the document requested is currently unavailable from EPA, the Resource Center has alternate ordering information. For information on the Compendium of Local Wellhead Protection Ordinances (EPA Doc. No. 570/9-91-024A-D), please contact your EPA Regional Groundwater Office.

Contact: Water Resource Center (RC4100)
Room G099B 401 M St., S.W.
Washington, DC 20460
(202)260-7786
(202)260-0386 (fax)

Internet: Waterpubs @ EPAmail.epa.gov.

Appendix B

The Groundwater Foundation

The Groundwater foundation is a national nonprofit organization dedicated to educating the public about the conservation and management of groundwater. The Foundation sponsors a variety of youth programs, such as the Nebraska Children's Water Festival and Groundwater University. The Foundation also sponsors the Groundwater Guardian program and a fall symposium that each year explores all aspects of a groundwater-related issue. Foundation publications include the *Aquifer*, a quarterly journal on groundwater issues; *Sprinkles*, a water festival newsletter; and guides, such as *Making Waves: How To Put On A Water Festival*, to help communities establish their own youth programs.

Contact: The Groundwater Foundation
P.O. Box 22558
Lincoln, NE 68542-2558
(800)858-4844

Groundwater Guardian Program

This is a national program to support and recognize communities actively protecting their groundwater. Communities form a Groundwater guardian team to develop and implement a program to increase groundwater awareness and protection. Communities designated Groundwater Guardians receive national recognition at an annual conference in November. The *Groundwater Guardian Program Guide* includes helpful information on forming a local team and activities to both educate the community about groundwater and involve the community in protecting local groundwater resources. All Guardian communities receive the quarterly newsletter, *Infiltration*.

Contact: The Groundwater Foundation
P.O. Box 22558
Lincoln, NE 68542-2558
(800)858-4844

Appendix B

Give Water a Hand: Youth Action Program Promoting Good Water Management Practices at home and in the Community. Kadi Row, Project Coordinator. *Leader Guidebook and Site Action Plan. Give Water a Hand* is a national youth water education program developed to engage you g people in community-based, natural resource service projects. The materials help young people protect and improve local water resources with the assistance of local resources experts. Using a watershed approach, the program illustrates the natural link between community action and environmental problem solving.

Contact: Kadi Row, Project Coordinator
University of Wisconsin-Extension
1450 linden Drive, Room 216
Madison, WI 53706
(800)928-3720
(608)262-2031 (fax)

Spread the Word for Water: The National Drinking Water Week Kit. American Water Works Association.
Drinking Water Week, a cooperative effort by the National Drinking Water Alliance, is an annual event in the first week of May. This kit contains a wide variety of resources to help communities plan media coverage and events for all ages. Included are informational materials on conserving and protecting water resources and getting involved in local drinking water issues. Outreach materials include information for the local media and student handouts and worksheets.

Contact: Public Affairs Department
American Water Works Association
6666 W. Quincy Avenue
Denver, Co 80235
(303)794-7711

Wellhead Protection Training Kit.
The Training Kit includes nine modules that describe each phase of wellhead protection program development and implementation. The modules cover each step of a wellhead protection program, an introduction to local ordinances, information specific to working with Native American tribes, and a brief description of the EPA technical assistance document on wellhead protection. Each module includes slides, detailed "instructors notes" for each slide, and "briefing notes" that describe the main points of each slide. The briefing and instructors notes may be copied for distribution to participants. For additional information about the kit, please contact your local EPA Regional Groundwater office.

Precious GEMS: Groundwater Education Strategies that Work. Sandy Fugate. W.K. Kellogg Foundation. 1993.
This report shares the experiences of the Groundwater Education in Michigan (GEM) program, which focuses on educating and empowering local citizens to protect their groundwater at the grass roots level. The report is full of advice and examples of what worked and failed in getting a community active in groundwater protection. The areas of importance are: local ownership, networking, education, leadership, and project sustainability. The report contains the contacts for various GEM projects and an extensive list of groundwater educational materials proven useful by GEM.

Contact: W.K. Kellogg Foundation
Literature Department
One Michigan Avenue
East Battle Creek, MI 49017-4058
(616)968-1611

Appendix B

Protect Your Groundwater: Educating for Action. Christine Mueller, Lucilla Tan, Monica Sullivan, and Elizabeth Kraft. League of Women Voters Education Fund. 1994. This publication is specifically written to help prevent groundwater contamination by educating the public and others about the sources of contamination. Informative diagrams in the introduction make one familiar with groundwater geology. Seven steps to a successful groundwater education program are covered. They are: getting started; researching and developing information, development and distribution of materials, organizing public meetings, forums, and workshops; publicity; fundraising, and keeping the program going. Specific tips, examples of projects, surveys, and publications covers, and case studies show how programs may be implemented. Five appendices provide more addresses, possible sources of groundwater contamination, forms to assist in the implementation of programs, and a list of resources.

Contact: Publications Department
League of Women Voters Education Fund
1730 M. Street, NW, 10th Floor
Washington, DC 20036
(202)429-1965

***Water Sourcebook*: A Series of Classroom Activities for Grades 3-5.**
Produced for Legacy, Inc., Partners in Environmental Education, in cooperation with US EPA. Prepared by Tennessee Valley Authority - Environmental Education Section.

Contact: Water Environment Federation
601 Wythe St.,
Alexandria, VA 22314-1994
(800)-666-0206

Water Wise, Colorado.
A curriculum project consisting of manuscript, computer software and field laboratory kits designed to educate primary and secondary school children in the wise use of water and improving water quality.

Contact: Central Colorado Water Conservancy District
3209 W. 28th St.,
Greeley, CO 80631
(303)-330-4540

Volunteers for the Environment: How-to Manual for Groundwater Protection Projects. Lillian Smith Mandarchik. National Association of RSVP Directors, Inc. 1992. This publication presents a case study of the groundwater protection program in El Paso, Texas, that used the technical training and guidance of volunteers to conduct an inventory of potential sources of groundwater contamination. This inventory was then used to delineate wellhead protection areas. It includes concise steps for recruiting volunteers and advice as to how to: use the media, conduct information seminars, conduct the inventory, and reward volunteers. An extensive list of suggestions for conducting the inventory is included, along with samples of volunteer information, and inventory form, a seminar agenda, and news releases.

Contact: RSVP Program
2 Civic Center Plaza
El Paso, TX 79901

Appendix B

Source Water Protection: An Ounce of Prevention.

This four-hour, two-cassette-length videotape captures the American Water Works Association's teleconference as it was broadcast live on August 3, 1995. All presentations, panel discussions, and question-and-answer sessions are included. Each teleconference video is accompanied by a copy of the 180 page Participant Guide, containing outlines and graphics of all presentations, as well as reprinted articles on related topics.

Contact: American Water Works Assoc.
(800)926-7337
Catalog number of the video and Participant guide: 65098
Catalog number for additional Participant Guides: 20408

Appendix C

There is a wealth of additional published information and technical resources available pertaining to all aspects of the WHP plan. The following materials are available for use by individuals, city/county planners and engineers, elected officials, Public Water System operators and others interested in learning more about protecting groundwater. Internet Web Sites listed on page C-5 are an excellent source of information. For background or basic information regarding the WHP plan, the general guidance documents may be consulted. If more specific or technical information is required, the technical assistance documents may be utilized. Copies may be obtained through the sources listed below; many are free.

Technical Assistance WHP Documents and Videotapes:

General: (Many of these also contain technical guidance on specific elements of WHP plans.)

- "Business Benefits of Wellhead Protection - Report No.1" (EPA 813-B-95-004);
- "Benefits and Costs of Prevention: Case Studies of Community Wellhead Protection - Volume 1" (EPA 813-B-95-005);
- "Benefits and Costs of Prevention: Case Studies of Community Wellhead Protection - Volume 2" (EPA 813-B-95-006);
- "Wellhead Protection: A Guide For Small Communities," (EPA 625/R-93/002);
- "A Guide to Wellhead Protection", American Planning Association - Planning Advisory Service, Report #457/458, August, 1995.
- "Protecting Local Ground-Water Supplies Through Wellhead Protection," (EPA 570/09/91-007);
- "Why Do Wellhead Protection?" (EPA 570/9-91-014);
- "Wellhead Protection Programs: Tools for Local Governments," (EPA 440/6-89-002);
- "The Power To Protect: 3 Stories About Ground Water," (EPA Videotape);
- "Protection of Public Water Supplies from Ground-Water Contamination," (EPA 625/4-85/016);
- "Case Studies in Wellhead Protection: Ten Examples of Innovative Wellhead Protection Management Programs," (EPA 813-R-92-002);
- "An Annotated Bibliography of Wellhead Protection References", (EPA 440/6-87-014);
- "Citizen's Guide To Ground-Water Protection," (EPA 440/6-90-004).

Appendix C

Delineating Wellhead Protection Areas (WHPAs):

- "Guidelines For Delineation Of Wellhead Protection Areas," (EPA 440/5-93-001);
- "Model Assessment for Delineating Wellhead Protection Areas", (EPA 440/6-88-002);
- "Delineation Of Wellhead Protection Areas In Fractured Rocks," (EPA 570/9-91-009);
- "Wellhead Protection Strategies For Confined-Aquifer Settings," (EPA 570/9-91-008);
- "Wellhead Protection in Confined, Semi-confined, Fractured, and Karst Aquifer Settings", (EPA 813/K-93-001);

Contaminant Source Inventories:

- "Guide For Conducting Contaminant Source Inventories For Public Drinking Water Supplies," (EPA 570/9-91-033);
- "A Review of Sources of Ground-Water Contamination from Light Industry," (EPA 440/6-90-005);

Contaminant Source Management Approaches:

- "Managing Ground Water Contamination Sources In Wellhead Protection Areas: A Priority Setting Approach," (EPA 570/9-91-023);
- "Compendium of Wellhead Protection Ordinances", (EPA 570/9-91-024B, 024C and 024D)

Contingency Planning:

- "Registry of Equipment Suppliers of Treatment Technologies (RESULTS)", National Drinking Water Clearinghouse, 1996.
- "Guide To Ground-Water Supply Contingency Planning For Local And State Governments," (EPA 440/6-90-003);
- "Emergency Management Manual for Rural Water Systems", National Rural Water Association, 1996;
- "Emergency Planning: The Big Picture for Water Utilities", AWWA (#65068V);
- "Emergency Planning for Water Utility Management, Third Edition", AWWA (#30019PA).

Appendix C

- "Wyoming Oil and Hazardous Substances Pollution Contingency Plan", Wyoming , Department of Environmental Quality, November 1989.
- "Emergency Response Handbook", Utah Department of Environmental Quality, Division of Drinking Water (DEQ-DDW), Salt Lake City, Utah, March 1992.
- "Manual of Small Public Water Supply Systems", EPA 570/9-91-003, May, 1991.
- "Protection of Public Water Supplies from Ground--Water Contamination", EPA 625/4-85/016.
- "Environmental Pollution Control Alternatives: Drinking Water Treatment for Small Communities", EPA 625/5-90/025, April, 1990.

Funding:

- "Local Financing For Wellhead Protection," (EPA 440/6-89-001).

To Order Copies of EPA Documents:

- Use Form(s) at the end of this Section:
- EPA Safe Drinking Water Hotline: (800)-426-4791
- Groundwater Protection Document Request Hotline: (800)-426-4791
- National Technical Information Service Hotline: (703)-487-4650

Others:

- American Water Works Association (AWWA): (800)-926-7337
- National Drinking Water Clearinghouse (NDWC): (800)-932-7459.
- National Rural Water Association (NRWA): (307)-436-8636

List of Contacts to Obtain Copies of State WHP Plan Guidance Document:

- Wyoming Department of Environmental Quality/Water Quality Division:

  Cheyenne: (307)-777-7781
  Sheridan: (307)-672-6457
  Lander: (307)-332-3144

- Wyoming Association of Rural Water Systems: (307)-436-8636

Appendix C

List of Technical Information Contacts:

- Wyoming Department of Environmental Quality/Water Quality Division:

  Cheyenne: (307)-777-7781
  Sheridan: (307)-672-6457
  Lander: (307)-332-3144

- Wyoming Association of Rural Water Systems: (307)-436-8636

- Wyoming State Engineer's Office:

  Cheyenne: (307)-777-6163
  Torrington: (307)-532-2248
  Sheridan: (307)-674-7012
  Riverton: (307)-856-0747
  Cokeville: (307)-279-3441

- Wyoming Oil & Gas Conservation Commission: (307)-234-7147

- Wyoming Department of Agriculture: (307)-777-6792

- Wyoming Water Development Commission: (307)-777-7626

- Wyoming Water Resources Center: (307)-766-2143

- Geological Survey of Wyoming: (307)-766-2286

- Department of Health: Local

- UW Cooperative Extension Service: Local

- EPA (Region VIII): (800)-227-8917

- US Geological Survey - Water Resource Division: (307)-778-2931

- Natural Resource and Conservation Service: Local

- Bureau of Land Management: Local

- US Forest Service Local

Appendix C

Internet Web Site Addresses:

WDEQ: http://deq.state.wy.us

Wyoming Natural Resources Data Clearinghouse: http://www.sdvc.uwyo.edu/clearinghouse

EPA Home Page: http://www.epa.gov

EPA Office of Ground Water and Drinking Water: http://www.epa.gov/OGWDW

EPA Office of Wetlands, Oceans and Watersheds: http://www.epa.gov/OWOW

EPA's "Surf Your Watershed": http://www.epa.gov/surf

USGS: http://water.usgs.gov

Nat'l. Drinking Water Clearinghouse: http://www.ndwc.wvu.edu

Appendix C
(EPA Document Request Forms)

GROUND-WATER PROTECTION DOCUMENT REQUEST

NAME: _____ TITLE: _____

ORGANIZATION: _____

ADDRESS: _____

CITY: _____ STATE: _____ ZIP: _____

EPA Region
Fed/Other
State
Local
Company
Individual
Int'l.
Other

EPA NUMBER	REF. NO.	TITLE	QTY
440/6-84-002	*G-1	EPA Ground-Water Protection Strategy	
	*G-2	Guidelines for Ground-Water Classification Under the EPA Ground-Water Protection Strategy	
440/6-87-013	*G-3	Improved Protection of Water Resources from Long-Term and Cumulative Pollution Prevention of Ground-Water Contamination in the U.S.	
440/6-84-001	*G-4	Protecting Ground-Water: The Hidden Resource	
440/6-85-006	*G-5	Protecting Our Ground-Water	
440/6-89-004	G-6	Funding of Ground-Water Protection: Quick Reference to Grants Available Under the Clean Water Act	
440/6-90-001	G-7	Progress in Ground-Water Protection and Restoration	
440/6-90-004	G-8	Citizen's Guide to Ground-Water Protection	
440/6-00-008	G-9	Compendium of Federal Financial Assistance Programs. Targeting Programs for State and Local Ground-Water Protection	
21Z-1020	G-10	Protecting The Nation's Ground-Water: EPA's Strategy For The 1990s	
440/6-87-014	*WP-1	An Annotated Bibliography of Wellhead Protection References	
440/6-88-003	WP-2	Developing a State Wellhead Protection Program: A User's Guide to Assist State Agencies under the Safe Drinking Water Act	
440/6-87-011	*WP-3	Guidance for Applicants for State Wellhead Program Assistance Funds under the Safe Drinking Water Act	
440/6-87-010	WP-4	Guidelines for Delineation of Wellhead Protection Areas	
440/6-88-002	WP-5	Model Assessments for Delineating Wellhead Protection Areas	
440/6-87-009	WP-6	Wellhead Protection: A Decision Makers' Guide	
440/6-89-002	WP-7	Wellhead Protection Program: Tools for Local Governments	
440/6-89-001	WP-8	Local Financing for Wellhead Protection	
440/6-90-002	WP-9	Hydrogeologic Mapping Needs for Ground-Water Protection and Management: Workshop Report	
440/6-90-003	WP-10	Guide to Ground-Water Supply Contingency Planning for Local and State Governments: Technical Assistance Document	
570/9-91-007	WP-11	Protecting Local Ground-Water Supplies Through Wellhead Protection	
570/9-91-008	WP-12	Wellhead Protection Strategies for Confined Aquifer Settings	
570/9-91-009	WP-13	Delineation of Wellhead Protection Areas in Fractured Rocks	
440/6-87-008	*SG-1	State and Territorial Use of Ground-Water Strategy Grant Funds (Section 106 of the CWA)	

* Available through NTIS only - see back for more information

ORDERED BY: _____ DATE: _____

METHOD OF DELIVERY: (Circle one) Pick-up/Courier Overnight Regular Mail 1st Class UPS

Appendix C
(EPA Document Request Forms)

EPA NUMBER	REF. NO.	TITLE	QTY
440/6-88-007	*SC-2	Survey of State Ground-Water Quality Protection Legislation Enacted 1985-1987	
440/6-87-002	*SC-1	EPA Activities Related to Sources of Ground-Water Contamination	
0/6-86-002	*SC-2	Pesticides in Ground-Water: Background Document	
440/6-88-001	*SC-3	Protecting Ground-Water: Pesticides and Agricultural Practices	
440/6-86-006	SC-4	Septic Systems and Ground-Water Contamination: A Program Manager's Guide and Reference Book	
440/6-86-006	SC-5	Septic Systems and Ground-Water Contamination: An Executive's Guide	
440/6-87-007	SC-6	Septic Tank Siting to Minimize the Contamination of Ground-Water by Microorganisms	
440/6-90-005	SC-7	A Review of Sources of Ground-Water Contamination from Light Industry: Technical Assistance Document	
570/9-91-010	SC-8	A Review of Methods for Assessing Nonpoint Source Contaminated Ground-Water Discharge to Surface Water	
440/6-88-005	DM-1	EPA Workshop to Recommend a Minimize Set of Data Elements for Ground-Water: Workshop Findings Report	
600-M-86-007	*DM-2	Ground-Water Data Management with STORET	
440/6-87-006	*DM-3	Ground-Water Data Requirements Analysis	
440/6-88-006	DM-4	Indicators for Measuring Progress in Ground-Water Protection	
440/6-87-016	*SS-1	Sole Source Aquifer Background Study: Cross-Program Analysis	
440/6-87-003	*SS-2	Sole Source Aquifer Designation Petitioners Guidance	
904/6-88-001		Application of Dye-Tracing Techniques for Determining Solute-Transport Characteristics of Ground-Water in Karst Terranes	

Send Orders To:

U.S. Environmental Protection Agency
Ground-Water Protection Division
Washington, D.C. 20460

Phone Orders:

(202) 260-7779

For NTIS Request, Please send NTIS Document Number To:

U.S. Department of Commerce
National Technical Information Service (NTIS)
Springfield, VA. 22161
(703) 487-4650

Appendix C
(EPA Document Request Forms)

PUBLICATION ORDER FORM

OFFICE OF WATER

NAME: _____

ADDRESS: _____

_____

_____

1. _____ 570/9-89-AAA Lead Contamination Control Act
2. _____ 570/9-89-BBB The Lead Ban
3. _____ 570/9-89-CCC Public Notification: Reporting Violations
4. _____ 570/9-89-DDD Public Water Systems
5. _____ 570/9-89-EEE Volatile Organic Chemicals
6. _____ 570/9-89-FFF Unregulated Contaminant Monitoring
7. _____ 570/9-90-GGG Bottled Water: Helpful Facts and Information
8. _____ 570/9-90-HHH Home Water Treatment: Filtering Fact From Fiction
9. _____ 570/9-89-005 Is Your Drinking Water Safe?
10. _____ 570/9-89-006 Public Notification for Public Water Systems (Flyer)
11. _____ 570/9-89-007 Cross-Connection Control Manual
12. _____ 570/9-89-008 Protection Our Drinking Water From Microbes
13. _____ 570/9-90-001 Maintaining Safe Drinking Water
14. _____ 570/9-90-002 Your Drinking Water: From Source to Tap (EPA Regulations & Guidance)
15. _____ 570/9-90-005 Citizen Monitoring: Recommendations to Public Water System Users
16. _____ 570/9-90-006 Citizen Monitoring: Recommendations to Household Well Users
17. _____ 570/9-90-007 Science Demonstration Projects in Drinking Water (Grades K-12)
18. _____ 570/9-90-013 Drinking Water from Household Wells
19. _____ OPA 87-006 Lead and Your Drinking Water
20. _____ 570/9-91-000 Office of Drinking Water Publications Listing
21. _____ 570/9-90-600 SDWA - Pocket Guide to the Requirements for the Operators of Small Water Systems

MAIL TO: CHARLENE SHAW OR CALL: PAT WOODS
OFFICE OF DRINKING WATER (202) 382-7786
USEPA, WH-550A, E1013B FTS 382-7786
401 M STREET
WASHINGTON, D.C. 20460
(202) 382-2285/FTS 382-2285

Appendix D

METHODS FOR THE DELINEATION OF WELLHEAD PROTECTION AREAS (WHPAs)

The Environmental Protection Agency (EPA) has recognized a wide variety of techniques to determine WHPAs ranging from very simple non-analytical methods to complex numerical transport models (see EPA, 1993, Guidelines for Delineation of Wellhead Protection Areas, EPA-440/5-93-001). According to Hasfurther and others (1992), selection of these methods is based on user expertise, available resources, existing and field collected data, and the desired degree of confidence in meeting protection goals.

The delineation method(s) chosen in establishing a WHP plan will determine the type and quantity of data required for delineation.

The techniques which EPA has identified for delineation of WHPAs are:

- Arbitrary Fixed Radius (AFR);
- Calculated Fixed Radius (CFR);
- Simplified Variable Shapes (SVS);
- Analytical models (AM);
- Hydrogeologic Mapping (HM); and
- Several Numerical Flow/Transport Models (NM).

These methods are listed generally in order of increasing complexity (i.e. sophistication) and not all of these methods may be applicable in every case. Hasfurther and others (1992) have outlined the limitations and strengths of each method and the differing amounts of data required to implement each method as described below.

The Arbitrary Fixed Radius, Calculated Fixed Radius, Hydrogeologic Mapping and Analytical Models methodologies have been adopted by the Wyoming Wellhead Protection Advisory Committee for use in delineating Wellhead Protection Areas (WHPAs) in Wyoming.

Arbitrary Fixed Radius (AFR):

The AFR method sets a fixed distance from a well, spring or tunnel, circumscribing a zone of equal distance around the well. It is used to define Zone 1 (**Accident Prevention Zone**) for wells completed in all types of aquifers (i.e. unconfined, semi-confined and confined) and flow conditions (i.e. diffuse and/or conduit flow). The AFR method is simple to apply and normally inexpensive.

As the name implies, the AFR technique is not based on in-depth knowledge of aquifer

properties or well characteristics, but rather considers existing regulatory drinking water supply set-back distances to establish the threshold for Zone 1. This gives the technique its virtue (simplicity), and its weakness (it may or may not afford adequate protection, resulting in either over-protection or under-protection of the drinking water supply). Since the AFR method is based on limited scientific criteria, the method has a degree of uncertainty attached to it.

Calculated Fixed Radius (CFR):

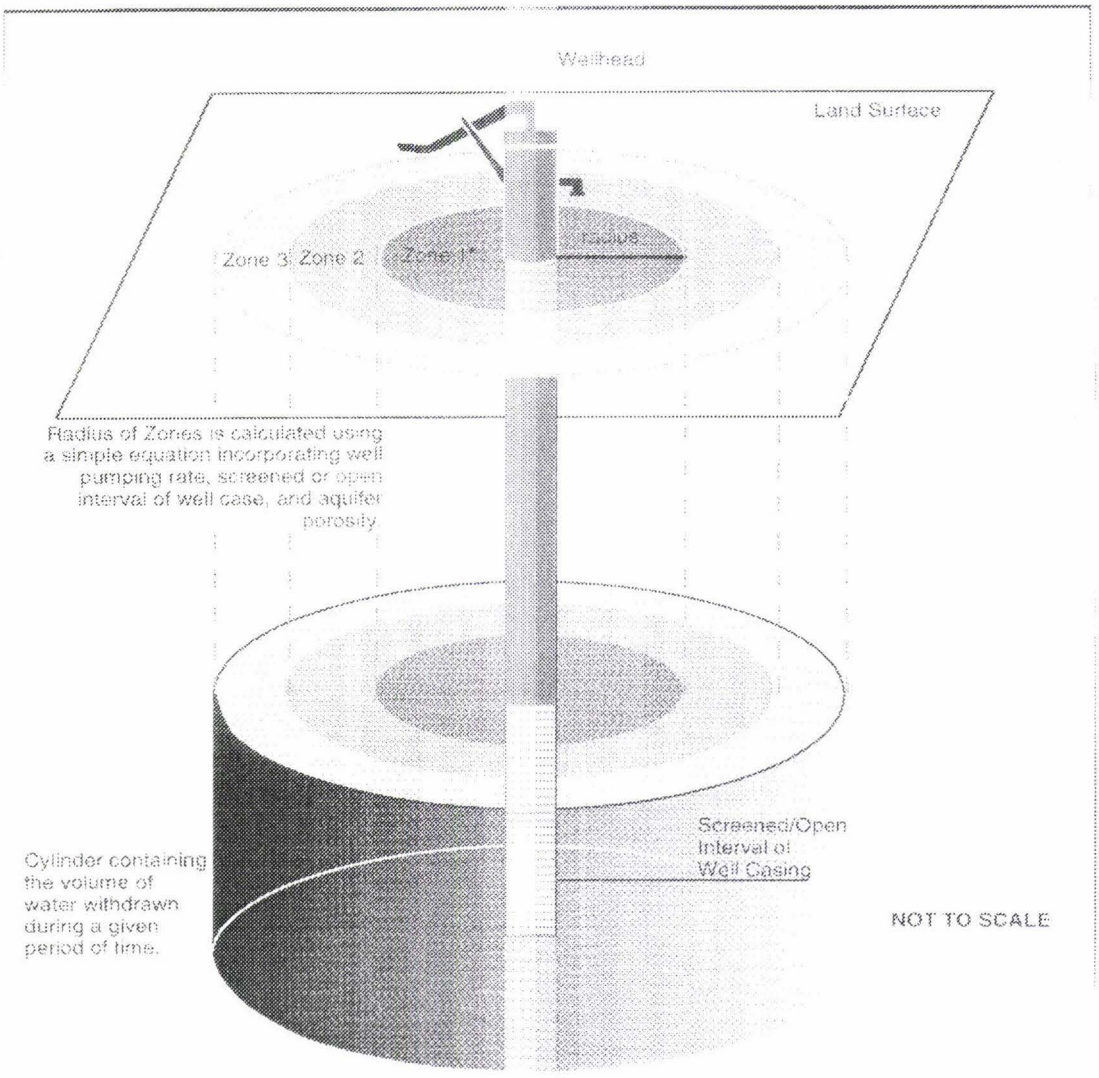
The CFR method is a relatively simplistic method that can be applied to many sources (i.e. wells, springs, tunnels) and is used to determine the circular areas (around the source) through which groundwater will travel over some period of time. The travel time of groundwater from the edge of the circle to the source well is dependent on the radius of the circle.

CFR is an appropriate method to use when groundwater flow to the well, spring or tunnel can be characterized as *'porous'* or *'diffuse'*, as opposed to *'conduit'* flow. Use Table II-1 (Section II of *Wyoming's Wellhead Protection Guidance Document*) to first determine if *'conduit'* flow conditions prevail; apply the CFR equation (Appendix D, Table D-1) to determine the 2 year and 5 year Time-of-Travel radii if *'porous'* or *'diffuse'* flow is confirmed when following Table II-1. If *'conduit'* flow is confirmed, refer to Table II-2 (Section II of *Wyoming's Wellhead Protection Guidance Document*) for instruction.

The CFR technique establishes a cylinder down into the aquifer where the radius of the cylinder is based on the Time of Travel (TOT) to the well; Table II-2 in Section II of this document establishes minimum TOT criteria (i.e. 2 years and 5 years) for using the CFR method to delineate Zones 2 and Zone 3 of the WHPA when *porous* or *diffuse* flow types prevail. TOT is an operationally defined measure of the rate of groundwater flow to the well, wellfield, spring or tunnel. The method is called the *"Calculated Fixed Radius"* (CFR) method because the area it describes is a circle, which has an equal radius in all directions. The radius is the distance from the well to a point where groundwater (and contaminant) travel time to the well is 2 years (or 5 years). Input data requirements are limited, consisting of the pumping rate, open (screened interval) of the well, porosity of the aquifer, and the selected TOT.

The CFR technique may not provide sufficient protection for the well-field. While it does take some aquifer properties into account, its tendency to generalize leads to errors, especially where the subsurface geology is markedly heterogeneous. Wyoming aquifers are frequently very heterogeneous, even on a relatively small geographic scale. An alluvial aquifer usually draws its water from alluvial type sediments which are often laced with pockets of cobbles, silt, and clay and may provide preferential flow paths or act as barriers to flow. Applying the CFR technique to wells completed in alluvium may not completely protect the wellfield from contamination arising from surface activity. For this reason, a **Factor of Safety (F.S.)** is incorporated in the CFR technique. Figure D-1 illustrates the CFR Method and Table D-1 provides the CFR equation and definitions of the required input data, including default values and Factors of Safety to be used for delineating Zones 2 and 3. An example of calculating the *annual average pumping rate* for a well follows Table D-1.

Appendix D



$$r = FS\sqrt{\frac{Qt}{7.48nH\pi}}$$

Where:
Q = Pumping Rate of Well
n = Aquifer Porosity = (See Table D-1)
H = Open Interval or Length of Well Screen
t = Time of Travel (2 years, 5 years)
F.S.(Safety Factor) = 1.3 if all values known
= 1.5 otherwise

*Note that for Zone 1, r = 50 or 100 feet
(See Table D-1 for more information)

Figure D-1
WYOMING WHP PROGRAM
ILLLUSTRATION OF A CALCULATED FIXED RADIUS MODEL

Appendix D

The 2 year (Zone 2) and 5 year (Zone 3) radii should be plotted, together with Zone 1, on a base map that shows major landmarks and topography. A 7 1/2 minute U.S. Geological Survey topographic map is generally acceptable. This is a map with a map scale of 24,000:1 or approximately 2.5 inches per mile. A map with a larger scale (3 to 4 inches per mile) is preferable in order to locate and identify potential contaminant sources that will be added to the map.

Table D-1
Calculated Fixed Radius (CFR) Equation, Definitions and Default Values

Calculated Fixed Radius Equation:	$r = FS\sqrt{\frac{Qt}{7.48nH\pi}}$
r_{min}	*Radius* of Zones 2 (and 3) measured from the well (in feet).
Q	*Annual average pumping rate* in gallons per year. Calculate or estimate as accurately as possible; should not be less than 5,000,000 gallons/year.
t	*Time-of-Travel* = 2 years for Zone 2; 5 years for Zone 3
n	*Porosity* (Ratio of pore volume in aquifer to total volume) Use actual value if known. If aquifer lithology is known, but not porosity, use: Fractured Shale or Fractured Crystalline Rock (Diffuse Flow) 0.02 Fractured Soluble Rocks (e.g. Limestone) (Diffuse Flow) 0.05 Sandstone or Glacial Till 0.15 Fractured Sandstone (Diffuse Flow) 0.17 Alluvium, Gravels, Sands, and Unconsolidated to Partially Consolidated Sandstone and Conglomerate 0.25
H	*Screened or perforated interval*[1] of well (feet). Actual Length, or 10 feet.
π	*pi* = 3.1416
7.48	*Conversion factor*: Gallons to ft^3.
F.S.	*Factor of Safety:* (to provide 'Buffer Zone') = 1.3 (when all values are known) = 1.5 (when one or more values is not known)

1 "Screened Interval" refers to the length of screening or perforation in the well through which water is pumped from the aquifer. If there is more than one screened interval, add the lengths together and use the sum for this value. For an unscreened well, the equivalent term is "Open Interval". This information may be available on the well log, the State Engineers' Office *Statement of Completion*, geologic or engineering reports. It is possible that the well has no screened (open) interval. If this is the case, or if you are unable to obtain this information, or for springs and tunnels, use a value of 10 feet.

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Example Calculation: Annual Average Pumping Rate

Use water meter data to perform this calculation if your source is metered. If your source is not metered, you will have to estimate your annual water volume (gal/year). If you know your pumping rate in gallons per minute (gpm) you can estimate annual usage in the following manner:

gal/min. x 60 min/hr x hr/day x day/year = gal/year

The next best method would be to substitute the value for pump capacity in place of pumping rate to estimate annual usage.

A third alternative would be to estimate your annual pumping based on the number of service connections on your system. For planning purposes, WDEQ/WQD considers 400 gallons a day per connection to be an average rate of consumption. This method works best for small community systems with single primary sources. With this method, the calculation would be:

# of service connections	X 400 Gallons per day per connection	X Average use days per year (365 for most)	= Estimated average pumping rate per year
50 connections	X 400 Gallons / day / connection	X 365 days / year	= 7,300,000 gallons / year

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Simplified Variable Shapes (SVS):

As detailed in Guidelines for Delineation of Wellhead Protection Areas (EPA-440/5-93-001), the SVS procedure involves generating a set of shapes that represent an array of hydrogeologic and pumping conditions. The variable shapes are calculated by computing the distance to downgradient and lateral extent of the groundwater flow boundaries around a pumping well according to analytical equations such as the uniform flow equations. The appropriate shape is then selected for the hydrogeologic and pumping conditions matching or similar to those found at the wellhead, and the shape is oriented around the well according to the groundwater flow patterns. A TOT or flow-system boundary criterion then determines the upgradient extent of the WHPA. The method is fairly easy to apply and requires little sophistication on the part of the modeler once the shapes have been defined. Data input is only slightly more involved than the CFR with the additional account of basic hydrogeologic parameters.

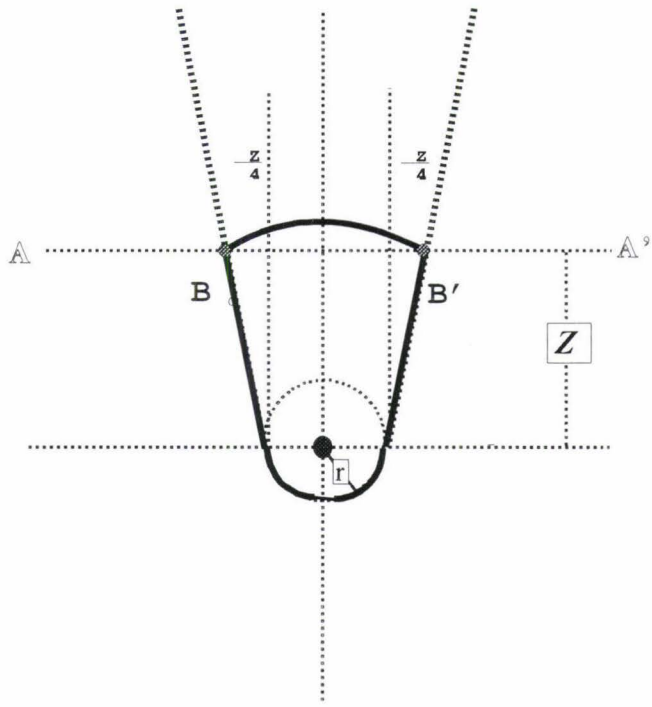
Where reasonable estimates of the hydraulic conductivity and hydraulic gradient can be determined (such as from median or conservative values cited in the literature, and generalized, regional potentiometric surface maps) a slightly more sophisticated method (Figure D-2) than the CFR may be employed. This **"Modified Simplified Variable Shapes"** method is particularly suitable for rural, non-community PWSs where site-specific data is limited, but regional or generalized information is available. The principle behind this method is in providing a factor of safety or buffer zone around what would be a good assessment of a WHPA if the data were more accurate, detailed, and reliable. For instance, in delineating a WHPA using the uniform flow equations (see Analytical Models below), the ZOC may be interpreted as a long, narrow band upgradient from the well. However, if the hydraulic gradient used in this delineation is over-estimated, the ZOC should be more circular and include more of the downgradient and lateral regions. In fact, as the hydraulic gradient goes to zero (stagnant groundwater), the CFR best estimates the ZOC. The Modified Simplified Variable Shapes method thus accounts for under-estimated hydraulic gradients by including a buffer zone in the upgradient direction, over-estimated hydraulic gradients by including a buffer zone in the downgradient direction, and poorly estimated flow lines by including a buffer zone defined by extending the region out 250 feet for every 1000 feet upgradient from the CFR. These buffer zones also serve as a factor of safety given uncertainty in the hydraulic conductivity value.

This method does not adequately represent aquifers with substantial hydrogeologic variability (heterogeneity) and does not take into account hydrologic boundaries such as irrigation canals, lakes, or streams. As previously described, flow in many Wyoming aquifers is affected by geologic and hydrologic boundary conditions. For example, the hydrology of some Wyoming community's water supplies is influenced by the irrigation canals upgradient and a major river downgradient. The degree of influence of these boundaries may vary seasonally as the water levels from these features change. Where hydrologic boundaries may exist, *Hydrogeologic Mapping and/or Field Test Data* should be employed to and applied to appropriately establish Zones 2 and 3 of the WHPA.

Figure D-2

Appendix D

Modified Simplified Variable Shape



To delineate a WHPA using the Modified Simplified Variable Shape method:

1) Draw a circle around the well using the Calculated Fixed Radius method (see Fig. D-1):

$$r = F.S. \sqrt{\frac{Qt}{7.48nH\pi}}$$

2) Draw a centerline though the well in the up-gradient direction of flow to determine the approximate distance of travel from the well ("*z*") using

$$z = \frac{Ki}{n} t$$

Appendix D

Table D-2
Modified Simplified Variable Shape method
Equation Constants

Equation Constants	Description
n	*Porosity* (Ratio of pore volume in aquifer to total volume) Use actual value if known. If aquifer lithology is known, but not porosity, use: Fractured Shale or Fractured Crystalline Rock (Diffuse Flow) 0.02 Fractured Soluble Rocks (e.g. Limestone) (Diffuse Flow) 0.05 Sandstone or Glacial Till 0.15 Fractured Sandstone (Diffuse Flow) 0.17 Alluvium, Gravels, Sands, and Unconsolidated to Partially Consolidated Sandstone and Conglomerate 0.25
K	Hydraulic Conductivity
I	Hydraulic Gradient
t	*Time-of-Travel* = 2 years for Zone 2; 5 years for Zone 3

3) Draw a line perpendicular to the centerline at a distance '*z*' from the centerpoint; label this line A-A'

4) Draw two lines tangent to the circle and parallel to the centerline. Where these cross line A-A', measure outward a distance z/4; show as points B and B'.

5) Draw tangent lines from B and B' to the circle.

6) Using the well as the centerpoint draw as arc from B to B'. (Hydrologic boundaries, when present, may provide this up-gradient boundary)

Appendix D

Analytical Models (AM)[1]:

The AM approach uses well established hydrologic equations to model groundwater flow and pollutant transport. A host of such analytical equations are available. The equations are generally fairly simple to solve but require a number of input hydrologic parameters which are generally assumed to be homogeneous throughout the saturated depth of the aquifer. This method tailors the results to a specific site through the use of the input parameters and, thus, can achieve considerable accuracy at a modest cost. Again, assumed subsurface uniformity may be a problem.

EPA's guidance document *"Delineation of Wellhead Protection Areas in Fractured Rocks"* contains good descriptions of established hydrologic equations such as the Uniform Flow Equation and TOT calculations based on groundwater velocity. These equations can be used to delineate WHPAs that are more sophisticated, accurate, and defensible than WHPAs delineated by the CFR method.

Despite the increase of accuracy and defensibility, there is always some level of uncertainty involved. This is especially true where analytical equations and models derive long and narrow WHPAs which have a high sensitivity to the position of the potentiometric contours. From the perspective of implementation, there is a significant problem with a narrow WHPA because a relatively small error in the potentiometric map can result in a major shift in the ZOC. Therefore, a factor of safety or "buffer zone" around WHPAs delineated by analytical equations and models is, again, a practice that is strongly encouraged. For example, a buffer zone may extend outward from the mapped ZOC boundary by 250 feet for every 1000 feet of distance upgradient from the well.

What follows is a list and brief discussion of analytical and semi-analytical computer software developed by EPA which uses hydraulic and groundwater flow equations to model WHPAs based upon time-of-travel criteria. Sources and contacts for additional information (including WHPA and W*h*AEM software and user guides) available for use in completing WHPA delineations and *Delineation Reports* are provided in Appendix C.

WHPA, version 2.2, is a semi-analytical groundwater flow model that consists of four computational modules designed to delineate WHPAs. This model was developed for the EPA Office of Groundwater Protection to assist communities in delineation of WHPAs. WHPA is thought to be an appropriate technique for many situations where the contaminant of interest is conservative. In other words, groundwater flow approximates solute movement in an unconfined, shallow aquifer. An example of the output from WHPA, version 2.2 for one of the

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1 Copies of the WHPA and W*h*AEM semi-analytical models, including instruction manuals can be obtained free of charge by sending requests to: NRMRL/SPRD, CSMoS, P.O. Box 1198, Ada, OK, 74821-1198, (405)-436-8594. Contact NRMRL for instructions prior to ordering. Models and manuals can also be downloaded off the Internet via NRMRL's Homepage at http://www.epa.gov/ada/kerrlab.html.

wells serving the City of Cheyenne (which taps the Ogallala aquifer) is depicted on Figure D-2. Three of the modules calculate capture zones for two-dimensional, steady state groundwater flow. The fourth module, called Monte Carlo, performs an uncertainty analysis of the delineated capture zone and is not individually discussed herein. The four modules are: (1) RESSQC, (2) the Multiple Well Capture Zone module (MWCAP), (3) the General Particle Tracking module (GPTRAC), and (4) the Monte Carlo module (Montec).

GPTRAC Option. The General Particle Tracking module (GPTRAC) contains two components, a semi-analytical and a numerical option. The numerical option is designed to be used as a post processor for numerical groundwater flow models. This option requires as input the hydraulic heads at nodes of the rectangular grid system. The head information is utilized to calculate x and y direction velocity components of groundwater flow at the edges of each grid block. Numerical integration of velocity components with respect to time and space is then applied to describe capture zones and streamlines.

The primary advantage of the numerical option is that a heterogeneous aquifer with complex boundary conditions can be considered. This method allows the aquifer to be divided into many zones with varying porosity, saturated thickness, and transmissivity in both the x and y directions. The numerical option delineates capture zones around pumping wells for steady state groundwater flow. Consequently, some assumptions are necessary as to the average daily pumping rates of municipal wells.

One shortcoming of this module is that it sometimes fails to produce reasonable results for smaller time-related capture zones. For simulation times less than three years, the capture zone pathlines sometimes do not conform to the regional hydraulic gradient. The EPA Office of Groundwater Protection recommends time periods of 10 to 25 years when determining time-related capture zones. It is necessary with this method to balance, when considering the lengths of simulation periods, the limited size of the study area and constraints of the model.

In conclusion, the GPTRAC numerical module appears to be the most versatile method. It is capable of delineating WHPAs for a heterogeneous aquifer(s) with a complex flow system. This module is limited only by the numerical model used to obtain the potentiometric head map.

The semi-analytical option assumes a system of pumping and injection wells that fully penetrate a homogeneous aquifer under steady state conditions. A constant-head or no-flow boundary can be specified along any edge of the study area. Well interferences are accounted for by superposition of solutions. Specifically, the input requirements include: (1) the regional hydraulic gradient, (2) the direction of groundwater flow, (3) porosity, (4) saturated thickness, and (5) transmissivity, etc. From the input information, it is evident that this module is best suited for a one-directional, homogeneous flow system with simple boundary conditions and a constant hydraulic gradient.

RESSQC Option. RESSQC is used to delineate time-related capture zones for a steady-state flow system including both injection and pumping wells in a homogeneous aquifer. Stream and

barrier boundaries can be implemented using image well theory. Well interferences arising in a multiple well system are determined by superposition. The primary disadvantage of this method is that aquifer flow parameters such as, hydraulic gradient and flow direction, are held as constants. The impermeable zones in a study area have to be simulated with image wells.

MWCAP Option. The Multiple Well Capture Zone module (MWCAP) is designed to delineate time-related capture zones for steady-state pumping wells in a homogeneous aquifer. Streams or boundaries can be simulated and are assumed to be linear and fully penetrating. Well interferences are neglected; each well is assumed to operate independently.

This module provides a little more flexibility, in some ways, than the RESSQC module discussed previously. Input parameters can be specified for each well rather than for the entire aquifer. Input requirements for each well include: (1) regional hydraulic gradient, (2) flow direction, (3) conductivity, (4) saturated thickness, (5) porosity, and (6) the boundary type and the perpendicular distance from the well.

WhAEM, also developed by EPA, has superseded and improves upon WHPA 2.2 and is an analytical groundwater model developed to determine time-of-travel capture zones in relatively simple hydrological settings for either confined or unconfined aquifers. WhAEM consists of two executables: the preprocessor GAEP, and the flow model CZAEM. GAEP is designed to simplify the procedures for getting data into a groundwater model; specifically it facilitates the interactive process of groundwater flow modeling that precedes capture zone delineation. WhAEM can handle fairly realistic boundary conditions such as streams, lakes and aquifer recharge due to precipitation.

The WHPA modeler must have some familiarity with the site being delineated and be able to use sound judgment in selecting input information from the range of hydrologic values likely to be available. Costs associated with obtaining input data are about the same as for the Simplified Variable Shapes (SVS) technique.

Hydrogeologic Mapping (HM):

HM identifies the physical and hydrologic features that control groundwater flow within an aquifer system. Included within this method is ***Flow-System Mapping*** which delineates the ZOC for a well, spring, or tunnel by identifying flow system boundaries. Physical boundaries to groundwater flow can include the geologic contacts that form the limits of the aquifer, structural features such as fault-block walls or zones of fracturing, and topographic features that may function as groundwater divides. Hydrologic features, including rivers, canals, and lakes can also function as flow-system boundaries.

Vulnerability Mapping is another HM technique which identifies areas particularly vulnerable to groundwater contamination. Such areas include shallow or exposed bedrock, permeable soils, faults zones, fracture zones, and karst features such as solution cavities and sinkholes. For the purposes of wellhead protection, it is most important to find the vulnerable areas where

contaminants potentially released at the surface may be most likely transported to the water supply. Vulnerability mapping does not necessarily produce a ZOC for a given well; used in combination with flow-system mapping however, it is an excellent method for assessing the susceptibility of more specific regions within the flow-system boundaries to groundwater contamination.

Aquifer 'sensitivity' maps are available for many Wyoming counties[2] and are excellent tools for identifying areas within WHPAs where the 'uppermost' aquifer is most 'sensitive', or susceptible to contamination from a release of a contaminant at the surface. Generally speaking, 'sensitive' areas within WHPAs may be considered to be vulnerable to contamination unless adequate protection measures (see Section IV of *Wyoming's Wellhead Protection Guidance Document)* are in place.

HM works well in regions where subsurface geology is variable, such as in fractured rocks, and where near surface boundaries occur. EPA (see EPA, 1991, *Delineation of Wellhead Protection Areas in Fractured Rocks*, EPA-570/9-91-009) suggests the flow-system boundary criterion is an excellent approach to use when hydrologic boundaries are close to a well, spring or tunnel; however, when boundaries are distant, EPA (1991) indicates the WHPA may be too large to manage effectively.

The information required for hydrogeologic mapping is available for most of the populated areas of the state. These include topographic maps, aerial photos, geologic and hydrogeologic maps and reports, well logs, geologic field reconnaissance data, and aquifer test data. Topographic maps suggest the location of groundwater divides in unconfined aquifers. Aerial photos can be used to locate faults and fracture traces; infrared photos identify riparian vegetation that can indicate the extent of an unconfined alluvial aquifer. Hydrogeologic maps and reports contain information on aquifer parameters such as gradient, transmissivity, direction of flow and hydraulic conductivity. Geologic reports show outcrop areas and strike and dip of aquifer formations; they also show the location of faults, synclines and anticlines. Well logs contain a description of aquifer materials, evidence of fracturing, well completion, pump test, depth of the well and static water level.

Professional geologic/hydrogeologic training and experience is required on the part of the investigator to interpret all mapping data. For example, hydrogeologic investigations in fractured rock aquifers typically requires two approaches to fracture characterization. The discrete approach requires investigating each individual fracture. Conversely, the continuum approach assumes the fractured medium approaches a porous medium at some working scale. The mapping data may not be sufficiently detailed to accurately reflect the subsurface conditions. Costs accrued in obtaining required hydrologic knowledge will vary with the complexity of the subsurface lithology. An example of a WHPA delineated using HM is depicted on Figure D-3 for a PWS in the Overthrust Belt area near southwestern Wyoming.

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[2] Contact the Wyoming Water Resources Center or WDEQ/WQD (Appendix C) for information on availability and ordering.

Appendix D

Aquifer ***Field Tests*** also can provide information useful for the characterization of aquifer (and well) flow systems and boundary conditions. While not exclusively a subset of the *Hydrogeologic Mapping* method, scientists and engineers can often delineate WHPAs from field test data and observations. For further descriptions and additional information on these types of tests and the results they produce, please refer to the EPA document referenced above.

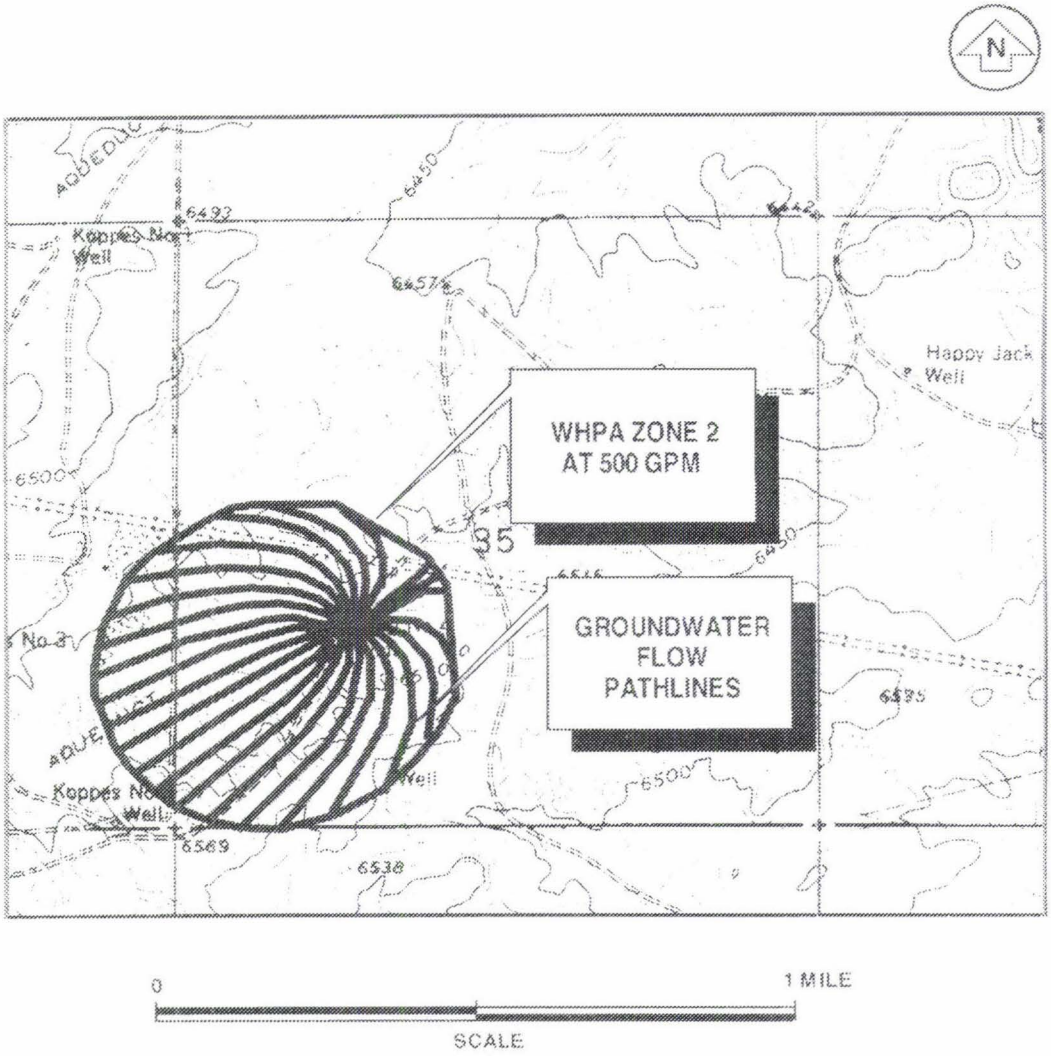

Figure D-3
EXAMPLE OF EPA MODEL
CITY OF CHEYENNE BOARD OF PUBLIC UTILITIES
KING No. 4 WELL

Appendix D

Numerical Models (NM):

Numerical models allow intricate subsurface conditions and hydrologic features to be represented with a fair degree of accuracy. Some models may use analytical models to depict contaminant transport, affixing the analytical transport model to the numerical flow model which includes advection and dispersion processes within the aquifer. The models demand a considerable amount of input information, particularly if they have analytical components. If the model is to be accurate, the number of grid cells needs to be numerous in regions where strong changes are occurring. This increases the overall cost of the modeling and may require the use of a mainframe or larger microcomputer. The modeler must be experienced in its use and be able to recognize the model's limitations and quirks. Generally, communities in Wyoming do not have people on staff with sufficient expertise to readily and accurately apply the NM technique, and an outside consultant would generally be needed in order to carry out numerical WHPA delineation studies.

WHPA Version 2.2: GPTRAC - Numerical Option. The General Particle Tracking module (GPTRAC) contains two components, a semi-analytical and a numerical option. The numerical option is designed to be used as a post processor for numerical groundwater flow models. This option requires as input the hydraulic heads at nodes of the rectangular grid system. The head information is utilized to calculate x and y direction velocity components of groundwater flow at the edges of each grid block. Numerical integration of velocity components with respect to time and space is then applied to describe capture zones and streamlines.

The primary advantage of the numerical option is that a heterogeneous aquifer with complex boundary conditions can be considered. This method allows the aquifer to be divided into many zones with varying porosity, saturated thickness, and transmissivity in both the x and y directions. The numerical option delineates capture zones around pumping wells for steady state groundwater flow. Consequently, some assumptions are necessary as to the average daily pumping rates of municipal wells.

One shortcoming of this module is that it sometimes fails to produce reasonable results for smaller time-related capture zones. For simulation times less than three years, the capture zone pathlines sometimes do not conform to the regional hydraulic gradient. The EPA Office of Groundwater Protection recommends time periods of 10 to 25 years when determining time-related capture zones. It is necessary with this method to balance, when considering the lengths of simulation periods, the limited size of the study area and constraints of the model.

In conclusion, the GPTRAC numerical module appears to be the most versatile method. It is capable of delineating WHPAs for a heterogeneous aquifer(s) with a complex flow system. This module is limited only by the numerical model used to obtain the potentiometric head map.

Other commonly used numerical models include MODFLOW, FLOWPATH, PLASM and SUTRA.

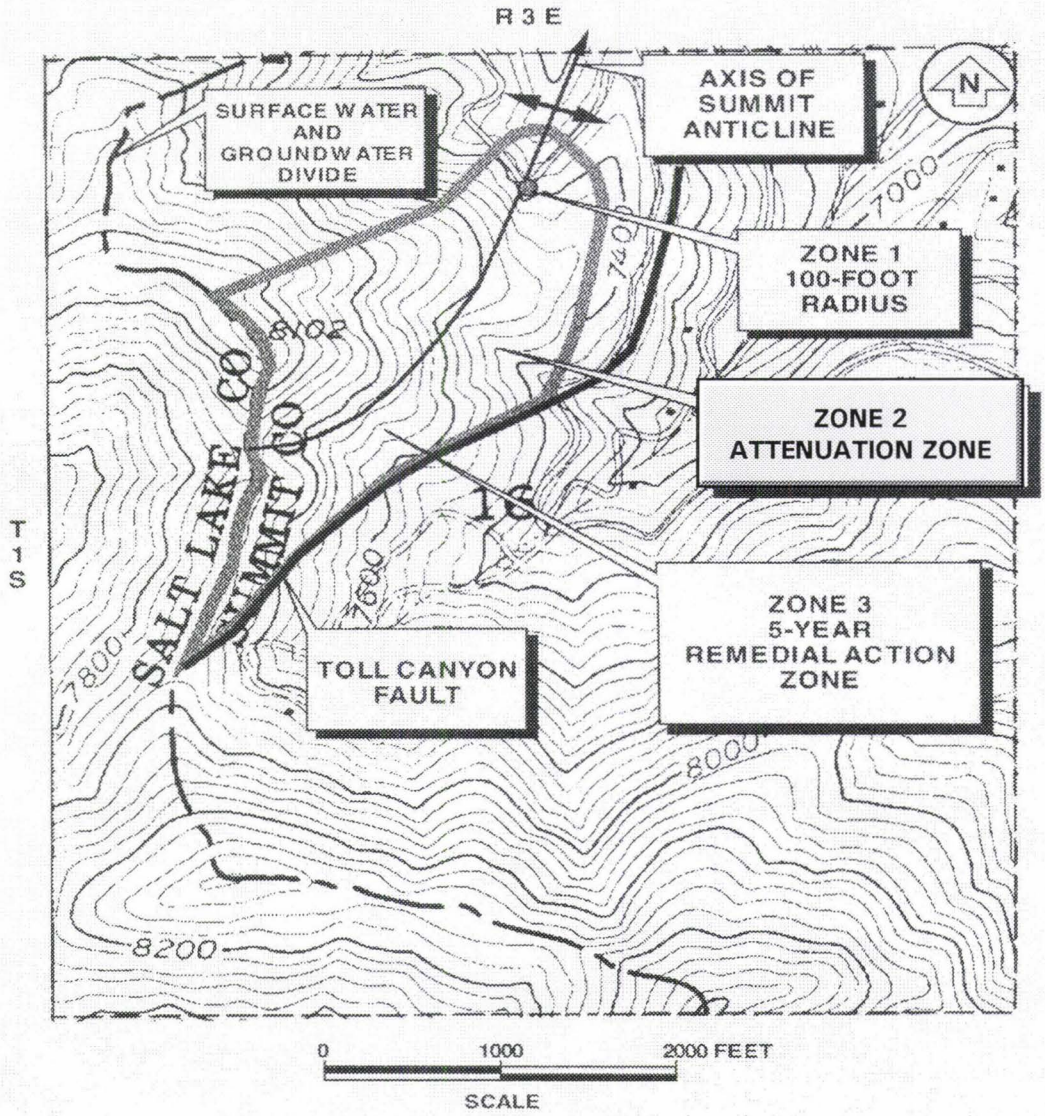

Figure D-4
WYOMING WHP PROGRAM
EXAMPLE OF WHPA ZONES USING HYDROGEOLOGIC MAPPING FOR PWS IN OVERTHRUST BELT

Appendix E

THE AQUIFERS AND AQUIFER SYSTEMS IN WYOMING: OVERVIEW OF GEOLOGIC AND HYDROGEOLOGIC SETTINGS IN WYOMING[1]

Wyoming is a diverse state in terms of physiography, geology and hydrogeology. As one drives across the state, it is obvious from the surface terrain that the State is composed of massive, rugged glaciated mountains interspersed with relatively featureless large sedimentary basins. The bulk of the Wyoming ranges are cored with Precambrian metamorphic and igneous rocks which constitute some of the oldest rocks in North America. Some of the mountains in northwest and northeast Wyoming are composed of Tertiary and Quaternary intrusive and volcanic rocks. The mountains are usually uplifted along deep seated faults which in many cases effectively sever the hydraulic continuity of the regional aquifers. Large thicknesses of sedimentary rocks overlie the Precambrian complexes and generally appear as asymmetrical synclinal basins interspersed between mountain ranges (see Figure E-1). These basins contain tens of thousands of feet of sedimentary rocks from Cambrian to Tertiary. Sedimentary formations generally are steeply dipping along the margins of the basins and flatten out a short distance from the mountain front. Locally, the relief is significant between the mountain ranges and the adjacent sedimentary basins. The diverse geologic features result in significant differences in the occurrence and availability of groundwater in the state.

Virtually all of the stratigraphic units in Wyoming basins play a hydrologic role either as a major aquifer, a minor aquifer, aquiclude or aquitard. Over 100 aquifers and aquifer systems have been identified within the State by Antcil (1994); however, many are limited in extent and yield only small amounts of water to wells and springs. The principal aquifer systems in the State include the unconsolidated alluvial deposits principally found along or adjacent to major drainages; semi-consolidated to locally consolidated sedimentary rocks forming the Tertiary aquifers; the consolidated sedimentary rocks (including carbonates) found within or flanking the structural basins and the Overthrust Belt of western Wyoming, and the crystalline and metamorphic rocks coring the mountain uplifts. Principal recharge of deeper aquifers is from basin margin outcrop areas, whereas more shallow aquifers receive recharge from outcrops, infiltration and vertical leakage between adjacent water-bearing units.

Figure E-2 depicts the generalized hydrostratigraphy of the State, along with a partial listing of Wyoming communities tapping the principal aquifers in the State. Note the majority of groundwater development in the State relies upon the alluvial aquifers situated along major drainages, the Tertiary aquifers, and the Paleozoic aquifer system.

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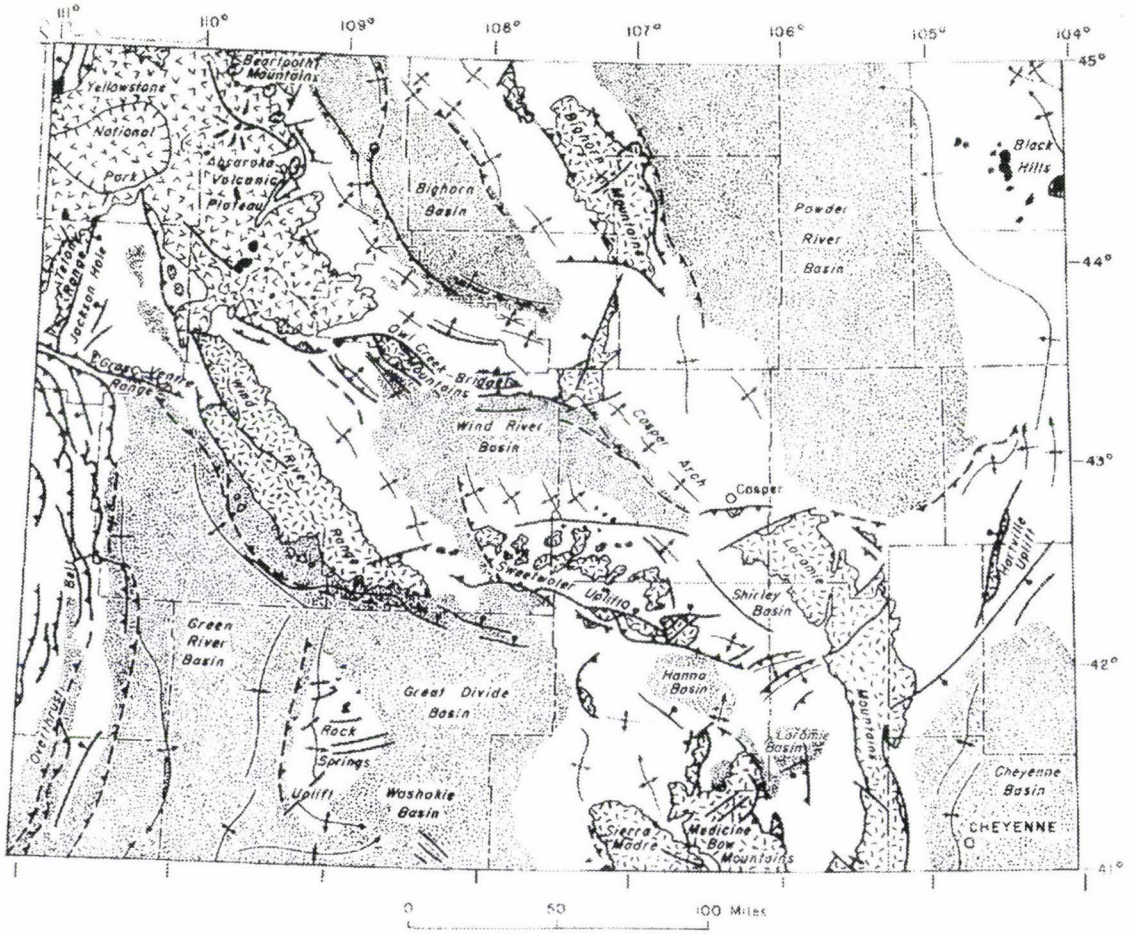
[1] For more detailed studies, the reader is referred to the comprehensive reports prepared by the Wyoming Water Resources Center at the University of Wyoming, that describe the occurrence and characteristics of groundwater in all basins involving most parts of the State of Wyoming. A listing of these reports, along with the principal aquifers developed in each basin is included in this Appendix. A summary of the hydraulic properties of the principal aquifers can also be found in this Appendix.



(Map courtesy of Geological Survey of Wyoming)

FIGURE E-1
WYOMING WHP PROGRAM
IDEALIZED GEOLOGIC MAP OF STATE OF WYOMING

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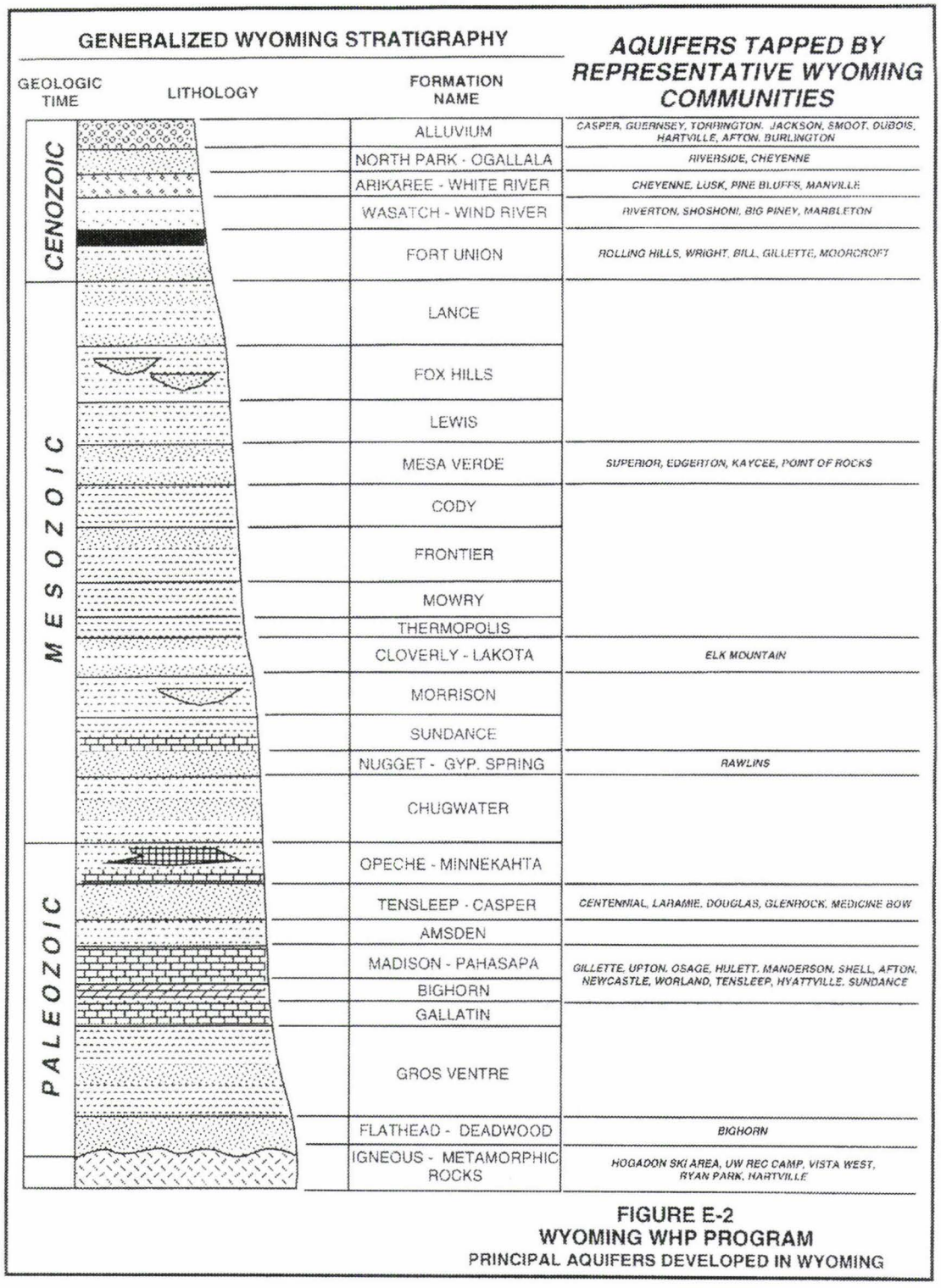

FIGURE E-2
WYOMING WHP PROGRAM
PRINCIPAL AQUIFERS DEVELOPED IN WYOMING

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Hydrogeologic conditions vary for the PWSs across the state. Well depths range from tens to thousands of feet below the land surface. The types and thicknesses of overlying materials that may protect the aquifer from contamination also vary. Variations in individual WHPA delineation methods and criteria will need to reflect these hydrogeologic differences.

Because of the diversity of the hydrogeology in the State of Wyoming, this section describes in summary form the major aquifers and/or aquifer systems of Wyoming. The purpose of this overview is to assist in first-order WHPA delineations by characterizing and documenting the hydrogeologic properties, water quality, availability, and use of the principal water-bearing units throughout the state.

The bulk of the following information has been adapted from Antcil (1994). Antcil completed extensive literature search of the available groundwater investigations, test data, and general stratigraphic and structural geology to identify currently-producing aquifers and those with a potential for development. No attempt was made to identify existing or potential groundwater availability or quality problems. These and other problems would be better addressed in more local studies.

By definition, the sedimentary and other rock sequences in the State that are comprised of permeable, water-saturated units which yield water to wells and springs are aquifers. Relatively impermeable rocks above and below aquifers are defined as aquitards, leaky aquitards, or confining layers. Aquifer systems refer to a series of stacked or serial aquifers that have similar hydraulic and geologic properties and are hydraulically connected, of reasonably large areal extent, and sealed from each other by regionally extensive confining layers.

HYDROGEOLOGY

There are three types of aquifers present in Wyoming, most of which have differing characteristics and requirements for evaluation, management, vulnerability and exploitation. In the state, unconfined aquifers consist of shallow flood plain (alluvial) and terrace deposits. Locally, glacial outwash deposits are important water-bearing units. Other unconsolidated bedrock deposits (such as the Ogallala Formation) can be several hundreds of feet deep and may be unconfined, semi-confined, and confined aquifers due to the complex stratigraphic architecture associated with deposition of the formation materials. Generally, these relatively shallow units are composed of sand, silt and gravel. These are the most vulnerable of all aquifers because of their shallow depths and general lack of laterally extensive confining layers.

Confined aquifers are those that exist within bedrock formations of differing permeabilities, such as sandstone or shale, and are stratigraphically bound by less permeable strata. As the water in these aquifers is under pressure greater than atmospheric, it causes water levels in wells to rise above the top of the confining unit in many instances. Often, a free-flowing artesian system is established. Groundwater from the confined aquifer may also discharge as a spring or from a flowing well, particularly those situated along an uplift or valley margin. These aquifers are the least vulnerable to human activities, except in special instances, such as penetration by a well which is poorly constructed or abandoned.

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Fractured bedrock or solution-enhanced karst systems constitute some of the most productive aquifers in Wyoming. However, groundwater time of travel can be rapid and may be several orders of magnitude greater than groundwater circulation in other aquifers, thus increasing the vulnerability of the aquifers to contamination. Post depositional tectonic forces created most of the enhanced hydraulic characteristics of fractured bedrock aquifers, whereas fresh water derived from the mountain highlands created solution-enhanced channels in the carbonate rock units.

Alluvial Aquifers:

The U.S. Geological Survey has established three criteria that are used to differentiate alluvial aquifers from other types of aquifers (see Heath, 1984): (1) the valleys contain sand and gravel deposits thick enough to supply water to wells at moderate to large rates; (2) the sand and gravel deposits are in hydraulic connection with a perennial stream which serves as a source of recharge and whose flow commonly exceeds the demand; and (3) the sand and gravel deposits occur in a clearly defined band (or channel) that normally does not extend beyond the floodplain and adjacent terraces (the width of the deposits is small compared with its length).

The alluvial aquifers of Wyoming fit these criteria and consist mostly of alluvial and terrace deposits that border the major rivers in the State. Those deposits of importance are located along the North Platte, the upper Snake, the Bear, and the Greybull Rivers. Antcil (1994) reports that at least five additional rivers systems have been classified as alluvial aquifers, but are mostly of local concern.

The North Platte is an interstate stream that begins in northern Colorado, flows northward into Wyoming to the general area of Casper where it loops southeastward and exits the state into Nebraska near Torrington. Alluvium along the North Platte constitutes the largest alluvial aquifer in the state in terms of length, drainage-basin size and water storage, and availability for agricultural, municipal and industrial uses. It is comprised of unconsolidated sand, silt, clay and gravel, the local mix of which provides a variety of geologic and hydrologic aquifer conditions. The principal Wyoming communities relying on the alluvium along the North Platter River as a water supply include the City of Casper, and the Towns of Guernsey, Hartville, and Torrington.

Alluvium deposited along other major rivers in Wyoming also serve as community water supplies derived from wells. The upper Snake River heads in the Teton National Park area and flows southward ultimately entering Idaho. The Town of Jackson wells may partially tap the alluvium and older sediments along the Snake River. The Wind River heads in the Wind River Mountains and flows southeast to the Bighorn River. Wells serving the Town of Dubois tap the alluvium along the Wind River. Many of the small communities in the Star Valley located in western Wyoming may partially tap the alluvium and deeper sediments along the Salt River. It is certain other communities rely on alluvium associated with other rivers and streams in Wyoming.

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High Plains Aquifer System:

Although the High Plains aquifer system underlies portions of eight states, in Wyoming it occurs only in the southeast quarter of the state. There it consists mostly of Tertiary and Quaternary sediments that are mostly unconsolidated with varying degrees of confinement by lower permeability strata. In general, the water-bearing strata in the upper portions of the aquifer are poorly consolidated and unconfined; the deeper water-bearing strata are typically more consolidated and semi-confined to confined by lower permeability strata.

Most groundwater in the High Plains aquifer system is found in the Ogallala Formation and the underlying Arikaree Formation. The Ogallala is generally unconsolidated and consists of poorly sorted silt, sand and gravel with minor clay, which becomes coarser and less cemented in the lower parts of the formation. The Arikaree rocks are predominantly massive, fine-grained sandstone with localized beds of other fine grained to amorphous sediments. The aquifer can exceed 1,000 feet in thickness in some places. Locally, the Oligocene Brule Formation is considered a part of the High Plains aquifer where it contains sandstones or secondary permeability in the form of karst or fractures. Representative Wyoming communities relying on this aquifer system include the City of Cheyenne, and the Towns of Lusk, Pine Bluffs, and Manville.

Wyoming Basins:

The asymmetrical structural basins of Wyoming are somewhat similar to one another in that surrounding tectonic elements are mountain uplifts cored by faults with up to several miles of structural offset. Precambrian igneous and metamorphic rocks are exposed as cores of the mountain uplifts with steeply-dipping Paleozoic sediments outcropping on their slopes. A variety of folds and faults can be found in the basin interiors. The principal anomaly to the structural style of the basins is the Overthrust Belt in the southwest corner of the state where a thick block of sedimentary rocks has been thrust eastward into the Green River Basin along low angle faults.

Virtually all of the stratigraphic units in Wyoming basins play a hydrogeologic role either as a major aquifer, a minor aquifer or a confining layer, which separate deep and shallow aquifer systems. Principal recharge of the deeper aquifers is from basin margin outcrop zones, whereas shallower ones receive recharge from outcrop areas, infiltration and vertical leakage from adjacent aquifers.

In most basins, hydrostratigraphic systems have been defined as water-bearing units consisting of possibly several formations. They are commonly adjacent units which have similar areal extent, hydraulic properties, water quality and are not separated by areally extensive confining units. Thick sequences of shales and siltstones usually separate the Paleozoic from the shallower Mesozoic and Tertiary aquifer systems. Exploitation of the deeper systems, particularly those with overlying highly productive aquifers, may limit the development of deeply buried production in the foreseeable future.

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Rather than repeat the information prepared on the individual Wyoming Basins by the Wyoming Water Research Institute (Water Resource Center), the key reference and important aquifers are summarized by individual basin:

Powder River Basin:

Feathers, K. R., Libra, R., and Stephenson, T. R, 1980, Occurrence and Characteristics of Ground Water in the Powder River Basin, Wyoming: University of Wyoming Water Resources Research Institute report to U.S. Environmental Protection Agency, Vol. I-A and I-B (1981), 203 pp., 8 plates.

Major aquifers identified within the Powder River Basin:

- Quaternary Deposits
- Wasatch/Fort Union Formations
- Fox Hill/Lance Formations
- Dakota Sandstone
- Madison Limestone

Denver-Julesburg Basin:

Libra, Robert D., Collentine, M., and Feathers, K. R., 1981, Occurrence and Characteristics of Ground Water in the Denver-Julesburg Basin, Wyoming: University of Wyoming Water Resources Research Institute report to U.S. Environmental Protection Agency, Vol. VII-A and VII-B, 101 pp., 8 plates.

Major aquifers identified within the Denver-Julesburg Basin:

- Quaternary Deposits
- Tertiary Aquifer System (Ogallala and Arikaree Formations)
- Lance Formation- Fox Hills Sandstone
- Discontinuous Mesozoic Sandstones
  (within the Pierre Shale, Niobrara Formation, Frontier Formation)
- Paleozoic Aquifer System
  (Hartville, Casper, Guernsey, and Flathead Formations)
- Precambrian Rocks (weathered surficial zones)

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Bighorn Basin:

Libra, R., Doremus, D., and Goodwin, C., 1981, Occurrence and Characteristics of Ground Water in the Bighorn Basin, Wyoming: University of Wyoming Water Resources Research Institute report to U.S. Environmental Protection Agency, Vol. II-A and II-B, 104 pp., 5 plates.

Major aquifers identified within the Bighorn Basin:

Quaternary Deposits
Upper Cretaceous-Tertiary Aquifer System
(Mesaverde, Meeteetse, Lance, Fort Union, and Willwood Formations)
Paleozoic Aquifer System
(Flathead Sandstone, Bighorn Dolomite, Madison Limestone, and Tensleep Sandstone)

Wind River Basin:

Richter, H. R., 1981, Occurrence and Characteristics of Ground Water in the Wind River Basin, Wyoming: University of Wyoming Water Resources Research Institute report to U.S. Environmental Protection Agency, Vol. IV-A and IV-B, 149 pp., 11 plates.

Major aquifers identified within the Wind River Basin:

Quaternary Deposits
Upper Cretaceous-Tertiary Aquifer System
(Mesaverde, Lance, Fort Union, Wind River, and Arikaree Formations)
Muddy Sandstone
Cloverly Group (Dakota and Lakota Sandstones)
Sundance Formation - Nugget Sandstone
Phosphoria Formation
Paleozoic Aquifer System
(Tensleep Sandstone, Amsden Formation, Madison Limestone, Darby Formation, Bighorn Dolomite, and Flathead Sandstone)

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Green River Basin and Overthrust Belt:

Ahern, J., Collentine, M, and Cooke, S., 1981, Occurrence and Characteristics of Ground Water in the Green River Basin and Overthrust Belt, Wyoming: University of Wyoming Water Resources Research Institute report to U.S. Environmental Protection Agency, Vol. V-A and V-B, 123 pp., 6 plates.

Major aquifers identified within the Green River Basin and Overthrust Belt:

Quaternary Deposits
Tertiary Aquifer System
(Late Tertiary sandstones and conglomerates, Fowkes, Bridger, Wasatch Formations)
Mesaverde - Adaville Formations
Nugget Aquifer System
Paleozoic Aquifer System
(Tensleep Sandstone, Madison Limestone, Darby Formation, and Bighorn Dolomite)

Great Divide and Washakie Basins:

Collentine, M., Libra, R., Feathers, K. R., and Hamden L., 1981, Occurrence and Characteristics of Ground Water in the Great Divide and Washakie Basins, Wyoming: University of Wyoming Water Resources Research Institute report to U.S. Environmental Protection Agency, Vol. VI-A and VI-B, 112 pp., 10 plates.

Major aquifers identified within the Great Divide and Washakie Basins:

Quaternary Deposits
Tertiary Aquifer System
(Wasatch, Battle Spring, Fort Union, and Lance-Fox Hills Formations)
Mesaverde Formation
Paleozoic Aquifer System
(Tensleep Sandstone, Madison Limestone, undifferentiated Cambrian rocks)

Laramie, Shirley and Hanna Basins:

Richter, H. R., 1981, Occurrence and Characteristics of Ground Water in the Laramie, Shirley, and Hanna Basins, Wyoming: University of Wyoming Water Resources Research Institute report to U.S. Environmental Protection Agency, Vol. III-A and III-B, 117 pp., 6 plates.

Major aquifers identified within the Laramie, Shirley, and Hanna Basins:

Tertiary Formations
Cloverly Group (Dakota and Lakota Sandstones)
Casper-Tensleep Formations

Appendix F

Susceptibility Assessment Form
(Version 1.0)

IMPORTANT! **When submitted by a *'Non-community'* Public Water System and approved by WDEQ, this form and its accompanying map illustrating the delineated Wellhead Protection Area (WHPA), may serve as that PWS's Wellhead Protection Plan. This form (and accompanying map) may not serve as a complete Wellhead Protection Plan for a *'Community'* Public Water System; *'Community'* systems must meet the requirements (i.e *WHPA Delineation Report*, etc.) identified in *Wyoming's Wellhead Protection Guidance Document,* including completion of this form, in order to obtain WDEQ approval of their Wellhead Protection Plan.**

Please complete one form for each groundwater source (well, spring, or tunnel) used in your Public Water System (PWS). Photocopy this form as necessary. Refer to Appendix G (Assistance Package) for details and instructions for completing this form.

Part I: System Information

Well owner/manager: _____

City: _____

County: _____

PWS Name: _____

PWS ID # (EPA): _____

Well depth (feet): _____

Source (e.g. well) name: _____

State Engineer's Office Permit No.: _____

Number of connections: _____ Population Served: _____

Township: _____ Range: _____ Section: _____ ¼, ¼ Section: _____

Latitude/longitude (if available): _____

How was lat./long. determined?

___ global positioning device ___ survey ___ topo. map other: _____

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Part II: Well Construction and Aquifer Characteristics Information

1. Date well originally constructed (month/day/year): _____

   Last re-construction (month/day/year): _____

2. Well driller: _____

3. Type of well:

Drilled	Rotary	Bored	Cable Tool	Dug	Springs	Ranney Collector	Driven	Jetted

   Other: _____

   Additional Comments: _____

   _____

4. State Engineer's Office (SEO) *Statement of Completion* report available?

Yes (attach copy to form)	No

   If no well log is available, please attach any other records documenting well construction, such as boring logs, "as-built" diagrams, engineering reports, or well reconstruction logs.

5. Average pumping rate: ___ gallons per minute (gpm).

   SEO adjudicated (permitted) pumping rate: ___ gallons per minute (gpm).

   Source of information: _____

   If not documented, how was pumping rate determined? _____

   _____

   _____

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6. Is this source treated?

Yes	No

If so, what type of treatment is used?

Disinfection	Filtration	Carbon Filter	Air Stripper	Other

Purpose of treatment (describe materials to be removed or controlled by treatment): ____

_____

7. Is source chlorinated?

Yes	No

Residual chlorine level:___ (Point closest to source)

8. Wellhead Elevation (feet above mean sea level): _____

How was wellhead elevation determined?

topo. map	altimeter	drill/well log

Other: _____

9. Depth to top of screened interval: ___ Feet below wellhead.

10. Depth to groundwater (static water level): ___ Feet below wellhead.

Flowing well/spring?

Yes	No

How was water level determined?

____ Well log Other: _____

____ Measured

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11. If the source is a flowing well or spring, what is the shut-in pressure?

_____ psi (pounds per square inch), or

_____ feet above wellhead

12. If source is a flowing well or spring, is there a surface impoundment, reservoir, or catchment associated with this source?

Yes	No

13. Confining layers: *(This question can be completed only for those sources with a drilling log, well log, or geologic/engineering report describing subsurface conditions).*

Is there evidence of a confining layer in the drilling log, well log, or geologic/engineering report?

Yes	No

If there is evidence of a confining layer, is the depth to groundwater more than 20 feet above the bottom of the lowest confining layers?

Yes	No

14. *'Accident Prevention Zone'* (Zone 1 of WHPA):

50 ft.	100 ft.

The criteria that determine an acceptable radius (i.e 50' or 100') of the *'Accident Prevention Zone'* (Zone 1 of WHPA) are established in Section II, *Wyoming's Wellhead Protection Guidance Document.*

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15. Wellhead control and access:

No wellhead control _____

Wellhead enclosed in a wellhouse: _____

Wellhead enclosed in a pitless adapter: _____

Controlled access (please describe):_____

_____

Other uses for wellhouse (please describe): _____

_____

16. Surface casing and annular seal:

Surface casing present? _____

Depth of surface casing: _____

Surface casing material: _____

Annular seal present? _____

Depth of annular seal: _____

Annular seal material: _____

17. Surface seal and well opening:

Surface (protective) casing present? _____

Height of surface casing above ground: _____

Surface casing material and diameter: _____

Well cap in place? _____

Well cap locked? _____

Surface seal present? _____

Surface seal material: _____

Length: _____

Width: _____

Thickness: _____

Condition of seal: _____

Seal slope away from casing? _____

Appendix F

Part III: Assessment of Water Quality

1. Indicate if any of the following potential contaminant sources listed on the Table are present within Zones 1, 2 or 3 of your Wellhead Protection Area (WHPA).

Type of Potential Source	Zone 1	Zone 2	Zone 3
Pesticide application			
Stormwater injection wells			
Other injection wells			
Abandoned water wells			
Abandoned oil wells			
Landfills, dumps, disposal areas			
Known hazardous materials clean-up site			
Known water quality problems			
Population density > 1 house/acre			
Septic systems, Cesspools, Outhouses, Privies			
Wastewater or sewage treatment lagoons			
Sites used for land application of sewage sludge or other wastes			

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If other recorded or potential sources of groundwater contamination (See Table III-1, *Wyoming's Wellhead Protection Guidance Document*) exist within the WHPA, please describe below (use additional sheets if necessary):

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2. Source-specific water quality records:

Please indicated the occurrence of any test results since 1986 that meet the following conditions:

A. Nitrate as N:

(Nitrate MCL = 10 mg/L)

	Yes
Results greater than MCL	
<2 mg/L nitrate	
2-5 mg/L nitrate	
>5 mg/L nitrate	
No nitrate sampling records	

B. VOCs:

(VOC detection level 0.5 μg/L)

	Yes
Results greater than MCL	
VOCs detected at least once	
VOCs never detected	
No VOCs sampling records	

C. SOCs (Pesticides, etc.):

	Yes
Results greater than MCL	
SOCs detected at least once	
SOCs never detected	
No SOCs sampling records	

If any SOCs were detected, please identify and date. Laboratory data sheets may be submitted in lieu of compiling list. If SOCs tests were performed, but no SOCs detected, list test methods here:_____

_____

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D. Bacteria contamination:

	Yes
Any bacterial detection(s) in past 3 years in samples collected from the source (not distribution sampling records)	
In past 3 years, has anyone found a bacteriological contamination problem in distribution samples that were attributed to the source?	
No bacteria sampling records	

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Part IV: Geographic or Hydrologic Factors Contributing to a Non-Circular Zone of Contribution

1. Is there evidence of a potential *hydrologic boundary* within the WHPA? (i.e. Does the boundary extend over a stream, river, lake, up a steep slope, or over a mountain or ridge?)

Yes	No

If yes, please mark and identify on your WHPA map; describe: _____

_____

_____

2. Aquifer Material:

A. Have drilling logs, well logs, geologic maps, aerial photos, geologic/engineering reports and/or aquifer/pump test data been reviewed and analyzed for the presence of *faulting, fracturing and karst conditions*, both within the aquifer as well as within any overlying strata or sediments?

Yes	No

Indicate which of the above have been reviewed; cite references used: _____

_____

_____

_____

_____

B. Do any of the information sources in (A) above indicate that the well is located in an area where the underground conditions are *fractured, faulted or karst*?

Yes	No

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3. Do any of the information sources in 2(A) above indicate that the well is located in an area where the underground conditions are primarily identified as *coarse sand and gravel*?

Yes	No

4. Are there other *high-capacity wells* (municipal, agricultural, and/or industrial) located within the WHPA?

Yes	No

A. Presence of groundwater extraction wells pumping more than approximately 500 gallons per minute within . . .

	Yes	No	Unknown
Zone 1			
Zone 2			
Zone 3			

B. Presence of groundwater recharge wells (e.g. drainage wells, etc.) or heavy irrigation within...

	Yes	No	Unknown
Zone 1			
Zone 2			
Zone 3			

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Please identify or describe *additional hydrologic or geographic conditions* that you believe may affect the shape of the WHPA for this source. Where possible, reference them to their location on the map.

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Part V: Potential Source Hazards, Controls, Assessment, and Management

Only *'Non-Community'* Public Water Systems need to complete this part.

Name and describe the management strategy (or strategies) you are planning to implement to help reduce the potential for contamination of the drinking water supply by the potential contamination source(s) located within the Wellhead Protection Area (WHPA). Also, please include the date you will begin implementation of each strategy. Complete this form for each potential contamination source.

* Plan additional controls for inadequately controlled potential contamination sources.
* Set an implementation date for each additional control.

Example:

Potential Contamination Source: Residential sources of pesticides and fertilizers

Existing Controls: Manufacturers' guidelines prescribe safe handling and application of chemicals.

Adequately managed? No, highly vulnerable aquifer thought to require additional controls.___

Strategy 1: Acme Lawn Care - Description: Establish an agreement for them to install spill protection in their bulk mixing area.

Implementation Date: 3/15/95

Strategy 2: Public education - Description: Issue an educational brochure to homeowners about the proper use of pesticides and fertilizers within source protection areas.

Implementation Date: *4/21/95*

Potential Contamination source:_____

Existing Controls:_____

_____

_____

Adequately Managed? _____

Strategy 1: _____ Description: _____

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_____

_____

_____ Implementation Date: _____

Strategy 2: _____ Description: _____

_____

_____

_____ Implementation Date: _____

*** Keep Records**

File Copies of all public education programs, letters, memoranda of agreement, memoranda of understanding, permits, etc., for this potential contamination source behind this cover sheet.

NOTES: _____

_____

_____

_____

_____

_____

_____

_____

_____

Appendix F

Part VI: Contingency Planning

Emergency Contractors (list names and phone numbers):

Pump Servicing Contractor: _____

phone: _____

Well Drilling Contractor: _____

phone: _____

Heavy Equipment Operator: _____

phone: _____

Water Treatment Chemical Supplier (e.g., chlorine supplier): _____

phone: _____

Bottled Water Supplier: _____

phone: _____

County Emergency Coordinator: _____

phone: _____

Technical Consultants (e.g., geologist, engineer): _____

phone: _____

List causes of last three water supply service interruptions, shortages or contamination events and briefly explain how each situation was resolved and steps take to prevent the recurrence of each:

1. _____

_____

2. _____

_____

3. _____

_____

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List the three most likely causes of future service interruptions, shortages, or supply contamination:

1. _____
2. _____
3. _____

List anticipated response(s) to the above scenarios:

1. _____
2. _____
3. _____

List steps that could be taken to lessen the possibility of the above scenarios occurring (e.g., provide back-up emergency power supply, installation of a backup well, etc.):

1. _____
2. _____
3. _____

List possible alternative water sources that could be used in the case of a service interruption or contamination event. (If the alternative is a nearby well, indicate whether it develops water from the same aquifer as main water supply well, if known.): _____

_____

List emergency funding source(s) that may be utilized to prevent interruption of the water supply or to restore the water supply. _____

_____

_____

Appendix G

Assistance Packet
(Susceptibility Assessment Form)

This form has been developed in order to help assess the susceptibility of your groundwater source(s) to potential sources of contamination. The Wyoming Department of Environmental Quality, Water Quality Division (WDEQ/WQD) will use the information on this form to evaluate geologic and hydrologic factors associated with each of your Public Water System (PWS) sources (i.e. well, spring or tunnel) in order to estimate the source's potential vulnerability to contaminants that are regulated under the Safe Drinking Water Act (SDWA).

IMPORTANT! **When submitted by a *'Non-community'* Public Water System (See Glossary) and approved by WDEQ, this form and its accompanying map illustrating the delineated Wellhead Protection Area (WHPA) may serve as that PWS's Wellhead Protection Plan. This form (and accompanying map) <u>may not</u> serve as a complete Wellhead Protection Plan for a *'Community'* Public Water System; *'Community'* systems must meet the requirements (i.e *WHPA Delineation Report*, etc.) identified in *Wyoming's Wellhead Protection Guidance Document,* including completion of this form, in order to obtain WDEQ approval of their Wellhead Protection Plan.**

Regardless of the type of Public Water System (Community, Transient Non-community, or Non-transient Non-community) the Susceptibility Assessment Form (Appendix F) must be completed and included as part of any Wellhead Protection Plan submitted to WDEQ for approval.

The information requested on this form may be gathered from a variety of records. Some information can be found on your *Statement of Completion and Description of Well or Spring (Form UW 6)* filed with the State Engineer's Office (SEO). Please take the time to verify this information. If this information is not current, please note any needed changes. Other useful records include your source and system monitoring records as well as system design plans, water right records, engineering and geologic reports, and water quality monitoring records. If your records are not complete, you may be able to obtain some of this information from the SEO, WDEQ/WQD, or the Wyoming Water Development Commission.

Many of the questions request information about the construction of your well. If your water system utilizes only springs or tunnels, you should still complete the Susceptibility Assessment Form; simply leave blank those questions which do not apply.

Incorrect information or incomplete forms may raise your susceptibility risk evaluation. For these reasons it is important that you take some time to complete the form to the best of your ability. You may not have all of the information that is requested on the form. You may indicate "information unavailable/unknown" in response to certain queries if this is the case.

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EPA and Vulnerability:

In 1986 Congress passed amendments to the Safe Drinking Water Act (SDWA). These amendments have been implemented in phases. The most recent phases to be implemented are Phase II and Phase V monitoring requirements which went into effect between 1993 and 1995. Phase II and V deal mainly with monitoring for volatile organic and synthetic organic compounds (VOCs and SOCs). Under Phase II & V the monitoring requirements for these compounds are significantly increased for Public Water Systems (PWS). Realizing that the increased monitoring requirements can be very costly to water systems, EPA has allowed PWSs to reduce or waive monitoring requirements depending upon how vulnerable the water system's sources are to contamination. That is, those sources which are vulnerable to contamination may have more monitoring requirements while those sources that are less vulnerable may have reduced or no monitoring required for many chemicals.

What is Vulnerability?

Vulnerability can be thought of as a water source's (e.g. well, spring or tunnel) potential for contamination. Vulnerability is composed of two factors: the physical susceptibility to the infiltration of contaminants; and the source's risk of exposure to contaminants. Susceptibility is determined by conditions that affect the movement of contaminants from the land surface into a water supply. This would include the depth of the well, its construction, the geology of the area, the pumping rate, the source(s) of groundwater recharge, and the aquifer material. The risk of exposure to contaminants is determined by whether or not contaminants were used in the area of a water supply.

Susceptibility Assessments:

In order to determine a drinking water source's vulnerability to contamination WDEQ/WQD has developed the Susceptibility Assessment Survey Form. This survey form catalogs key susceptibility factors for each source in order to evaluate overall susceptibility. The following information is needed to evaluate hydrologic susceptibility:

1) Well logs, or other indicators of aquifer characteristics,
2) Depth and length of open interval,
3) Date and description of construction,
4) Record of past monitoring results (nitrates, VOCs, SOCs, metals, and bacteria),
5) A specific (and accurate) location of the source,
6) Water level information,
7) Estimate of wellhead elevation,
8) A general evaluation of land-use surrounding the wellhead,
9) Size of the water system, and
10) Contingency planning.

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Monitoring Waivers:

Depending on the results of the susceptibility assessment, EPA may allow that some or all of the monitoring requirements (number and type of paramters, frequency of monitoring) for certain chemicals be waived. This type of waiver is considered to be a "susceptibility waiver". If source information does not allow a system to qualify for a susceptibility waiver, the system can pursue other types of waivers. One option, the Contaminant Use Waiver, involves a more intense inventory of the contaminants that may be found within the source's recharge area. "State-wide waivers" may also offer some monitoring relief. These are blanket waivers granted for chemicals not commonly detected in the state.

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PART I: System Information

With a few exceptions, all of the information in this section can be taken from your State Engineer's Office (SEO) *Statement of Completion (Form UW 6)*. The SEO should have a copy on file if your copy has been misplaced. Of particular concern is the information concerning source location and quarter/quarter section, and well depth. You should also note the population served and number of connections in this section; this information should be available from the water system records. Please use this opportunity to review your system records and make sure they are up-to-date.

There are optional items in this section. These include the State Engineer's Office permit number and a latitude and longitude location. If this information is not readily available, these areas can be left blank.

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PART II: Well Construction and Aquifer Characteristics Information

Most of the well information can be obtained from the *Statement of Completion* (Form UW 6 filed with the State Engineer's Office) and design plans that were prepared for the water system. In some cases the information may be found in other system records. Estimates can be made for some factors but these responses must be identified as estimates.

1) **Date Well Constructed/Reconstructed:**

   This information may be found in Item 8 on the SEO *Statement of Completion*. If you have multiple records representing reconstruction or redevelopment of the well, use the most recent one. Please include a copy of the well log (*Statement of Completion* - Item 13) with this form.

2) **Well Driller:**

   This can be found in Item 7 on the SEO *Statement of Completion*. Please enter the name and address if possible.

3) **Well Type:**

   Mark the type of well construction. It can often be found in Item 5 of the SEO *Statement of Completion*. If this area has not been filled in, please check system records.

4) **Well Report (Well Log):**

   This would include a driller's log, well log, or a detailed design that includes an engineer's "as built" along with a geologic log. The *Statement of Completion* items 6 and 13 should include a information regarding well construction and the well log(s) for your system if you cannot locate this information in your files. Please attach a copy to your response form.

5) **Average Pumping Rate:**

   This may be available from the system plan or from Item 9 of the SEO *Statement of Completion*. It is an estimate of the pumping rate in gallons per minute (gpm). If the current pumping rate is different than that listed on the *Statement of Completion*, or if documentation is absent, please explain how the pumping rate was determined.

6) **Source Treatment:**

   If your water source is treated in any way prior to delivery to your customers, please record that information here. Many water sources are not treated. Of those that are, chlorination (for disinfection) is the most common. Some other common types of water treatment include: other type of disinfection, filtration, fluoridation, or softening (to remove unwanted minerals or chemicals).

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It is possible that your system has more than one source that is combined prior to treatment. If that is the case, please record this information in the comment section.

7) Chlorine Residuals:

To be completed only for those sources that are chlorinated. If your system is chlorinated, please record the average chlorine residual for that source (within the distribution system). If more than one source is combined before treatment be sure to record the same information on both susceptibility assessments.

8) Depth to Top of Open Interval:

This is the depth to the top of the screen/perforated area of the well. If there is more than one screened interval, use the depth to the top of uppermost one. If the well is not fully cased use the depth to the bottom of the casing. This information is generally found on the SEO *Statement of Completion*, Item 6 or in an engineer's "as built" design report. If the well is cased but there is no screen(s) simply mark the depth to the bottom of the casing.

9) Depth to Groundwater:

On the SEO *Statement of Completion* this would be listed in Item 6. It is the static level of water in the well measured as the depth from the top of the well. It may be significantly different from either the depth of the well or the top of the open interval. If this information is not available on the well log, a current water level measurement can be used as an estimate. If the well is under pressure, or is a flowing well or spring, please mark the form accordingly.

10) Flowing Wells and Springs:

If this source is a flowing well (artesian or free flowing well) or is spring, is there a measure of the flowing or confining pressure? This is an alternative way to measure the aquifer pressure associated with a source. Some artesian wells and springs are under pressure and flow freely at the land surface without the aid of a pump.

This information may be listed in pounds per square inch (psi) or as a flow rate in gallons per minute (gpm). If the information is listed as a flow rate be sure it is not a pumping rate.

11) Surface Impoundments and Reservoirs:

If your source is a flowing well or spring, does it include a surface impoundment, reservoir, pond, catchment basin, or lake as part of its collection system? For this question, "surface impoundments" do not include dosed or covered spring boxes, but refer to impoundments that are open to the atmosphere.

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12) Wellhead Elevation:

This is the elevation above sea level of the top of the well casing (that extends above the ground). Sometimes this information can be found on the well log in part 8. An estimate can be made by altimeter or by using a topographic map and estimating the approximate elevation of the wellhead. Elevation can also be estimated relative to a nearby reference point. If an alternative method is used please explain how the estimate was made.

13) Confining Layers:

This section can only be completed with the use of a drilling log, well log, or geologic/engineering report. The log will show the depth, thickness and type of material that was encountered during drilling. These materials may be described in the log as cobbles, gravel, sand, rock, fractured rock, basalt, shale, till, hardpan, or clay. The log should also identify the strata that yielded water. They may be clearly identified or simply noted as "wet" or "seepage". Generally the most productive water bearing zone is where the well has been screened.

14) *'Accident Prevention Zone'* (Zone 1 of the WHPA):

Public Water Systems should establish a control zone (i.e. WHPA Zone 1) around the well that excludes major potential contaminant sources. Zone 1 is either a 50 foot or 100 foot radius around the well (See Section II, *Wyoming's Wellhead Protection Guidance Document*) but can be larger in some cases. This area should exclude buildings, roads, driveways, storage facilities, drainfields and other possible contaminant sources.

15) Wellhead Control and Access:

Note if there is a well-house constructed around the pump and wellhead built specifically to protect the wellhead. Is there controlled access to the wellhead (fenced area, locking cap or access port)? If the wellhead is housed in a building used for other purposes (storage of treatment materials, etc.), please describe.

16) Surface (or Inner) Casing and Annular Seal:

Surface casing and the annular seal of a well commonly extend some distance down the annular space (the space between the well casing and the borehole wall) to protect the well from direct infiltration of surface contaminants. Indicate the type and depth of the surface (or inner) casing and the annular seal.

17) Surface (Protective) Casing, Seal and Well Cap:

A protective casing installed above ground over the well helps to prevent infiltration of surface water into the wellbore during periods of flooding of high runoff; a protective concrete seal set at the surface, sloping away from the well is further protection against the

introduction of surface contaminants into the well. A locking well cap helps prevent unauthorized entry or tampering with the source.

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PART III: Assessment of Water Quality

The purpose of this section is to evaluate existing evidence of water quality problems in your specific water supply source(s) and to inventory possible threats to future water quality in order to minimize the risk of future contamination.

1) Regional Sources of Risk to Groundwater:

Please indicate if any of the following potential contaminant sources listed on the Table are present within Zones 1, 2 or 3 of your Wellhead Protection Area (WHPA).

***'Non-Community'* PWSs**: Mark and identify the potential sources on the WHPA map, together with other potential sources (see Table III-1, *Wyoming's Wellhead Protection Guidance Document*) within your WHPA.

***'Community'* PWSs**: Mark and identify the potential sources on the WHPA map, together with other potential sources in your 'Contaminant Source Inventory' (see Section III, *Wyoming's Wellhead Protection Guidance Document*).

"Pesticide application" refers to those areas, excluding residential areas, where pesticides, hebicides, insecticides, etc. are commonly applied. Examples include agricultural land, managed forest land, nurseries, and recreational areas (golf courses, parks), all with areas greater than about 2 acres. Also consider right-of-ways (state/county highways, railroads, electric/telephone lines) where herbicides are applied and mosquito/vermin control areas. State and County Public Works Departments, County Weed and Pest Control Offices, and County Agricultural Extension Offices can often supply much of this information.

"Other injection wells" can include French drains (stone-lined pits or trenches) into which liquid waste is poured and allowed to percolate into the ground.

Local governments and health departments may also be able to provide information concerning known contaminant sources such as landfills, clean-up sites, permitted waste discharge sites and businesses or industries that store or dispose of significant quantities of hazardous waste materials in the immediate vicinity of your water supplies (service stations, auto shops, dry cleaners, chemical manufacturing/processing, etc.). This information may also be obtained by contacting WDEQ-Division of Solid and Hazardous Waste. Telephone numbers of municipal and county agencies can be found in the government listings in the White Pages of your telephone directory; state agency contacts are provided in Table III-2 of *Wyoming's Wellhead Protection Guidance Document*.

If you are unable to obtain sufficient information from public agencies to respond to this question, a simple alternative is to identify the area on a local map and complete either a walking or driving survey of the area, noting potential sources of contamination as discussed in Section III of *Wyoming's Wellhead Protection Guidance Document*.

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2) **Source Specific Water Quality Records:**

The following four sections will require the review of your water quality testing records. Of primary interest are any records indicating past water quality problems for your source(s) since 1986.

A) **Nitrate Monitoring History** - The U.S. EPA Maximum Contaminant Level (MCL) for nitrates plus nitrites (as Nitrogen) is 10 mg/l. Levels between 5 and 10 mg/l may indicate some nitrate leaching from surface sources. Note in the appropriate boxes whether you have had nitrate detections below the MCL.

B) **Volatile Organic Compounds (VOCs)** - MCLs vary for each VOC. Use EPA or lab notification of MCL violations. Total Trihalomethane (TTHM) data should not be considered here.

C) **Synthetic Organic Compounds (SOCs)** - If you have completed any pesticide monitoring the results should be recorded in this section.

D) **Bacterial Contamination** - Use coliform monitoring records to respond. IMPORTANT: The main emphasis in this set of questions is to identify those water sources that have a history of source related bacterial contamination. Most of the current bacterial testing is done within a system's distribution system and not at the source. Bacterial contamination in the water system does not necessarily indicate contamination of the groundwater source.

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PART IV: Geographic or Hydrologic Factors Contributing to a Non-Circular Zone of Contribution

The *Calculated Fixed Radius (CFR)* delineation method is simple and relatively easy to apply (see Appendix D); however, it is based on a number of assumptions concerning the aquifer and underground conditions. Very rarely are all of these assumptions true.

The following questions will help identify aquifer conditions which may not be accurately represented by the *Calculated Fixed Radius (CFR)* method; answer these questions only if you are a *'Non-Community'* PWS, or a *'Community'* PWS using the *Calculated Fixed Radius (CFR)* method to delineate the WHPA. If you answer 'Yes' to questions #1, 2(B), 3 or 4 you must either modify the WHPA accordingly or apply one or more alternative delineation methods (see Appendix D, *Wyoming's Wellhead Protection Guidance Document*) in order to obtain WDEQ approval.

1) Hydrologic Boundaries:

Hydrologic boundaries are natural features in the earth which shape groundwater flow patterns. Examples include surface streams, lakes, reservoirs, mountains, ridges and other steep changes in elevations. A topographic (topo) map is useful in determining whether such features are present within the circular area around your source(s) having a 5-year travel time radius. If possible, simply attach to this form a copy of such a map with your water source(s) marked and labeled.

Topo maps can be purchased locally throughout the state at map stores, camping stores, etc. You may need more than one map to include your WHPA. If you use a U.S. Geological Survey topographic map please use one that is based on a 7 1/2 minute scale.

2) Aquifer Material:

These questions help identify those sources that may be found in geologic conditions that may affect the source's overall susceptibility. An important consideration can be the nature of the material that makes up the underground environment and forms the aquifer. The information needed to answer these questions might be found in drilling logs, well logs, aerial photos, geologic maps or reports, or engineering reports of aquifer/pump test data and interpretations.

A) The *Calculated Fixed Radius* best applies to groundwater exhibiting *'porous'* or *'diffuse'* flow behavior, as opposed to *'conduit'* flow behavior. The presence of faulting, fracturing and karst conditions are often indicators that conduit flow exists. Have any of the above mentioned sources of information been reviewed and analyzed for the presence of *faulting, fracturing and karst conditions*, both within the aquifer as well as within any overlying strata or sediments?

B) Do any of the above mentioned sources of information reveal or indicate that the well

is located in an area where the underground conditions are *fractured, faulted or karst*?

3) **Groundwater Flow Type and High Horizontal Flow Rate:**

This question will help identify those wells that are located in settings that produce very high natural groundwater flow rates, such as those which often occur in areas where underground conditions include multiple or extensive stratification of coarse sand or gravel. These may be identified in the drilling logs as: gravelly sands, sands and gravel, cobbles, gravel, boulders, or pebbles and are often associated with alluvial fans and outwash deposits, fluvial flood plains and glacial outwash deposits. In these settings, it is possible that the area of contribution around the well is influenced more by the aquifer flow conditions than by the pumping rate of the well, and the WHPA may be highly elongated and not circular. Do any of the above mentioned sources of information reveal or indicate that the well is located in an area where these highly porous and transmissive conditions exist?

4) **High-Volume Wells:**

These types of activities can have a tremendous effect on the shape of the flow system providing groundwater to your source. Wells located near these types of activities may be influenced by them. Indicate if you are aware of other high-capacity groundwater wells (> 500 gal/min) located within the WHPA. Indicate if there are any large recharge wells (e.g.stormwater run-off, drainage wells, etc.) or large-scale irrigation wells within the WHPA.

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PART V: Potential Source Hazards, Controls, Assessment and Management

Only *'Non-Community'* Public Water Systems need to complete this part; *'Community'* PWSs must follow the guidelines set forth in Section IV of *Wyoming's Wellhead Protection Guidance Document.*

The ultimate objective of Wellhead Protection is to prevent groundwater contamination within the Wellhead Protection Area (WHPA). Therefore, management of potential contaminant sources (within the WHPA) is an essential component of Wellhead Protection. *Non-community PWSs* that submit this form (as their WHP plan) to WDEQ/WQD must describe the techniques that will be employed to manage and minimize the threats posed by the potential contamination sources identified

1) Management of Existing and Future Contaminant Sources:

As described below, varying levels of source management approaches are suggested based upon the potential of contaminant sources to impact the drining water supply (i.e. aquifer) or source (i.e. well, spring or tunnel). Public Water Systems should appropriately identify existing controls, assess the adequacy of existing controls, and propose management strategies for potential contaminant sources; on the form, indicate the strategies to be implemented and related information.

Regulatory Management Strategies:

- Source prohibition and permits;
- Subdivision regulations, and codes;
- Land use agreements;
- Tax incentives;
- Design and operating standards;
- Site plan review;
- Purchase of property and development rights;
- Zoning ordinances; and
- Inspectors at construction and drilling sites.

Non-Regulatory Management Strategies:

- Best management practices;
- Memoranda of understanding;
- Training;
- Water conservation programs;
- Household hazardous waste collection program;
- Public education programs (brochures, etc.); and
- Surface and groundwater monitoring.

Regulatory management strategies generally can afford a greater degree of protection, as

compared to non-regulatory methods. A more complete description of the applicability, including examples of these strategies is provided in Section IV and Appendices I and L of *Wyoming's Wellhead Protection Guidance Document*.

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PART VI: Contingency Planning (Non-Community PWSs Only)

Only *'Non-Community'* Public Water Systems need to complete this part; *'Community'* PWSs must follow the guidelines set forth in Section V of *Wyoming's Wellhead Protection Guidance Document.*

The purpose of this section is to address problems that Non-community Public Water Systems need to overcome in the event of water supply shortages or contamination incidents that may impact the system's ability to supply an adequate quantity of safe drinking water to the public. Contingency plans should focus on the identification of, and solutions for, problems that may arise if protective and preventative measures fail. Potential emergencies such as well, wellfield, or spring contamination, water shortages due to droughts, and interruption of water supply due to power outages or infrastructure failure should be identified and addressed in a contingency plan.

1) Contingency Plan Organization:

The formulation of the contingency plan can be substantially completed and implemented by the public water system. Broader contingency planning has been required since 1986 under the Federal Emergency Planning and Community Right-to-Know Act (SARA Title III). Title III establishes a network of State Emergency Response Commissions and Local Emergency Planning Committees charged with planning response to emergency releases of hazardous chemicals; local emergency response plans may provide a starting point for WHP contingency planning.

In formulating a contingency plan, the Non-Community PWS must address the following considerations: (1) existing system condition and the possible water system failure modes; (2) responsibilities during an emergency; (3) emergency response procedures and contacts; (4) development of new ground and surface water sources in case of long-term shortages or abandonment of contaminated supplies; and (5) sources of emergency funds and procedures for requesting and dispersing such funds. Chapter V of *Wyoming's Wellhead Protection Guidance Document* (Planning for the Future) can be referenced for more specific contingency planning, additional guidance and information.

Appendix H

SOURCE IDENTIFICATION FORM
(FORM III-1)

City/Town _____ Well Name _____
EPA PWS ID# _____ WHPA Zone # (1,2,3) _____
Form Completed By _____ Date _____
Type of Survey (i.e., windshield survey, personal interview, site inspection, etc.) _____
Name of Person(s) Interviewed _____

SITE INFORMATION:

Site Name _____ Owner/ Leaseholder _____
Phone # _____ Site Location/Address _____
Owner's/ Leaseholder's Address _____

NATURE OF PROPERTY:

Residential ___ Retail ___ Agricultural ___ Industrial ___ Government ___
Other ___

POTENTIAL AND KNOWN SOURCES OF CONTAMINATION

Using Table III-1 (Section III), list the *Facility Type (i.e. Agricultural, Residential, etc.)* and Contaminant Source (i.e. feedlot, septic system) code numbers (e.g. (K-0009)) for each source found at this site. Under quantity, indicate the number of each identified source present.

POTENTIAL SOURCE	CODE	QUANTITY	COMMENTS
1) (Example) Animal Feedlot	0006	1	Approximately 150 Head of Cattle
2)			
3)			
4)			
5)			
6)			

(Continued On Back)

whp/seciii-1.frm

(SKETCH OF SITE OR ADDITIONAL COMMENTS ON BACK)

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POTENTIAL SOURCE	CODE	QUANTITY	COMMENTS
7)			
8)			
9)			
10)			
11)			
12)			

Sketch of Site or Additional Comments:

Appendix I.

Summary of Wellhead Protection Tools[1]

	Applicability to Wellhead Protection	Land Use Practice	Legal Considerations	Administrative Considerations
Regulatory: Zoning				
Overlay GW Protection Districts	Used to map WHPAs. Provides for identification of sensitive areas for protection. Used in conjunction with other tools that follow.	Community identifies WHPAs on practical base/zoning map.	Well-accepted method of identifying sensitive areas. May face legal challenges if WHPA boundaries are based solely on arbitrary delineation.	Requires staff to develop overlay map. Inherent nature of zoning provides "grandfather"protection to pre-existing uses and structures.
Prohibition of Various Land Uses	Used within mapped WHPAs to prohibit known groundwater contaminants and uses that generate contaminants.	Community adopts prohibited uses list within their zoning ordinance.	Well-recognized function of zoning. Appropriate technique to protect natural resources from contamination.	Requires amendment to zoning ordinance. Requires enforcement by both visual inspection and on-site investigations.
Special Permitting	Used to restrict uses within WHPAs that may cause groundwater contamination if left unregulated.	Community adopts special permit "thresholds" for various uses and structures within WHPAs. Community grants special permits for "threshold" uses only if groundwater quality will not be compromised.	Well-recognized method of segregating land uses within critical resource areas such as WHPAs. Requires case-by-case analysis to ensure equal treatment of applicants.	Requires detailed understanding of WHPAs sensitivity by local permit granting authority. Requires enforcement of special permit requirements and on-site investigations.
Large-Lot Zoning	Used to reduce impacts of residential development by limiting numbers of units within WHPAs.	Community "downzones" to increase minimum acreage needed for residential development.	Well-recognized prerogative of local government. Requires rational connection between minimum lot size selected and resource protection goals. Arbitrary large lot zones have been struck down without logical connection to Master Plan or WHPA program.	Requires amendment to zoning ordinance.

1 This is Appendix C of *A Guide to Wellhead Protection*. Reprinted with permission from *A Guide to Wellhead Protection* by Jon Witten and Scott Horsley with Sanjay Jeer and Erin K. Flanagan, Planning Advisory Services Report 457/458 (Chicago: American Planning Association, August 1995).

Appendix I.

	Applicability to Wellhead Protection	Land Use Practice	Legal Considerations	Administrative Considerations
Transfer of Development Rights	Used to transfer development from WHPAs to locations outside WHPAs.	Community offers transfer option within zoning ordinance. Community identifies areas where development is to be transferred "from" and "to".	Accepted land-use planning tool.	Cumbersome administrative requirements. Not well-suited for small communities without significant administrative resources.
Cluster/PUD Design	Used to guide residential development outside of WHPAs. Allows for "point source" discharges that are more easily monitored.	Community offers cluster/PUD as development option within zoning ordinance. Community identifies areas where cluster/PUD is allowed (i.e., within WHPAs).	Well-accepted option for residential land development.	Slightly more complicated to administer than traditional "grid" subdivision. Enforcement/inspection requirements are similar to "grid" subdivision.
Growth Controls/Timing	Used to time the occurrence of development within WHPAs. Allows communities the opportunity to plan for wellhead delineation and protection.	Community imposes growth controls in the form of building caps, subdivision phasing or other limitation tied to planning concerns.	Well-accepted option for communities facing development pressures within sensitive resource areas. Growth controls may be challenged if they are imposed without a rational connection to the resource being protected.	Generally complicated administrative process. Requires administrative staff to issue permits and enforce growth control ordinances.
Performance Standards	Used to regulate development within WHPAs by enforcing pre-determined standards for water quality. Allows for aggressive protection of WHPAs by limiting development within WHPAs to an accepted level.	Community identifies WHPAs and establishes "thresholds" for water quality.	Adoption of specific WHPAs performance standards requires sound technical support. Performance standards must be enforced on a case-by-case basis.	Complex administrative requirements to evaluate impacts of land development within WHPAs.
Regulatory: Subdivision Control				
Drainage Requirements	Used to ensure that subdivision road drainage is directed outside of WHPAs. Used to employ advanced engineering designs of subdivision roads within WHPAs.	Community adopts stringent subdivision rules and regulations to regulate road drainage/runoff in subdivisions within WHPAs.	Well-accepted purpose of subdivision control.	Requires moderate level of inspection and enforcement by administrative staff.

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	Applicability to Wellhead Protection	Land Use Practice	Legal Considerations	Administrative Considerations
Regulatory: Health Regulations				
Underground Fuel Storage Systems	Used to prohibit underground fuel storage systems (UST) within WHPAs. Used to regulate USTs within WHPAs.	Community adopts health/zoning ordinance prohibiting USTs within WHPAs. Community adopts special permit or performance standards for use of USTs within WHPAs.	Well-accepted regulatory option for local government.	Prohibition of USTs require little administrative support. Regulating USTs require moderate amounts of administrative support for inspection follow-up and enforcement.
Privately Owned Wastewater Treatment Plants (Small Sewage Treatment Plants)	Used to prohibit Small Sewage Treatment Plants (SSTP) within WHPAs.	Community adopts health/zoning ordinance prohibiting SSTPs within WHPAs. Community adopts special permit or performance standards for use of SSTPs within WHPAs.	Well-accepted regulatory option for local government.	Prohibition of SSTPs require little administrative support. Regulating SSTPs require moderate amount of administrative support for inspection follow up and enforcement.
Septic Cleaner Ban	Used to prohibit the application of certain solvent septic cleaners within WHPAs, a known groundwater contaminant.	Community adopts health/zoning ordinance prohibiting the use of septic cleaners containing 1, 1, 1-trichloroethane or other solvent compounds within WHPAs.	Well-accepted method of protecting groundwater quality.	Difficult regulation to enforce even with sufficient administrative support.
Septic System Upgrades	Used to require periodic inspection and upgrading of septic systems.	Community adopts health/zoning ordinance requiring inspection and, if necessary, upgrading of septic systems on a time basis (e.g., every 2 years) or upon title/property transfer.	Well-accepted purview of government to ensure protection of groundwater.	Significant administrative resources required for this option to be successful.
Toxic and Hazardous Material Handling Regulations	Used to ensure proper handling and disposal of toxic materials/waste.	Community adopts health/zoning ordinance requiring registration and inspection of all businesses within WHPAs using toxic/hazardous materials above certain quantities.	Well-accepted purview of government to ensure protection of groundwater.	Requires administrative support and on-site inspections.

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	Applicability to Wellhead Protection	Land Use Practice	Legal Considerations	Administrative Considerations
Private Well Protection	Used to protect private on-site water supply wells.	Community adopts health/zoning ordinance to require permits for new private wells and to ensure appropriate well to septic system setbacks. Also requires pump and water quality testing.	Well-accepted purview of government to ensure protection of groundwater.	Requires administrative support and review of applications.
Nonregulatory: Land Transfer and Voluntary Restrictions				
Sale/Donation	Land acquired by a community within WHPAs, either by purchase or donation. Provides broad protection to the groundwater supply.	As nonregulatory technique, communities generally work in partnership with nonprofit land conservation organizations.	There are many legal consequences of accepting land for donation or sale from the private sector, mostly involving liability.	There are few administrative requirements involve in accepting donations or sales of land from the private sector. Administrative requirements for maintenance of land accepted or purchased may be substantial, particularly if the community does not have a program for open space maintenance.
Conservation Easements	Can be used to limit development within WHPAs.	Similar to sales/donations, conservation easements are generally obtained with the assistance of nonprofit land conservation organization.	Same as above.	Same as above.
Limited Development	As the title implies, this technique limits development of portions of a land parcel outside of WHPAs.	Land developers work with community as part of a cluster/PUD to develop limited portions of a site and restrict other portions, particularly those within WHPAs.	Similar to those noted in cluster/PUD under zoning.	Similar to those noted in cluster/PUD under zoning.

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	Applicability to Wellhead Protection	Land Use Practice	Legal Considerations	Administrative Considerations
Monitoring	Used to monitor groundwater quality within WHPAs.	Communities establish groundwater monitoring program within WHPAs. Communities require developers within WHPAs to monitor groundwater quality down gradient from their development.	Accepted method of ensuring groundwater quality.	Requires moderate administrative staffing to ensure routine sampling and response if sampling indicates contamination.
Contingency Plans	Used to ensure appropriate response in cases of contaminant release or other emergencies within WHPAs.	Community prepares a contingency plan involving wide range of municipal/county officials.	None.	Requires significant up-front planning to anticipate and be prepared for emergencies.
Hazardous Waste Collection	Used to reduce accumulation of hazardous materials within WHPAs and the community at large.	Communities, in cooperation with the state, regional planning commission, or other entity, sponsor a "hazardous waste collection day" several times per year.	There are several legal issues raised by the collection, transport, and disposal of hazardous waste.	Hazardous waste collection programs are generally sponsored by government agencies, but administered by a private contractor.
Public Education	Used to inform community residents of the connection between land use within WHPAs and drinking water quality.	Communities can employ a variety of public education techniques ranging from brochures detailing their WHPAs program, to seminars, to involvement in events such as hazardous waste collection days.	No outstanding legal considerations.	Requires some degree of administrative support for programs, such as brochure mailing, to more intensive support for seminars and hazardous waste collection days.

Appendix I.

	Applicability to Wellhead Protection	Land Use Practice	Legal Considerations	Administrative Considerations
Legislative:				
Regional WHPA Districts	Used to protect regional aquifer systems by establishing new legislative districts that often transcend existing corporate boundaries.	Requires state legislative action to create a new legislative authority.	Well-accepted method of protecting regional groundwater resources.	Administrative requirements will vary depending on the goal of the regional district. Mapping of the regional WHPAs requires moderate administrative support, while creating land use controls within the WHPAs will require significant administrative personnel and support.
Land Banking	Used to acquire and protect land within WHPAs.	Land banks are usually accomplished with a transfer tax established by state government empowering local government to impose a tax on the transfer of land from one party to another.	Land banks can be subject to legal challenge as an unjust tax, but have been accepted as a legitimate method of raising revenue for resource protection.	Land banks require significant administrative support if they are to function effectively.

Appendix J

Potential and Known Source Hazards, Controls, Assessment and Management (Form IV-1)

From Form III-1; ('Source Identification Form') for this Site/Address:

City/Town _____ Well Name _____
EPA PWS Name and ID# _____ WHPA Zone # (1,2,3) _____

Form Completed By _____ Site Name/Address _____
Date _____

Name and describe the potential or known source and the source management strategy used to reduce or eliminate the risk of contamination from this source. Highlight each known, or existing source where a release has been identified, or if the site is listed on one of WDEQ's contaminated site databases. For sites/sources listed on one of WDEQ's databases, the management strategy will be *"State Agency Oversight"*. For sites where a release has been identified but the site is not listed on one of WDEQ's databases, list the strategy as "?". Include the implementation date, or proposed implementation date for the management strategy. File one form for each site or address identified on the Source Inventory List.

Example:

Potential Source #:	#1
Priority Rank #:	#5 (or Medium)
Potential Source Type:	Abandoned Well
Strategy:	Contact property owner to request that well be properly plugged and abandoned. Follow up with contact or visit to confirm plugging.
Implementation Date:	July, 1996.

Potential Source #__: Priority Rank # ___. Potential Source Type: _____.
Strategy: _____
_____
_____
_____
Implementation Date: _____
Potential Source #__: Priority Rank # ___. Potential Source Type: _____.
Strategy: _____
_____
_____
_____
Implementation Date: _____
Potential Source #__: Priority Rank # ___. Potential Source Type: _____.
Strategy: _____
_____
_____
_____

(Continued on Back)

Appendix J

Potential Source #__: Priority Rank # ___. Potential Source Type: _____.
Strategy: _____
_____
_____
_____
Implementation Date: _____
Potential Source #__: Priority Rank # ___. Potential Source Type: _____.
Strategy: _____
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Implementation Date: _____
Potential Source #__: Priority Rank # ___. Potential Source Type: _____.
Strategy: _____
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Implementation Date: _____
Potential Source #__: Priority Rank # ___. Potential Source Type: _____.
Strategy: _____
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Implementation Date: _____
Potential Source #__: Priority Rank # ___. Potential Source Type: _____.
Strategy: _____
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Implementation Date: _____
Potential Source #__: Priority Rank # ___. Potential Source Type: _____.
Strategy: _____
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_____
Implementation Date: _____

Appendix K

WELLHEAD PROTECTION
1991 Public Education and Information Meetings

Cheyenne:	June 25
Wheatland:	June 26
Torrington:	June 27
Sundance:	July 1
Powell:	July 9
Worland:	July 10
Casper:	July 11
Riverton:	July 16
Rawlins:	July 17
Jackson:	July 18
Evanston:	August 15

Appendix K

Wellhead Protection Questionnaire

The following questions relate to issues associated with groundwater contamination, and the protection of Public Water System (PWS) drinking water supply wells and aquifers form contamination. The purpose of this survey is to help the Wyoming Department of Environmental Quality to better define the public's need and /or desire for wellhead protection, as well as preference for alternative methods to be considered if a Wellhead Protection Program is developed in Wyoming. Questions were prepared by staff from the Department of Environmental Quality's Water Quality Division with assistance from the Wyoming Water Research Center, University of Wyoming, and the EPA.

1. Please name the county in which you reside_____

2. Do you reside inside the city limits? YES NO

   If you answered yes to this question, please name the town/city in which you reside: _____

3. Please indicate the type of water supply from which you currently derive your drinking water:

   _____ Individual private well
   _____ Municipal (city) water supply
   _____ Non-municipal (water and sewer district, subdivision, trailer park) water supply
   _____ Unknown
   _____ Other (please list): _____

4. Do you feel that your community drinking water supply is in danger of contamination from

   a. Existing groundwater contamination YES NO
   b. Future groundwater contamination YES NO

5. Please indicate the source(s) of groundwater contamination which you believe have the potential to contaminate community drinking water sources (aquifers) and/or supplies (wells).

   _____ Point sources (i.e., underground storage tanks, above ground storage tanks, municipal landfills, hazardous waste sites, septic tanks and drain fields, leaky sewer lines, abandoned wells, feedlots)

   _____ Non-point sources (i.e., land application of waste, pesticide and fertilizer application, mining activities, construction activities, road salting)

Appendix K

6. Do you feel that your community should protect its public drinking water supply wells and/or aquifers from potentially hazardous or toxic contamination?

YES NO

7. Do you feel that your community needs to protect its drinking water supply wells and/or aquifers from potentially hazardous or toxic contamination?

YES NO

8. Should a Wellhead Protection Program be established in your community?

YES NO

9. Given the importance of groundwater supplies for drinking water, should the State impose the implementation of a Wellhead Protection Program if communities do not wish to participate?

YES NO

If you answered yes to this question, please indicate which community(ies) should be required to participate.

____ My community
____ All communities
____ Only communities with contaminated public drinking water wells
____ The state should not impose a Wellhead Protection Program on any community

10. For those communities that want a Wellhead Protection Program, should the State assist them in developing Wellhead Protection Programs?

YES NO

If you answered yes to this question, please indicate the form(s) of assistance they should receive.

____ Technical assistance
____ Financial assistance
____ Education/information aids (fact sheets, guidance documents, etc.)
____ Other (please list): _____

11. If technical assistance is requested, additional State funding would be necessary to provide technical staff to handle the increased work load. Would you support the use of additional State funding for technical staff?

YES NO

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12. Of those listed below, who should pay the costs associated with implementing a Wellhead Protection Program in those communities that want such a program?

    _____ The water user
    _____ The local city/county government
    _____ The State

13. In many instances, funding for treatment or replacement of contaminated drinking water supplies is inadequate or unavailable. At what level of government should new funding be developed to provide for treatment or replacement of contaminated drinking water supply(ies)?

    _____ The municipal water user should provide for treatment, or an alternative source of safe drinking water
    _____ The local city /county government should provide for treatment, or an alternative source of safe drinking water
    _____ The State should provide for treatment, or an alternative source of safe drinking water
    _____ Other (please list): _____

14. In many instances, funding for investigation and clean-up of groundwater contamination is inadequate or unavailable. If your community's drinking water supply well(s) and/or aquifer is contaminated by hazardous or toxic pollution, who should be responsible for paying to restore (clean-up) the groundwater?

    _____ The person(s) responsible should pay for restoration of the aquifer's water to its natural quality
    _____ The municipal water user should pay for restoration of the aquifer's water to its natural quality
    _____ The local city /county government should pay for restoration of the aquifer's water to its natural quality
    _____ The State should pay for restoration of the aquifer's water to its natural quality
    _____ Other (please list): _____

Appendix K

15. Which of the following management approaches seem reasonable to implement for protection of drinking water aquifers and wells?

____ **REGULATORY**
- ____ Permit programs
- ____ Enforcement
- ____ Zoning ordinances
  - ____ Land use control (to protect future well sites)
  - ____ Performance controls
  - ____ Operating controls

____ **NON-REGULATORY**
- ____ Best Management Practices (BMP's)
- ____ Public education
- ____ Planning
- ____ Land acquisition
- ____ Capital improvements
- ____ Environmental audits
- ____ Household hazardous waste collection
- ____ Abandon wells (which have been improperly constructed)

16. Who should do the delineations for the Wellhead Protection Areas in the community?

____ The public water systems operator
____ The local city/county government
____ The State
____ Other (please list): _____

17. Who should pay for the delineations of the Wellhead Protection Areas?

____ The water user
____ The local city/county government
____ The State
____ Other (please list): _____

18. Who should perform the contaminant source inventory in the community?

____ The public water systems operator
____ The local city/county government
____ The State
____ Other (please list): _____

Appendix K

19. Who should pay for the contaminant source inventory in the community?

____ The water user
____ The local city/county government
____ The State
____ Other (please list): _____

Additional Comments

_____

_____

_____

_____

_____

_____

_____

_____

_____

Thank you for taking the time to complete this questionnaire. Results from this survey will be available form the Department of Environmental Quality's Water Quality Division at a future date.

Appendix K

Results from the Wellhead Protection Survey

1. Questionnaire responses by county of residence:

Natrona	17	Big Horn	4
Teton	12	Crook	3
Fremont	10	Hot Springs	3
Park	8	Lincoln	3
Platte	8	Niobrara	3
Carbon	7	Sweetwater	3
Washakie	7	Albany	2
Unita	6	Laramie	2
Converse	5	Sublette	1
Goshen	5	Weston	1

2. Residence is or is not within city limits:

	Number	Percent
(Y)	60	56.6
(N)	46	43.4
Total	106	100.0

City/Town of Residence:

Casper	12	Edgerton	1
Powell	5	Gillette	1
Rawlins	5	Glendo	1
Glenrock	4	Jeffery City	1
Jackson	4	Laramie	1
Evanston	3	Lusk	1
Riverton	3	Medicine Bow	1
Wheatland	3	Newcastle	1
Worland	3	Opal	1
Cody	2	Sundance	1
Shoshoni	2	Thermopolis	1
Torrington	2	Wright	1
Cheyenne	1	Yoder	1
Chugwater	1		

3. Type of water supply from which you currently derive your drinking water:

	Number	Percent
Individual private well	30	26.5
Municipal (city) water supply	72	63.7
Non-municipal (water and sewer district subdivision trailer park) water supply	8	7.1
Unknown	0	0.0
Other	3	2.7
Total	113	100.0

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4. Do you feel that your community drinking water supply is in danger of contamination from

a. Existing groundwater contamination

	Number	Percent
(Y)	38	40.4
(N)	56	59.6
Total	94	100.0

b. Future groundwater contamination

	Number	Percent
(Y)	61	68.5
(N)	28	31.5
Total	89	100.0

5. Source(s) of groundwater contamination which you believe have the potential to contaminate community drinking water sources (aquifers) and/or supplies (wells):

	Number	Percent
Point sources	71	49.3
Non-point sources	73	50.7
Total	144	100.0

6. Community should protect its public drinking water supply wells and/or aquifers from potentially hazardous or toxic contamination:

	Number	Percent
(Y)	106	100.0
(N)	0	0
Total	106	100.0

7. Community needs to protect its drinking water supply wells and/or aquifers from potentially hazardous or toxic contamination:

	Number	Percent
(Y)	97	97
(N)	3	3
Total	100	100.0

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8. A Wellhead Protection Program should be established in your community:

	Number	Percent
(Y)	92	90.2
(N)	10	9.8
Total	102	100.0

9. State should impose a Wellhead Protection Program even if communities do not wish to participate:

	Number	Percent
(Y)	80	76.9
(N)	24	23.1
Total	104	100.0

If yes, communities that should be required to participate are:

	Number	Percent
My community	3	3.8
All communities	69	86.4
Only communities with contaminated public drinking water wells	7	8.8
The state should not impose a Wellhead Protection Program on any community	4	5.0
Total	83	100.0

10. The State should assist those communities who want to develop a Wellhead Protection Programs:

	Number	Percent
(Y)	103	98.1
(N)	2	1.9
Total	105	100.0

If yes, the form(s) of assistance received:

	Number	Percent
Technical assistance	92	89.3
Financial assistance	75	72.8
Education/information aids	95	92.2
Other	5	4.9
Total	267	259.2

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11. Do you support the use of additional State funding for technical staff for the Wellhead Protection Program:

	Number	Percent
(Y)	95	93.1
(N)	7	6.9
Total	102	100.0

12. Who should pay the costs associated with implementing a Wellhead Protection Program for those communities who want the program:

	Number	Percent
The water user	56	32.4
The local city/county government	63	36.4
The State	54	31.2
Total	173	100.0

13. Level of government that should develop new funding to provide for treatment of contaminated drinking water supply(ies):

	Number	Percent
The municipal water user	35	21.4
The local city/county government	57	35.1
The State	49	30.1
Other	22	13.4
Total	163	100.0

14. If the groundwater supply becomes or is contaminated, the responsible party to provide funds to restore (clean-up) the groundwater supply should be:

	Number	Percent
The person(s) responsible	80	45.1
The municipal water user	19	11.0
The local city/county government	23	13.0
The State	33	18.5
Other	22	12.4
Total	177	100.0

Appendix K

15. Reasonable management approaches to implement for protection of drinking water aquifers and wells:

REGULATORY	Number	Percent
Permit programs	64	37.8
Enforcement	43	25.5
Zoning ordinances	62	36.7
Total	169	100.0
Zoning ordinances	Number	Percent
Land use control	54	87.1
Performance controls	36	58.1
Operating controls	34	54.8
Total	124	200.0

NON-REGULATORY	Number	Percent
Best Management Practices (BMP's)	70	17.0
Public education	80	19.4
Planning	66	16.0
Land acquisition	30	7.3
Capital improvements	30	7.3
Environmental audits	41	9.9
Household hazardous waste collection	50	12.1
Abandon wells (which have been improperly constructed)	45	11.0
Total	412	100.0

16. Person responsible for doing the Wellhead delineations for the Wellhead Protection Areas in the community:

	Number	Percent
The public water systems operator	31	22.8
The local city/county government	59	43.4
The State	34	25.0
Other	12	8.8
Total	136	100.0

Appendix K

17. Person responsible to pay for the delineations:

	Number	Percent
The water user	50	31.3
The local city/county government	64	40.0
The State	37	23.1
Other	9	5.6
Total	160	100.0

18. Person responsible to perform the contaminant source inventory in the community?

	Number	Percent
The public water systems operator	35	23.0
The local city/county government	73	48.0
The State	36	23.7
Other	8	5.3
Total	152	100.0

19. Person responsible to pay for the contaminant source inventory in the community?

	Number	Percent
The water user	22	15.2
The local city/county government	70	48.3
The State	44	30.3
Other	9	6.2
Total	145	100.0

Appendix L

Sample Wellhead Protection Ordinance Provisions[1]

by

Sanjay Jeer, Senior Research Associate, APA

The provisions listed below are basic components for most wellhead protection ordinances. In deciding whether to include any of these provisions, you must answer two questions:

1) **Are these provisions permitted under your State enabling legislation?** Not all provisions are applicable in all states. Moreover, some states' enabling legislation allows such provisions to be part of the health or building codes instead of the zoning code, especially those that pertain to continuous compliance, monitoring, and emergency response. All provisions used in the wellhead protection ordinance must be permitted through enabling legislation or municipal charter.

2) **Are these provisions appropriate in the wellhead protection ordinance portion of the zoning code?** Often communities have general code provisions with overlapping intent that could be referenced in the wellhead provisions of the ordinance. Typically, such provisions are found in other groundwater or aquifer-protection-related standards. Cross-referencing such general provisions in the wellhead section of the ordinance may be sufficient if they are appropriate to the wellhead protection areas.

The provisions are organized into sections that are found in most zoning ordinances. Each section contains a statement of purpose followed by applicable notes. Where useful, a summary of key elements is also provided. Sample language is provided and is taken, wherever possible, from ordinances presently in use. These sample provisions are from zoning ordinances or special ordinances and tribal regulations that are similar to zoning enforcement and authority. They do not include wellhead protection standards that local governments typically maintain in other regulations, such as health regulations, or building and construction codes.

Note that these provisions are provided for illustration only and may be inappropriate or require significant modification to suit local needs.

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1 This is Appendix D of *A Guide to Wellhead Protection*. Reprinted with permission from *A Guide to Wellhead Protection* by Jon Witten and Scott Horsley with Sanjay Jeer and Erin K. Flanagan, Planning Advisory Services Report 457/458 (Chicago: American Planning Association, August 1995).

Appendix L

1. Title

Purpose: To give the ordinance a brief descriptive title.

Notes: The title should be specific to the scope of applicability (e.g., use Wellhead Protection District for a regular district or Wellhead Protection Overlay District for an overlay district). If wellhead protection is incorporated into an overall groundwater or aquifer protection district, the title sound reflect a general designation, such as Groundwater Protection or Aquifer Protection District, and make clear how the specific ordinance related to the overall plan.

If there are separate sets of regulations for the wellfields and the zone of contribution for the zone of recharge), use appropriate terms. For example, use Wellhead Operation District for wellfields, and Wellhead Protection District for the zone of contribution. Such distinctions should also be made in cases where the wellhead protection ordinance is not part of the zoning ordinance. Some of the common titles for wellhead protection provisions are:

Wellhead Protection District
[Cinton, Maine, Zoning Ordinance, 1993]

Wellhead Operation District (WO); and Well Field Protection Overlay District (WP)
[City of Dayton, Ohio, Zoning Ordinance, Sections 150.600 and 150.610, 1988]

Aquifer Protection District
[Town of Southington, Connecticut, Zoning Ordinance, Section 17, 1980]

Public Wellhead Recharge District
[Nantucket, Massachusetts, Zoning Ordinance, Section 139-12 B. 1986]

South Tacoma Groundwater Protection District
[Tacoma, Washington, Zoning Ordinance, Chapter 13.09. 1988]

For overlay-type zoning districts:

Water Source Protection Overlay District
[Minnehaha County, South Dakota, Zoning Ordinance, Article 11. 1991]

Aquifer Sensitive Area Overlay Zone
[(Spokane County, Washington, Zoning Ordinance, Section 4.16A, 1983]

Appendix L

2. Purpose and Intent

Purpose: To set forth the goals and objectives to be achieved through this ordinance.

Key Issues:

- Protection of public health, welfare, and safety
- Protection of groundwater resources from contamination
- Protection of groundwater resources from excessive extraction
- Management of land-use activities that store, handle, or produce regulated substances
- Encouragement of the use of best management practices (regulatory and nonregulatory) Protection of future groundwater sources of drinking water
- Recognition of local government responsibility in protection groundwater resources
- Encouragement for municipalities to work with neighboring communities for adequate protection of resource areas extending into other jurisdictions

Notes: In addition to stating public health, welfare, and safety concerns, include any special circumstances that are of particular importance to the community (e.g., the well or wellfield being the only source of public drinking water for the community?. The goals and objectives should be clearly stated and quantifiable, if possible. It is also necessary to make it clear if the ordinance applies to both public and private wells.

> *The purpose of the Wellhead Protection Ordinance is to protect the public, municipal water supply for the town of Norway from land uses which pose a threat to the quality and quantity of the groundwater being extracted from the Norway municipal well(s).*
> **[Town of Norway, Maine, Wellhead Protection Management Plan, October 1993]**

Provide separate purpose and intent statements for the resource or protection areas being addressed in the ordinance, such as the immediate area surrounding wells, or wellfields and the recharge area (or zone of influence) if there are separate zoning district for each zone. For example, the City of Dayton, Ohio, has one zoning district (Well Head Operation District) for the actual location of wellfields, and an overlay zoning district (Well Field Protection Overlay District) for the recharge area.

> *The WO Well Head Operation District is designed to safeguard the public health, safety, and welfare of citizens and institutions that are customers of the Dayton Water system by regulating the land use and the storage, handling, use and/or production of Regulated Substances within the zone of influence. The intent of this designation is to protect the community's potable water supply against contamination. This district will be mapped on property owned by the city at the location of any presently city-owned and operated or designated future or proposed public water supply well, recharge lagoon, or other related water facility as part of the Cit of Dayton Master Plan for Water supply and Treatment.*
> **[City of Dayton, Ohio, zoning Ordinance, Section 150.600, 1988]**

> *The WP Well field Protection Overlay District is designed to safeguard the public health, safety, and welfare of citizens and institutions that are customers of the Dayton Water system by regulating the land use and the storage, handling, use, and/or production of Regulated substances within the zone described as the land area adjacent to the existing and proposed municipal water wellfields, within the city, not included within the WQ Well Field Operation District, which lies within the one(1) year capture area, including a one*

thousand (1,000) foot strip of land outside of the direct recharge area in locations where the direct recharge area within the one(1) year capture area impinges on the aquifer boundary. The intent of this designation is to protect the community's potable water supply against contamination.

[City of Dayton, Ohio, zoning Ordinance, Section 150.610, 1988]

If there are other natural resources and geologic features (e.g. a carbonate geologic formation, lakes, and lake watershed that discharge to groundwater) that merit protection, identify them in this part of the ordinance when defining intent. Similarly, include any known threats and constraints, such as conditions inhibiting recharge capacity, land subsidence, and sinkholes.

In addition to the general goals listed in the statements of Purpose and Community Development Objectives, it is the purpose of this Article to protect a uniquely sensitive and valuable groundwater resource area, defined by a carbonate geologic formation identified in the East Marlborough township Comprehensive Plan, against land development patterns that would deplete the groundwater supply through excess demand, threaten its quality through wastewater pollution, inhibit the recharge capability of the area through exorbitant impervious surface areas, and increase the dangers of land subsidence and sinkholes.

The GP, Groundwater Protection District, shall be deemed an overlay on the application zoning district, and shall be shown on the East Marlborough Township Groundwater Protection Overlay Map. In the GP Overlay District, the following regulation shall apply, unless superseded by a more stringent regulation of the base zoning district.

[City of East Marlborough Township, Pennsylvania, Zoning Ordinance, Section 1201A, 1979]

If the aquifer or groundwater is not the only (sole) source of water supply, but a significant source of supply of the community's water needs, indicate that fact in the statement of intent.

(Note that a federal provision contained in the Safe Drinking Water Act provides for Sole source Aquifer (SSA) designation if at least 50 percent of the water delivered to the service area is dependent on reserves drawn from the SSA, provided there are no other alternative viable water sources that could supply at least 50 percent of the required water to be delivered to the service area. To qualify for such a designation and protection under the act, a community must petition EPA and meet the requirements of the Sole Source Aquifer Program. The designation permits EPA to conduct a limited review of federal financially assisted projects to determine their potential contamination threat.)

The purpose of this regulation is to safeguard public health by reducing risks of contamination of public water supply in the Town of Cheshire. Over 80 percent of Cheshire residents are served by public water supply wells which draw upon stratified drift aquifers that lie within the town boundaries, and the other 20 percent rely on private wells. In recognition of the fact that these aquifers are vulnerable to contamination from land-use activities, and that protection of Cheshire's groundwater resources is vial to ensure an adequate supply of safe, potable water, this section establishes Aquifer Protection Zones and prescribes land-use regulation within the zones.

[Town of Cheshire, Connecticut, zoning Ordinance, Section 47.1, January 1994]

Appendix L

The Brookings County Planning Commission and Board of County Commissioners recognize (1) that resident of Brookings county rely exclusively on groundwater for a safe drinking water supply and (2) that certain land uses in Brookings County can contaminate groundwater, particularly in shallow/surficial aquifers.

The purpose of the Aquifer Protection Overlay District is to protect public health and safety by minimizing contamination of the shallow/surficial aquifers of Brookings county. It is the intent to accomplish this, as much as possible, by public education and securing public cooperation.

Appropriate land-use regulations will be imposed, however, which are in addition to these imposed in the underlying zoning districts or in other county regulations. It is not the intent to grandfather in existing land uses which pose a serious threat to public health through potential contamination of public water supply wellhead areas.

[Brookings County, South Dakota, Zoning Ordinance, Section 1106, 1989]

Promote the idea of shared responsibility for groundwater protection between the business and commercial uses, residential needs, and local government authority. And seek regulatory and nonregulatory approaches to groundwater resource protection.

It is the purpose of this ordinance to promote the public health, safety, and general welfare and to minimize public and private losses due to contamination of the public water supply, to maximize groundwater protection pollution abatement control procedures, and minimize land-use restrictions that:

(1) Protect human life and health;
(2) Minimize expenditure of public money for costly pollution remediation projects;
(3) Minimize regulations on land use (for those activities that are not a threat to public water supplies);
(4) Minimize business interruptions;
(5) Minimize damage to public facilities and utilities such as water mains, sewer lines, and treatment facilities;
(6) Insure that the public is provided with safe potable water supply now and for future generation'
(7) Protect the natural resources of the State.

[City of Rockdale, Texas, General Ordinance, Section 3, 1991]

The intent and purpose of this ordinance is to safeguard the public health, safety, and welfare of the people of Volusia County, Florida, by providing for regulation of the storage, handling, use, or production of hazardous substances within zones of protection surrounding potable water supply wellfields, thereby protecting the potable water supply from contamination and other areas of Volusia County as provided herein.

[Volusia county, Florida, Zoning Ordinance, Section 701.00. draft]

This is an example of a detailed description to be used in a statement of purpose or intent.

1. *The aquifer lying under the area described in (the study of) McAllister aquifer is one of the most important sources of drinking water in Thurston County. Approximately 47,000 persons in the cities of Olympia and Lacey obtain their drinking water from*

springs fed by this aquifer. This aquifer is capable of providing water to twice these numbers and will be the major source of drinking water in Thurston county well into the future.

2. *This aquifer consists primarily of course sands and gravels, with approximately five to ten percent less permeable glacial till. These coarse sands and gravels allow relatively rapid infiltration and transmission of water and have high percolation rates. These soils are also generally poor at binding, trapping, and filtering* contaminants. Consequently, they have low potential to treat and retain pollutants.

[Thurston County, Washington, Resolution No. H3-90. 1990]

Appendix L

3. Authority and Applicability

Purpose: To establish local government (or an authorized jurisdiction's) authority and responsibility to manage and otherwise regulate wellhead protection areas, aquifers, and groundwater resources.

Key Issues:

- Refer or cite enabling legislation.
- Include references to any adopted map that defines the delineated boundaries.
- Make clear the duties and make up of any special citizen's review board or commission.
- Identify the authority and responsibility of appointed officials, such as the zoning administrator, planning director, water or public works director.
- Include a standard statement of abrogation and greater restrictions. Include a standard statement of severability.

Notes: Refer or cite the relevant federal and State enabling legislation along with local ordinances to establish the authority to regulate and the applicability of wellhead protection to protect groundwater. This section should include references to State statutes, areas of the jurisdiction where such statutes are applicable, and a general description of boundaries or reference to an adopted map of the boundaries. Contact your local government's legal counsel for identifying such statutes and legal descriptions. Legal counsels are Law Directors, Commonwealth Attorney's, Town Counsel, etc. Also contact the appropriate State environmental agency, other communities who have adopted similar ordinances, and health officials.

Whereas, Article 1175, Subdivision 19 of the Texas Revised Civil Statutes states in pertinent part that a city has the power to prohibit the pollution of any streams, drain, or tributaries thereof, which may constitute the source of water supply of any city and to provide policing of same as well as to provide for the protection of any watersheds...

[City of Sweeny, Texas, General Ordinance, Section A, 1990]

This Ordinance applies to all land uses and activities located or proposed within the area delineated as the Wellhead Protection Area in Norway on a map available for inspection at the office of the Norway Water District and as defined in the definitions section of the ordinance. The Wellhead Protection Area consists of WHPA 1, WHPA 2, and WHPA 3, described below, for the Norway municipal well(s).

[Town of Norway, Maine, Wellhead Protection Ordinance, Section B, 1993]

When special committees are appointed to review provisions and make recommendations to the planning commission or the elected body, a reference to their role and authority should also be included here. Describe the composition of the body and its role in the review, revision, and interpretation of wellhead protection provisions of the zoning ordinance.

(a) A Resource Protection Area Technical Advisory Committee ("RPATAC") is hereby established in the New Castle county Department of Planning composed of one (1) representative from each of the following:

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Chemical Industry
Consulting Engineers Council
DNREC
Delaware Department of Health and Social Services, Division of Public Health
Delaware Geological Survey
New Castle County Chamber of Commerce
New Castle County Department of Planning
New Castle County Department of Public Works
Water Company Representative
Water Resources Agency of New Castle County

The members shall be appointed by the County Executive. The members shall be appointed to four (4) year terms, except that initially four (4) members shall be appointed for a two (2) year term, three (3) members shall be appointed for a three (3) year term; and three(3) members shall be appointed for a four (4) year term. They may be reappointed and shall serve until their successor is appointed. The chairman shall be designated by the County Executive.

(b) the purposes and duties of the RPATAC are to:

(1) Provide technical support and recommendations to the Department of Planning concerning the technical definition and criteria of any Resource Protection Area as depicted on the three-map series designated in Section 23-123.

(2) Advise the Department of Planning when the RPATAC determines that performance standards should be amended.

(3) Provide technical support and recommendations to the Board of Adjustment concerning any application made to that Board.

(4) Advise the Department of Planning when the RPATAC determines that this Article or any regulations promulgated pursuant to this Article should be amended.

(5) Assist the Department of Planning as requested.

[New Castle County, Delaware, Zoning Ordinance, Section 23-138 and 23-139, proposed]

A committee shall be established to assist in the interpretation of and/or revision of boundaries established in this article, the review of development plans within wellhead resources and recharge protection areas, and other related matters that may arise in the administration of this article. The committee shall consist of representatives from the Newark Planning and Water and Waste Water Departments, the Delaware Geological Survey, the Delaware Department of Natural Resources and Environmental Control, the Soil Conservation Service, and the Water Resources Agency for New Castle County. The committee shall be chaired by the Newark Director of Water and Waste Water and shall be convened by the director when, in the director's opinion, technical advice is necessary for the administration of this article as described herein. The committee shall be advisory only; all final determinations shall be made by the Water and Waste Water Director.

[City of Newark, Delaware, Zoning Ordinance, Section 30-53.d, 1991]

The City of Rockdale's Water and Sewer Superintendent is hereby appointed the wellhead protection area administrator to administer and implement the provisions of this ordinance and other appropriate sections of (Wellhead Protection Ordinance) of the Texas Water Code.

[City of Rockdale, Texas, Wellhead Protection Ordinance, Article 4, Section 1, 1991]

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A standard statement of responsibility of appointed local officials, such as the Planning Director, the Zoning Administrator, and other officials should be included and or amended as necessary.

> *The Board of Adjustment shall not consider any application for a variance from the provisions of this Article until the RPATAC (Resource Protection Area Technical Advisory Committee) has had an opportunity to review the application and make a written recommendation to the Board of Adjustment. Any application for a variance from this Article shall be transmitted to the RPATAC, which shall have forty-five (45) working days from the filing of the application to review and issue its recommendations. The application shall be advertised for public hearing for the next regularly scheduled Board of Adjustment meeting following the expiration of the forty-five (45) day -period.*
>
> **[New Castle County, Delaware, Zoning Ordinance, Section 23-138 and 23-139, proposed]**

These are some additional standard statements pertaining to the authority and applicability that are not necessary if such responsibilities are defined in other parts of the zoning ordinance.

> *Nothing contained in (the Wellhead Protection sections of the zoning ordinance shall be construed so as to interfere with the duties and powers of the Director of Water as set forth in Section 50.42 of the R.C.G.O.*
>
> **[City of Dayton, Ohio, Zoning Ordinance, Section 53.01.B(3), 1988]**

> *It shall be the responsibility of any person owning real property and/or owning or operating a business within the City of Dayton corporate limits to make a determination of the applicability of (Well Head and Well field Protection districts) as it pertains to the property and/or business under his ownership or operation, and his failure to do so shall not excuse any violations of said sections.*
>
> **[City of Dayton, Ohio, Zoning Ordinance, Section 53.01.I, 1988]**

A standard statement of abrogation and greater restrictions is appropriate at the end of this section of the ordinance, if none exists in the zoning ordinance.

> *It is not intended by this Article to repeal, abrogate, or impair any existing easements, covenants, or deed restrictions. However, where this Article imposes greater restrictions, the provisions of this Article shall prevail.*
>
> **[City of East Marlborough Township, Pennsylvania, Zoning Ordinance, Section 1204A.5, 1979]**

> *Nothing contained in (the Wellhead Protection Ordinance) shall be construed so as to interfere with any existing or future lawful requirements that may be, or heretofore were, imposed by any other public body authorized to enact sanitary, health, or water pollution abatement restrictions so long as such requirements are consistent with, or more stringent than, the stated purpose of this ordinance.*
>
> **[City of Dayton, Ohio, Zoning Ordinance, Section 53.01.B(2), 1988]**

Often, zoning ordinances include a severability clause. If the courts strike down part of an ordinance, a severability clause allows the community to continue enforcing other portions of this ordinance without invalidating the whole. Although this is a standard clause that is usually put in a general provisions section of the zoning ordinance, making

it applicable to the entire zoning ordinance, it is also repeated in most major chapters or articles of the ordinance.

> *Should any part or provision of this ordinance be declared by a court of competent jurisdiction to be invalid, the same shall not affect the validity of the ordinance as a whole or any part thereof other than the part held to be invalid.*
>
> **[Authors' recommended language]**

Communities that have experienced incidents of contamination and significant violations of the provisions of their ordinance have sometimes chosen to include statements of injunctive relief. Although the right to file for such relief in courts is available whether or not such a statement is explicitly stated in the ordinance, reiterating such rights in the ordinance acts as an added deterrence.

> *If any person who engages in nonresidential activities stores, handles, uses, and/or produces toxic substances listed in Table 1 (Toxic Substances List) within the well field zones of influence, as indicated on the Zone of Influence maps, without having obtained a permit as provided for herein or continues to operate in violation of the provisions of this ordinance, then Broward County may file an action for injunctive relief in the circuit court...*
>
> **[Broward County, Florida, Well Field Protection Ordinance, Section 11.01, 1989]**

Appendix L

4. Extent and Designations

Purpose: To establish the physical boundaries or limits of wellhead protection districts, aquifers, or groundwater resource areas that are addressed in this ordinance.

Key Issues:

- The extent and delineation of the boundaries should correspond t the study methodology and findings (remember, challenges to wellhead protection are more likely to be based on the arbitrariness of delineation than on the right to establish a wellhead protection zone).
- City the methodology used to delineate wellhead protection areas (State standard, EPA recommended standard, scientific modeling, etc.)
- References to maps, map areas, and terminology used to define areas must be consistent with the study and findings.
- Include a statement of authority to modify or expand the extent and designation of the wellhead protection areas.
- If the boundaries of the wellhead protection zones cut across existing property lines or a property is contained in more than one zone, include a general statement of clarification about which provisions apply (usually those of the more restrictive zone).
- If the boundary of the wellhead protection zone extends beyond the jurisdiction, but the jurisdiction has extraterritorial rights, include or cite such authority along with any interjurisdictional agreements that affect the management of wellhead protection areas.

Notes: The method for delineating wellhead protection areas should be consistent with the State program, if there is one. If there is no State-prescribed method, the method chosen should fit the level of detail required by the hydrogeologic setting. Some of the methods suggested by EPA include arbitrary fixed radius, calculated fixed radius, simplified variable shapes, analytical method, numerical method, and hydrogeologic mapping method. (See Chapter 3 above.) Verify if there is a specific method that the EPA and your State environmental agency recommends. The more comprehensive and detailed the method of delineation, the less likelihood of legal challenges to the wellhead protection boundaries. Delineating the wellhead protection areas separate from the aquifers may be necessary even if the entire jurisdiction is found to be in the zone of influence.

There is a significant distinction between aquifer protection areas and wellhead protection areas in State statutes, administrative regulations, and local ordinances. Aquifer protection areas have been traditionally used for the past 15 to 20 years by communities to generally protect large areas that have significant groundwater reserves. Wellhead protection areas are only those portions of aquifers (and may contain nonaquifer areas also) through which contaminants are likely to reach the wells.

If an arbitrary fixed radius is used to define the extent of a wellhead protection area when a more detailed study is still in progress, include the term "interim" in the designation. Make sure that the ordinance title, the heading of this section, and maps reflect the interim designation.

For wells serving more than five hundred (500) persons and located in unconsolidated (sand and gravel) aquifers, the Wellhead Protection Area (WHPA) consists of three (3) areas (WHPA 1, WHPA 2, and WHPA 3) which are listed and their hydrologic

characteristics described below:

(1) WHPA 1: WHPA 1 extends from the wellhead to the 200-day groundwater Time-of-Travel boundary.
(2) WHPA 2: WHPA 2 extends from the outer boundary of WHPA 1 to the 1000-day Time-of-Travel boundary.
(3) WHPA 3: WHPA 3 extends from outer boundary of WHPA 2 to the watershed's groundwater divide or Zone of contribution id delineated based on technical criteria more stringent than watershed determination.

[Town of Norway, Maine, Wellhead Protection Ordinance, Section C, 1993]

Communities that already have an aquifer protection ordinance may be able to modify it to include a delineated wellhead protection area. In this case, the community will need to consider if it has the ability and the resources to use the more restrictive wellhead protection management measures over the entire aquifer protection area or just within the wellhead protection overlay zone. The same is true for communities with numerous private wells and public drinking water wells. In this case, the protection area will likely be larger than anticipated because of the interaction between the pumping wells. In some parts of the country, the wellhead protection area will be nearly as large as the aquifer protection area, in which case it may make sense to use the more intensive wellhead protection management measures over the entire area.

Boundaries for the aquifer protection zones for the Aquifer Protection Overlay District are shown on published maps entitled "Wellhead Protection Area Maps, Brookings County Shallow Aquifer Map" ...(and) are hereby adopted by reference as part of this ordinance as if the maps were fully described herein.

The shallow/surficial aquifer boundary was mapped using data from the south Dakota Geological Survey and United States Geological Survey. The zone of contribution was mapped using an analytical technique outlined in the U.S. Environmental Protection Agency publication "Guidelines for Delineation of Wellhead Protection Areas, June, 1987." The Aquifer Protection Overlay District was divided into two zones.

[Brookings County, South Dakota, Zoning Ordinance, Section 1106, 1989]

Be certain to include a reference to procedures for amending the designation of aquifer protection zone boundaries. Although the definition of wellhead protection areas is inherently tied to knowing the exact location of wells, a description of the process for expanding aquifer protection boundaries should be included.

The recharge protection areas may be modified from time to time based on the recommendation of the technical advisory committee established in subsection (d) of this article and the Water Resource Protection Area map shall be revised accordingly; substantial changes in the Water Resources Protection Area Map, based on the recommendation of the technical advisory committee, shall be made by City Council by Ordinance.

[City of Newark, Delaware, Zoning Ordinance, Section 30-53.b(4), 1991]

Normally, zoning boundaries are made to coincide with parcel or site boundaries. But, when a fixed radius method is used to delineate the wellhead protection area, provisions to cover parcels that are only partly in the district may be needed. This exception also

applies when the boundary of the protection area cuts a large parcel.

In determining the location of properties within the zones depicted on the zones of influence maps, the following rules shall apply:

(1) Properties located wholly within one (1) zone reflected on the applicable zones of influence maps shall be governed by the restrictions applicable to that Zone.

(2) Properties having parts lying within more than one (1) zone as reflected on the applicable zones of influence maps shall be governed by the restrictions applicable to the zone in which the part of the property is located

(3) Where a travel-time contour which delineates the boundary between two zones of influence passes through a building, the entire building shall be considered to be in that zone in which more than fifty (50) percent of the floor space of the building is situated as of August 28, 1986.

[Broward County, Florida, General Ordinance, Section 27-381, 1984; 1989]

Appendix L

5. Use Regulations

Permitted Uses

Purpose: To identify the types of uses and activities allowed by right.

Notes: The only uses permitted by right in wellfield areas are those that are directly related to the operation of the wellfields. However, in some cases, single-family and passive recreational uses are allowed by right. In an overlay-type district, permitted uses are those that are allowed by right in the underlying zoning district.

> *Municipal water supply and treatment facilities in accordance with the City of Dayton Master Plan for Water Supply and Treatment.*
>
> **[City of Dayton, Ohio, Zoning Ordinance, Section 150.601(A), 1988]**

> *The permitted uses, bulk and yard regulations within the* WP Well *Field Protection Overlay District shall be those of the underlying zoning district.*
>
> **[City of Dayton, Ohio, Zoning Ordinance, Section 150.611, 1988]**

Prohibited Uses

Purpose: To identify prohibited uses and activities. Such prohibited uses and activities remain prohibited in an overlay district even if they are allowed by right in the underlying zoning district.

Notes: The primary reason that a use should be prohibited is tied to the threat of contamination of groundwater by that use. Note that the criteria for prohibition should be based on the association of known contaminants with uses. Traditionally, State wellhead protection programs and local ordinances associated land-use activities with contaminants, but the emphasis in the ordinance should be on the contaminants and not the use or activity. If the threat of contamination can be adequately mitigated, some uses may be allowed through other zoning provisions, such as conditional use permits, special exception processes, or a variance procedure. In the case of an overlay district, uses prohibited in the underlying zone are also prohibited in the overlay zone.

Contaminants can be grouped under the following major categories:

- Inorganic compounds (e.g., nitrogen and phosphorus nutrients, heavy metals, sodium, and chloride)
- Viral or bacterial contaminants (e.g., pathogens)
- Organic compounds (e.g., petroleum- and hydrocarbon-based projects, PCBs, pesticides, and other volatile and semi-volatile compounds, such as benzene, napthalenes and phenols)

An important component of the specifications of the prohibited uses must include flexibility for the implementing authority to determine, and document when necessary, the right to modify this section as information on contaminants or land-use activities that might pose a threat to groundwater quality becomes available. In determining which contaminants are

subject to this ordinance, the implementing authority may obtain appropriate lists and confer with State and federal environmental and health agencies.

Sanitary landfills, landfills composed of demolition debris, and dry wells are prohibited uses in the "WP" Well Field Protection District.

[City of Harrison, Ohio, Zoning Ordinance, Section 2707, 1989]

The following uses are prohibited in the Columbia South Shore Plan District;

(1) Manufacturing and production of hazardous materials, excluding production for on-site usage only. These materials include:

a) Any hazardous substance or hazardous waste as listed in the following federal regulations:

(1) Superfund Amendments and Reauthorization Act (SARA) of 1986 Section 302 Extremely Hazardous Substances List (40 C.F.R. 300 App. A and B);

(2) Comprehensive Environmental Response Compensation and Liability Act superfund (CERCLA) of 1980. Hazardous Substances List (40 C.F.R. 302, Table 203.4);

(3) SARA of 1986, Section 313, Toxic Chemicals List (40 C.F.R. Section 372.45); and

(4) Resource Conservation and Recovery Act (RCRA) of 1976 and 1984 Amendments, Hazardous Wastes Lists (P and U Categories) (40 C.F.R. Section 261.33(e) and (f).

Note: The lists reverenced in Section B.1.a. are summarized in the Title III List of Lists - Chemicals Subject to Reporting Under Title III of the Superfund Amendments and Reauthorization Action (SARA) of 1986, published July 1987, U.S. EPA.

b) Nuclear or radioactive materials or wastes.

(2) The following specific uses are prohibited:

a) Bulk plans for hazardous materials as defined in Subsection 33.455.125.C. including petroleum refining.

b) Permanent storage or disposal of hazardous wastes (as defined under the Federal Resource Conservation and Recovery Act, Subpart D, 40 CFR 261.30; 261.31; 261.32; 261.33), industrial or municipal sludge, or radioactive materials, including solid waste landfills.

c) Collection and transfer facilities for hazardous wastes, solid wastes that contain hazardous materials from off-site sources, and radioactive materials;

d) Wood-preserving operations using formulations of Chrome-Copper-Arsenate (CCC), pentachlorophenol (PENTA), and creosote and related chemicals;

e) Battery recycling and reprocessing;

f) Retain gas stations and truck stops;

g) Agricultural application of halogenated volatile liquid organic pesticides (e.g., ethylene dibromide (EDB) and dibromochloropropane (DBCP), related chemicals and their commercial formulations);

h) Processing, reprocessing, and storage (and disposal) of PCB containing oils;

i) Manufacturing and production of paving, roofing, and other construction materials, using asphaltic- and petroleum-based coating and preserving materials; and

j) Primary and secondary metal industries that manufacture, produce, smelt, or refine ferrous and non-ferrous metals.
[City of Portland, Oregon, Zoning Ordinance, Section 22.705.040.B, 1988]

It is a good idea to include language indicating that the use lists are not exhaustive and that information pertaining to changing technology and activities will require periodic evaluation of this list and the advice of outside experts to assess risks associated with uses not included in the ordinance.

(3) Use List Not Exhaustive: The uses prohibited by this district represent the State of present knowledge and most common description of said uses. As other polluting uses are discovered, or other terms of description become necessary, it is the intention to add them to the list of uses prohibited by this district. To screen for such other uses or terms for uses, no use shall be permitted in this district without first submitting its building, site, and operational plans for Planning Commission review and approval under Section 17.05 of this ordinance.

(4) Changing Technology: The uses prohibited by this district are prohibited based upon the combined pollution experience of many individual uses, and the technology generally employed by that class of uses, which technology causes the uses as a class to be groundwater pollution risks. As the technology of identified use classes changes to non-risk materials or methods, upon petition from such a use, and after conferring with expert geological and other opinion, it is the intention to delete from the prohibited list or allow conditionally, uses which demonstrate convincingly that they no longer pose a pollution hazard.

[Town of Weston, Wisconsin, Zoning Ordinance, Wellhead Protection District, Section 17.11-14. 1993]

Conditional Uses and Special Uses

Purpose: To set forth additional conditions and standards for some uses in the wellhead protection zone.

Notes: Conditional and special uses require additional standards be provided in the wellhead protection ordinance. In an overlay protection-type zoning district, if a proposed use is deemed a conditional use in the underlying zoning district, it must conform to both the provisions in the overlay district and the provisions of the underlying zoning district. As the conditional and special use applications are typically reviewed by the Board of Zoning Appeals or a similar body independent of the Planning Commission (e.g., any special body created to review applications for uses in wellhead protection areas), the uses that will be subjected to such additional review will have to be specifically identified. Zoning ordinances often contain a separate chapter for the submission and review requirements for conditional uses. But the specific uses in wellhead protection zones that trigger review may also be included here.

The following standards shall be applicable to any conditional uses permitted pursuant to the Article:

(1) The peak rate of stormwater runoff shall not exceed the pre-development peak rate. Stormwater runoff volume shall not exceed the pre-development volume for the duration of the pre-development stormwater runoff hydrograph.
(2) The quantity and quality of groundwater recharge shall be maintained at pre-development levels.

(3) In order to establish the pre-development standards required by subparagraphs (1) and (2) above, a study shall be prepared under the supervision of a Delaware registered professional geologist or engineer trained and experienced in hydrogeology. The report of the study shall be submitted to the New Castle County Departments of Planning and Public Works, and the Water Resources Agency for New Castle County.

(4) All development shall be maintained at a minimum sixty (60) day horizontal time of travel from any public water supply well as established by the on-site hydrogeologic study required by subparagraph (3) above.

(5) To assure that the quality of groundwater recharge shall be maintained, a groundwater monitoring program shall be established as part of the report prepared pursuant to subparagraph (3) above. The program shall establish the number of wells to be installed, s well as the duration and frequency regarding the monitoring of the wells to be installed. All laboratory test results shall be submitted to New Castle County in order to assure the County that satisfactory water quality is maintained.

[New Castle County, Delaware, Zoning Ordinance, Section 23-133 (a), proposed]

Commercial and industrial uses are permitted when allowed in the underlying zone subject to the procedures and restrictions in the underlying zone and subject to the following additional limitations and restrictions:

(1) New commercial and industrial uses or changes I use or the enlargement and alteration of commercial and industrial uses existing as of the effective date of this ordinance and permitted outright in the underlying zone are permitted outright in the WPA when no chemicals or other products are used, produced by, or commonly associated with the activity which, in the event of introduction of a large quantity thereof into the groundwater, might cause, materially contribute to, or create a material risk of any adverse effect upon the city of Enterprise municipal water source.

(2) A new commercial or industrial use or change in use not permitted outright under subparagraph 1 above may be permitted by the Commission after issuance of a special use permit, following public hearing, upon a finding that the proposed use, considering the quantity and character of the chemical or other product, the methods of use, and the distance from the city of Enterprise municipal water source, would not have an adverse effect upon the city of Enterprise municipal water source in ;the event of a major spill, improper storage and ;handling, or improper disposal of said chemical or other product. If said use is permitted outright in the underlying zone, review by the Commission shall be limited to the determination of whether the standard contained in this subparagraph is met. Conditions may be imposed upon the permit by the Commission to insure protection of the city of Enterprise municipal water source.

[Wallowa County, Oregon, Zoning Ordinance, Section 24.090.1, 1988]

Include the following utilities to the definition of special uses.

(A) Public utility uses as follows:

(1) Electric and Telephone substations

(2) Gas Regulator and meter station buildings

(3) Police and fire stations that do not contain maintenance facilities)

(4) Electric transmission towers and structures (not related to oil storage and disposal)

(B) Radio, Television, or other transmission towers or masts, and the usual accessory buildings, only after their height and location have been approved by the government

agency charged with the responsibility for maintaining air safety and provided there is a yard area with a radius of half the height of the tower or mast.

[City of Dayton, Ohio, Zoning Ordinance, Section 150.602, 1988]

Sewage disposal systems are generally governed by a more stringent set of health code regulations. However, allowing such systems as part of the utilities may be subject to zoning provisions provided in the wellhead protection ordinance.

I. the designed sewage flow is no greater than 450 gallons per five acres per day, and
ii. the waste entering the on-site system is equivalent in quality to typical residential waste.

[Thurston County, Washington, Resolution No. H3-90, Section 30(d), 1990]

Excavation, mineral extraction, borrow pits and other uses, when permitted under conditional uses, impose conditions that include the following:

The *excavation, extraction, mining or processing of sand, gravel and limestone from the earth for resale shall remain as conditional uses in the WP Well Field Protection Overlay District subject to BZA approval of an excavation and facilities plan that includes, but is not limited to:*

(1) an existing site plan with topographic detail at two-foot contour intervals, all planimetric information, depth to groundwater and floodplain characteristics, where applicable
(2) the proposed extent and depth of excavations
(3) slope angle of excavation walls (any final slopes shall be at the angle of repose for the remaining material)
(4) use and disposition of the spoil and/or overburden materials from the excavations including a landscaping and vegetation plan to stabilize any disturbed material
(5) surface drainage plan
(a) drainage into on-site excavations from proximate off-site transportation facilities, such as roadways and roadbeds, and off-site watercourses is prohibited unless the applicant provides a plan which otherwise protects the excavations from off-site waterborne regulated substances.
(b) the final on-site grading shall minimize all surface drainage into the excavations.
(6) a post-excavation and operation land-use plan
(7) a security plan (unauthorized access shall be strictly prohibited as long as any excavations remain on site)

[City of Dayton, Ohio, Zoning Ordinance, Section 150.612(C),1988]

The *following uses are those industrial operations which normally produce noise, glare, air pollution fire hazards or safety hazards; such uses may only be permitted upon the granting of a special exception by the Zoning Board of Appeals, subject to such standards or conditions as are imposed by said Board and conditional to compliance with the provisions of Section 9:*

(A) Plants generating power, disposing of sewage and/or garbage
(B) The cooking, distillation, processing, and incineration of animal or vegetable products including, but not limited to, brewery, distillery, slaughterhouse, fat rendering, soap manufacture, tannery, paper manufacture, wool-scouring and cleaning, cotton textile sizing, scouring, bleaching, dyeing, and similar operations.

(C) The production of corrosive and noxious chemicals including, but not limited to, acids, acetylene gas, ammonia, chlorine, bleaching compound

(D) The production, processing, and storage of coal, coal tar, petroleum, and asphalt products including, but not limited to, coke manufacture, illuminating gas production, petroleum refining, bulk, gasoline and petroleum products storage, asphalt products, linoleum manufacture oil cloth manufacture, roofing material manufacture

(E) The processing or washing of earth materials including batching plants

(F) The use of hammer mills, ball mills, rolling mills, or drop forges in any industrial process

(G) Accessory uses in accordance with the provisions of Section 2-01A.

[City of Southington, Connecticut, Zoning Ordinance, Section 5-02.3, 1980]

Some industries have developed advances pollution control and waste management techniques that may lessen the level or chance of pollution from their activities. In recognizing such innovative approaches, the conditional use process is applied to review proposed uses that would otherwise be prohibited.

Water Quality Impact Reviews. The uses listed below traditionally utilize solvents and other hazardous materials. However, it is recognized that changes in operational and containment process technology may be proposed. These uses are not allowed unless approval is granted.

(1) The uses are as follows:

a) Furniture stripping or refinishing;

b) Exterior and vehicle salvage, drum recycling and cleaning, commercial truck or rail tanker cleaning operations;

c) Industrial and commercial dry cleaning plants;

d) Rolling, drawing, extruding, casting, forging and heat treating of ferrous and non-ferrous metals;

e) Industrial electroplating, plating, anodizing and coloring of ferrous and non-ferrous metals; and

f) Other similar uses as may be determined by the Planning Director to pose a high potential risk to the ground and surface water resources. The applicant will be notified of any such determination within ten working days after the pre-application conference.

[City of Portland, Oregon, Zoning Ordinance, Section 33.705.040.C, 1988]

Special Exceptions and Limited Exclusions

Purpose: To set forth the types of uses that may be excluded from the provisions of the permitted, prohibited, and conditional use sections.

Key Issues:

- Set maximum limits on the amount of cleaning agents and household chemicals.
- Define temporary storage of construction material.
- Permit transportation of hazardous materials on roads in the wellhead protection areas.
- Allow office and business supplies for administrative functions. Include public utility functions associated with electric, telephone, and gas substations that are excluded.
- Exclude family subdivisions of residential parcels that have adequate public sewer and stormwater drains.
- Exclude fire, police, and public safety functions that do not use, store, or dispose hazardous materials, generate sewer, or otherwise violate the prohibited use provisions of this ordinance.

- Exclude repair and maintenance of working wells.

Notes: Special exceptions and limited exclusions provide for mechanisms to handle uses and activities that are unique and incidental to other uses. For example, the transportation of hazardous materials on roads in a wellhead protection overlay zone may be excluded from the governance of this ordinance. The use of household products containing hazardous substances by facilities in the wellhead protection area also needs to be addressed. While limited exclusions are normally exempt from administrative review, special exceptions require an application and demonstration of compliance with the provisions of the ordinance. As is true for regulating special and nonconforming uses, some zoning ordinances have specific sections describing submittal and review requirements governing the special exception process. But the criteria for determining the relief through a special exception should be included here.

Limited exclusions from the provisions of (Permitted and Prohibited Uses Section), are authorized for:

(A) Non-Routine Maintenance or Repair of Property or Equipment: The use, storage, handling, and/or production of Regulated substances under this exclusion shall be limited to:

(1) The aggregate of Regulated substances in use, storage, handling, and/or production may not exceed fifty (50) gallons or four hundred (400) pounds at any time.

(2) The total use, storage, handling, and/or production of Regulated Substances may not exceed one hundred (100) gallons or eight hundred (800) pounds in any twelve (12) month period.

(B) Medical and Research Laboratory Uses: Excluded Regulated Substances shall be stored, handled, or used in containers not to exceed five (5) gallons or forty (40) pounds of each substance and the aggregate inventory of Regulated Substances shall not exceed two hundred and fifty (250) gallons or two thousand (2000) pounds.

(C) Cleaning Agents: Excluded Regulated substances which are cleaning agents shall be packaged for personal or household use or be present in the same form and concentration as a product packaged for use by the general public. The aggregate inventory of such cleaning agents shall not exceed one hundred (100) gallons or eight hundred (800) pounds at any time. In no case shall Regulated Substances claimed under this exclusion include hydrocarbon or halogenated gydrocarbon solvents.

(D) Construction Materials; Regulated substances associated with construction for which a permit has been issued, paving or the pouring of concrete shall be excluded from regulation while present on the construction site provided such regulated substances do not pose a real and present danger of contaminating surface and/or groundwater.

(E) Office Supplies: Office supplies that are used solely for the operation of on-site administrative offices, provided such supplies are prepackaged in a form ready for use.

[City of Harrison, Ohio, Zoning Ordinance, Section 2708.02, 1989]

(a) Exemption for Public Utilities: Public utilities shall be exempt from zone 1 and zone 2 prohibitions as set forth in section (on prohibited uses). However, all such utilities in zone 1 and zone 2 shall comply with all provisions of section 27-379(b)(2) through (4). The license exemption set forth in subsection (h) of this section for regulated substances contained in storage tanks and licensed under article X of this chapter shall apply. However, compliance in zone 1 and zone 2 with the requirements set forth in article X of this chapter shall be completed by August 28, 1988.

(b) Exemption for Continuous Transit: the transportation of any regulated substances

through zone 1 shall be allowed provided the transporting vehicle is in continuous transit.

(c) *Exemption for Vehicular Fuel and Lubricant Use: the use of any regulated substances solely as fuel in a vehicle fuel tank or as lubricant in a vehicle shall be exempt from the provisions of this article.*

(d) *Exemption for Use of Certain Regulated substances: The use of certain of the regulated substances such as pesticides, herbicides and fungicides in recreational, agricultural, pest control and aquatic weed control activities shall be allowed provided that:*

(1) *In all zones, the use is in strict conformity with the use requirements as set forth in the substances EPA registries and as indicated on the containers in which the substances are sold; and*

(2) *In all zones, the sue is in strict conformity with the requirements as set forth in chapters 482 and 487, Florida Statues, and chapters 5E-2 and 5E-9 Florida Administrative Code.*

(3) *In a zone 1, the use of any of the regulated substances shall be flagged in the records of the certified operator supervising* the *use. The certified operator shall provide specific notification in writing to the applicators under his or her supervision that they are working at a site located in a zone 1 for which particular care is required. Records shall be kept of the date and amount of regulated substances used at each location.*

(4) *In a zone 1, the regulated substances shall not be handled during use in a quantity exceeding seven hundred (700) gallons of formulation.*

(5) *All nonresidential uses of regulated substances in zone 1 and zone 2 shall comply with all the provisions of section 27-379(b). The use of regulated substances on nonresidential landscape areas smaller than five thousand (5,000) square feet shall be exempted from the provisions of this article, However, commercial or government services in all zones shall not be required to obtain individual licenses for every site at which they use the regulated substances, and these services shall be exempt from the provisions of this article with regard to the sites they serve provided the use is in accordance with (1), (2), (3), and (4) above. However, all records for such sites as required by chapter 482. Florida States, and chapter 10D-55, Florida Administrative code, shall be available for inspection by the county.*

[Broward County, Florida, General Ordinance, Section 27-380,1984; 1989]

The following activities or uses are exempt from the provision of this Article:

(1) *The transportation of any hazardous substance through either or both the Primary or Secondary Well field Protection zone, provided the transporting vehicle is in transit.*

(2) *Agricultural uses, including mosquiteo control, except that said uses shall comply with Chapter 487.011, et seq., the Florida Pesticide Law and the Florida Pesticide Application Act of 1974 and Rule 5E 2.001 et seq., and Rule 5E-9.001, et seq., Florida Administrative code.*

(3) *The use of any hazardous substance solely as fuel in a vehicle fuel tank or as a lubricant in a vehicle.*

(4) *Fire, police, emergency medical services, emergency management center facilities and public utilities of this Article.*

(5) *Retail sales establishments that store and handle hazardous substances for resale in their original unopened containers.*

(6) Office uses, except for the storage, handling or use of hazardous substances as provided for in applicable administrative codes.
(7) Repairing or maintaining any existing facility of improvement on lands within the Primary or Secondary Well Field Protection Zone.
(8) Storage tanks which are constructed and operated in accordance with the storage tank regulations as set forth in Chapter 17-61, Florida Administrative Code.
(9) Geotechnical borings.
(10) Residential activities.
(11) Public utility emergency generating facilities except that permanently installed fuel storage facilities exempted under Chapter 17-61, Florida Administrative Code, shall have secondary containment.
(12) Provided, however, that a local government may at its option delete in whole or in part, any of the above described exemptions, but in no case shall the local government include any additional exemptions in its ordinance adopted pursuant to this Article unless otherwise approved by the County Council.

[Volusia County, Florida, Zoning Ordinance, Section 7606.00. Draft]

Public utilities, in some wellhead protection ordinances, are treated as special exception uses when conditions or standards are not included in the ordinance. Although this allows greater flexibility in development reviews, it should be noted that, for consistency and expedition, some basic conditions or standards will have to be eventually included in the wellhead protection ordinance.

(A) Public utility uses as follows:
(1) Electric and telephone substations
(2) Gas regulator and meter station buildings
(3) Electric and communication transmission towers and structures

[City of Huber Heights, Ohio, Zoning Ordinance, Section 36.04, 1990]

Although there are few uses that are not prohibited in the wellhead protection overlay district and are either a conditional or special use in the underlying district, include a standard statement of "subject to approval" based on the performance standards of the wellhead protection ordinance. This reinforces the applicability of performance standards of both the underlying zoning district and the wellhead protection overlay district.

All special exceptions allowed in underlying districts may be approved by the board of Adjustment provided they can meet Performance Standards outlined for the Aquifer Protection Overlay Zones.

[Brookings County, South Dakota, Zoning Ordinance, Section 1106, 1989]

Family subdivisions (or minor subdivisions) are also commonly excluded from further administrative reviews provided they meet some distance and size requirements. The definition of a family or minor subdivision is provided in the subdivision regulations; such subdivisions are generally five parcels or less in residentially zoned areas.

Excluded developments: There shall be excluded from the procedures and requirements of this section all residential minor partition applications if the site thereof is more than 1320 feet from the exterior boundary of the city of Enterprise municipal water source, provided the residential use is permitted [by right] in the underlying zone and none of the parcels is less than five acres in size. All other partitions and subdivisions shall be subject to review under the procedures of this section.

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[Wallowa County, Oregon, Zoning Ordinance, Section 24.090.1. 1988]

Nonconforming Uses

Purpose: To set forth provisions for existing uses that do not conform to the wellhead protection standards.

Key Issues:

- Identifying nonconforming uses that were existing on the date of adoption of the wellhead protection ordinance and are permitted by right, by special exception, or by conditions.
- Making sure that it is understood that prohibited uses are excluded from obtaining relief under this section.
- Setting a limit for the expansion of nonconforming uses; beyond that limit, a nonconforming use will be treated as new use and will be subject to a complete review.

Notes: Typically, nonconforming uses in wellhead protection areas are either permitted, special exception, and conditional uses that were conforming before the designation of the wellhead protection area. Such uses are commonly nonconforming due to violations of the new lot size or minimum yard requirements set by the new district. These provisions should also set limits for expansion of a nonconforming use before it must become conforming. Under certain circumstances (e.g., discontinuation of use, destruction of a use by fire or flood, etc.), a nonconforming use may be required to become a conforming use.

The issue of nonconforming uses is probably one of the most contentious aspects of local zoning. In crafting appropriate safeguards in the wellhead protection ordinance, ensure that there is general conformity with the nonconforming sections of other parts of the zoning ordinance. Any deviation from established standards or precedents has to be associated with a substantially justifiable claim. Almost all courts have generally looked at nonconforming uses as uses that have a right to continue, at least for a time, as they were on the date of adoption of the more restrictive zoning ordinance--provided there is no substantial change. The debate is primarily about issues related to defining the time limit and what constitutes substantial change. These definitions vary from state to state and sometimes also within a state. Inclusion of any stricter nonconforming standards in the wellhead protection ordinance will have to be justified. Note that protection of nonconforming uses does not extend to the continuation of any prohibited use.

The samples provided here are very specific to the local conditions and precedents. Some of the standards for expansion and time limits may have very limited, if any, relevance outside the jurisdiction from which the example is cited.

If a non-conforming use of any land, building, or structure is discontinued for six (6) months or more, any further use shall be in conformity to this District.

[City of Huber Heights, Ohio, Zoning Ordinance, Section 36.06, 1990]

Non-conforming uses may continue in this District in the form in which they exist at the time of the adoption of this Ordinance. Any change of title or right to possession shall not affect such continuation of an existing use. Whenever a non-conforming use has been abandoned for a period of one (1) year, such use shall not thereafter be re-established and

any future use shall only be in compliance with the provisions of this Chapter. In the event such non-conforming use shall pose a direct hazard to the public water supply, New Castle County may take any action permitted by law to abate the hazard.

[New Castle County, Delaware, Zoning Ordinance, Section 23-137, proposed]

Expansion of up to 25% of land uses or activities previously existing at the time of adoption of the Ordinance and which do not conform to the Wellhead Protection Area Table is allowed, provided that

Best Management Practices (Section I of this Ordinance) are followed.

The addition or expansion does not increase the non-conformity of the use or activity.

The expansion of the non-conforming use may not be for the purpose of changing that use to another non-conforming use unless the applicant can demonstrate that the new use poses a lesser threat to groundwater than the current use.

Expansion of greater than 25% of such existing uses is treated as a new use (i.e., it is permitted, prohibited, or subject to Site Plan Review as per the Wellhead Protection Area Table.

[Town of Norway, Maine, Wellhead Protection Ordinance, Section D (1b), 1993]

This is an example of a description of nonconforming use definitions and procedures for evaluation. In lieu of restating the procedures, references to nonconforming portions of the zoning ordinance can be made, if such standards exists.

Enlargement of, or alteration of a commercial or industrial use existing as of the effective date of this ordinance, or the addition of a process or ancillary facility in conjunction with a use existing as of the effective date of this ordinance, not permitted outright under subparagraph I [Section 24.050.(1)] above, may be permitted in the WPA upon issuance of a special use permit and upon finding the proposed enlargement or expansion of the use, considering the quantities and character of the chemical or other product, the method of use, and the distance from the city of Enterprise water source, would not have an adverse effect, materially contribute to an adverse effect, or create a material risk of an adverse effect, upon the city of Enterprise municipal water source, and after consideration of any impoundment or other mitigating measures imposed by State and federal law, this ordinance, the Planning Director, or the Commission. Upon receipt of an application to enlarge or alter an existing commercial or industrial use or to add a process or ancillary facility in conjunction with a pre-existing use, said permit not reviewable under the provisions of subparagraph 1 [Section 24.050.(1)] above, the Director shall notify the city and, prior to scheduling a public hearing before the Commission, shall arrange a conference to be attended by the applicant, the city's representative, and the Director. The purpose of the conference shall be to review the application, the nature of the processes and chemicals, and the impoundment and other mitigating measures to be employed by the applicant to comply with the standards of this subparagraph. If, following the conference, the city and the applicant are in agreement, the application meets the burden of proof set forth in this subparagraph, the director shall proceed to review and issue the special use permit under the procedures set forth in Section 24.0801.

If, following the conference, the city and the applicant cannot reach agreement as to the compliance of the application to the standards set forth in the subparagraph, the Director shall schedule a public hearing before the Commission as required by Section 24.0801. Failure to conduct the conference within 45 days of the date of the application's submission shall require the Director to schedule the hearing before the Commission. If the proposed use or development is permitted outright in the underlying zone, review by the Director or Commission shall be limited to determination of the application's compliance with the standards set forth in this subparagraph. In the event the proposed use complies with federal and State laws and regulations, the city of Enterprise, or other opponent, shall have the burden of coming forth with evidence sufficient to provide a reasonable basis for concluding that said State and federal laws and regulations are inadequate to assure compliance with the standards set forth in this subparagraph upon presentation of such evidence the burden shall shift to the Director or Commission which insures the protection of the city of Enterprise municipal water source.

[Wallowa County, Oregon, Zoning Ordinance, Section 24.050.(3), 1988]

Variances

Purpose: To set forth the guidelines for providing variances from the strict interpretation of the provisions of the wellhead protection ordinance.

Key Issues:

- Ensure variance approval cannot be used to relax any standards for prohibited or special uses (or to provide a right to pollute).
- Variances are seen as loopholes; therefore, minimize reasons for an applicant to justify unnecessary hardship.
- Do not include more restrictive criteria to define when variances may be granted; that constitutes a derogation of the enabling statutes.

Notes: Although variances can be obtained for any of the provisions of any ordinance, the typical purpose for variances in wellhead protection ordinance provisions is to provide relief in setback or performance standards if a substantial hardship can be demonstrated under a strict interpretation of the ordinance. For instance, a strict application of setback or lot size standards may deprive the property of privileges or safety enjoyed by other similarly located parcels. Variance procedures, like those employed for special uses and conditional uses, require a separate application and review process that involves final adjudication by the Board of Zoning Appeals.

Since the power to grant variances by the zoning board comes directly from an explicit statutory authorization, courts have held that a local ordinance may not change the variance powers granted to the board. Zoning ordinances sometimes do, and courts have voided such ordinances. In effect, from an applicant's point of view, a more restrictive standard may not be invoked to hinder an attempt to obtain a variance. Historically, a number of states and local governments have held that variance powers involve a usurpation of legislative power by the board of appeals.

The debate revolves around the usual standard for granting variances--practical difficulty and unnecessary hardship. Defining criteria in the ordinance for all such unique circumstances is nearly impossible. However, in the context of wellhead protection,

address the issues related to contamination and the risk of contamination of drinking water supplies if variances are granted. One way to do this might be to require documentation, verification, and adequate guarantees that a variance will not result in an increase in risk in contamination.

(1) The Appeal Board as established by the community shall hear and render judgment on requests for variances from the requirements of this ordinance.

(2) The Appeal Board shall hear and render judgment on an appeal only when it is alleged there is an error in any requirement, decision, or determination made by the Wellhead Protection Area Administrator in the enforcement or administration of this ordinance.

(3) Any person or persons aggrieved by the decision of the Appeal Board may appeal such decision in the courts of competent jurisdiction.

(4) No variance may be requested nor granted as a means to circumvent the intentions of this ordinance or as a remedy for a violation of this ordinance (i.e., a variance cannot be issued after the fact).

(5) The Wellhead Protection Area Administrator shall maintain a record of all actions involving an appeal.

(6) Upon consideration of the intent of this ordinance, the Appeal Board may attach such conditions to the granting of variances as it deems necessary to further the purpose and objectives of this ordinance.

(7) Prerequisites for granting variances:

(a) Variances shall only be issued upon a determination that the variance is the minimum necessary considering the potential threat of contamination of the PWS well and aquifer, to afford relief.

(b) Variances shall only be issued upon: (I) showing a good and sufficient cause; (ii) a determination that failure to grant a variance would result in exceptional hardship to the applicant; and (iii) a determination that the granting of a variance will not result in additional threats to the public safety, extraordinary public expense, create nuisances, cause fraud on or victimization of the public or conflict with existing local laws or ordinances.

(c) Any applicant to whom a variance is granted shall be given written notice that the activity receiving this variance will decrease the travel time for potential contaminants to reach the PWS well and that any and all liability of a contamination event as a result of this activity receiving the variance is on the variance holder. Furthermore, the City, its offices, and services, as well as its employees, are released from any responsibility and liability for any damages and/or contamination events due to activity receiving the variance.

(8) Variances may be issued by a community for new development necessary for the conduct of the functionally dependent use provided that: (I) the criteria outlined in Article 4, Section D(1)-(8) are met; and (ii) the development is protected by methods that minimize the risk of a contamination and creates no additional threats to public safety.

[City of Sweeny, Texas, General Ordinance, Section D, 1990]

Variance to a regulation or restriction enacted through the WPA which affects a use or development permitted by or unregulated within the underlying zone may be permitted by the Commission, following public hearing, provided the requested variance:

(1) Relates solely to a regulation or restriction of the WPA and is not a variance which can be heard pursuant to the provisions of Article 8.

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(2) The variance is the minimum variance necessary to alleviate a hardship on the property owner related to the use and enjoyment of the property caused by the regulation or restriction as enacted within the WPA.

(3) The Commission finds the variance will not cause, materially contribute to, or create a material risk of any adverse effect upon the city of Enterprise municipal water source under reasonably possible hydrologic or geologic conditions.

[Wallowa County, Oregon, Zoning Ordinance, Section 24.075, 1988]

(a) The Planning Commission may grant a variance from the terms of this Article only [when], because of special circumstances applicable to the property involved, a strict application deprives such property of privileges or safety enjoyed by other similarly situated property with similarly timed development.

...[T]he variance permitted shall be the minimum departure from the terms of this Article necessary to avoid such deprivation of privileges enjoyed by such other property to facilitate a reasonable use, and which will not create significant probabilities of harmful environmental consequences. The Planning Commission may not grant a variance if it would provide the applicant with any special privileges not enjoyed by other similarly situated property with similarly timed development, or if based on a special or unique condition which was created as a result of the method by which a person voluntarily subdivides land after the effective date of this ordinance.

(b) The Planning Commission may grant a variance [if the regulations require] an unrealistic and unwarranted taking or an undue hardship. However, no such variance may be granted if the condition was created as a result of the method by which a person involuntarily subdivides land after the effective date of this ordinance. The granting or denial of this variance may be appealed to the City Council by any citizen.

[City of Austin, Texas, General Ordinance, Section 107.1, 1981]

Appendix L

6. Performance Standards

Purpose: To set forth standards that, if violated, will trigger an additional review for a proposed use in the wellhead protection area.

Key Issues:

- Specify maximum limits for materials with known contaminants for residential and other incidental uses.
- Limit lot size, setback, or buffer changes.
- Specify standards for determining whether review of expansion or alteration proposals for existing commercial and industrial uses is necessary.

Notes: Standards pertain to the size and quantity or volume of materials with known contaminants. These include standards for using regulated materials in small quantities for maintenance or repair of wells. Standards for residential use and storage of fuel in wellhead protection areas are specified here. Other standards, such as minimum lot size, modified setback requirements, etc., that are different from any of the underlying zoning districts are included here.

(A) Use of Regulated Substances in conjunction with municipal water supply and treatment activities shall not be restricted by this chapter.

(B) Use of Regulated Substances in conjunction with public parks, playgrounds, golf courses, and community centers shall be in accordance with the City of Dayton Park and Recreation Management Plan for maintenance of Sensitive Areas.

(C) Use of Regulated Substances in conjunction with conditional uses in this district shall be limited to:

(1) The aggregate of Required Substances in use may not exceed twenty (20) gallons or one hundred and sixty (160) pounds at any time.

(2) The total use of Regulated Substances may not exceed fifty (50) gallons or four hundred (400) pounds in any twelve (12) month period.

(D) A limited exclusion from the provisions of 150.603(C) is authorized for non-routine maintenance or repair of property or equipment. The use of Regulated Substances under this exclusion shall be limited to:

(1) The aggregate of Regulated Substances in use may not exceed fifty (50) gallons or four hundred (400) pounds at any time.

(2) The total use of Regulated Substances may not exceed one hundred (100) gallons or eight hundred (800) pounds in any twelve (12) month period.

(E) Storage of Regulated Substances in conjunction with municipal water supply and treatment activities shall not be restricted by this chapter.

(F) Storage of fuel and lubricants for vehicle operations in conjunction with permitted and conditional uses in this district shall be in underground tanks placed above the floor surface of a below-grade vault. Said vault shall allow access for physical inspection of the tank for leakage and the interior of the vault shall be continuously monitored and alarmed to provide for automatic and immediate detection of any release from the tank.

(G) Notwithstanding other provisions of this chapter, non-conforming uses in this district presently utilizing underground storage tanks for fuel and lubricants for vehicle operations shall be permitted to replace existing tanks with those constructed as per the specifications of 150.603(F) above and not exceeding the capacity of existing tanks. Replacement of underground tanks for Regulated Substances other than fuel

and lubricants for vehicle operations is not permitted.

(H) Storage of Regulated Substances other than fuel and lubricants for vehicle operations in conjunction with permitted and conditional uses in this district is prohibited.

(I) As part of the findings required under Section 150.424(D), the Zoning Administrator shall utilize the Hazard Potential Ranking System, Section 150.620 to assist in the determination of intensity of use within this district. No substitutions of a non-conforming use shall be permitted which result in an increase of the Hazard Potential Ranking on a parcel within this district.

(J) All uses within this district shall be connected to the public wastewater disposal system.

[City of Dayton, Ohio, Zoning Ordinance, Section 150.603. 1988]

(1) The lot size shall be as required by other existing Norway Ordinances, including Norway's Subdivision Regulation, or State of Maine laws and regulations.

(2) The percentage of the lot which can be covered by impermeable surfaces, including parking areas, shall be limited as presented in the following table.

WHPA	*Maximum Lot Coverage*
1	*30%*
2	*50%*
3	*50%*

[Town of Norway, Maine, Wellhead Protection Ordinance, Section E. 1993]

A gasoline station lot and/or fuel storage tanks shall not be location within two thousand five hundred (2,500) feet of any municipal water wells or other municipal water supply source.

[City of Oswego, New York, Zoning Ordinance, Section 125-50 (2), 1985]

No storage of potatoes or other putrescible crops which are likely to ferment or rot are permitted within 1,000 feet of the diversion point for any of the city of Enterprise Springs, as marked upon the ground by the city. Beyond 1,000 feet, storage of potatoes or other putrescible crops likely to ferment or rot is permitted if stored in silos or other storage facility adequate to insure there will be no leaching into the groundwater.

[Wallowa County, Oregon, Zoning Ordinance, Section 24.025. 1988]

Well spacing requirements are commonly dependent on geologic conditions, demand for water from the aquifer, and other local conditions. Specification of such standards may be included in the zoning ordinance under perofrmance standards if excessive drawing of well water from an aquifer is a concern.

All well locations described in applications for a permit to appropriate water for beneficial use, other than domestic, which propose the diversion or withdrawal of water from the unconsolidated aquifer, commonly described as the Ogallala aquifer, or an alluvial aquifer, or both, shall be placed so that spacing between that well and all other nondomestic wells with a diversion rate of 51 gallons per minute or more meets the following well spacing requirements.

(1) The minimum spacing of wells with a diversion rate of from 51 to 400 gallons per minute shall be 1,300 feet.

(2) The minimum spacing of wells iwth a diversion rate in excess of 400 gallons per minute shall be 2,300 feet.

[Southwest Kansas Groundwater Management District No. 3, Kansas, General Ordinance, Section 5-23.3.(a), 1981]

Appendix L

7. Site Plan Submission and Administrative Requirements

Purpose: To set the application requirements for content, format, and supporting documentation (e.g., such as maps and plans) for site plans for uses in the wellhead protection areas.

Key Elements:

- List of hazardous, toxic, and other regulated materials
- Location of existing wells and public water supply systems
- Location of significant geologic and natural features
- Fees, funding, and disbursement criteria

Notes: In addition to routine site plan submission requirements, additional information about the types and volumes of all hazardous materials expected to be used at a proposed facility should be required on site plans for uses in the wellhead protection area. This information typically must describe the types of wastes a use will generate as well as the methods that will be used to dispose of such wastes. For maps and plans, the location of all existing wells within a certain distance of the property line may be required for reference. Mapping of sensitive geologic or natural resources may also be required. In addition, for stormwater runoff control and management, a separate plan may be required.

Note that, for monitoring and continuous evaluation of contaminants and risks associated with them, the requirements for reporting of hazardous materials use, storage, or disposal should be handled in other codes, outside the scope of zoning powers. These include building codes, health codes, and emergency plans. The site plan provisions in a zoning ordinance are a one-time opportunity for ensuring that development proposals comply witht he ordinance. This opportunity exists before the developments are approved. Because of turnover in land uses and tenants, what may have been approved at the site plan stage may no longer accurately reflect future risks of contamination.

The following written and mapped information shall be submitted:

Description of proposed use: type of use or activity; commercial (trades and services), industrial (manufacturing and processing); product produced: Standard Industrial Code (S.I.C.) if applicable.

A complete list of the types of volumes of all hazardous materials (including fuels) used, stored, processed, handled or disposed, other than those volumes and types associated with normal household use.

Description of types of wastes generated and method of disposal including: solid wastes, hazardous wastes, sewage and non-sewage wastewater discharges. Location of adjacent (within 200 feet of property line) private drinking water supply wells.

Location of public water supply wells within 1,000 feet.

Provisions for management of storm water runoff.

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A site plan and building plan showing: hazardous materials loading, storage, handling and process areas; floor drains; process vents; sewage disposal; and waste storage or disposal areas.

Plans and documents containing information to show compliance with the Performance and Design Standards.

Other additional information as may be requried by reviewing agencies regarding: the proposed use, its potenital impact to water quality, hydrogeologic information, monitoring, and mitigation measures.

[Connecticut Department of Environmental Protection, *A Guide for Drafting Local Aquifer Protection Regulations.* Bureau of Water Management, Planning and Standards Division, Section VII, 1989]

Except for applicants initially electing to submit an Environmental Assessment Report as set forth in Section 917.7, all other applicants whose properties are located entirely or partially within the Carbonate Area District, as defined in Section 917.2, shall submit the following information to the township.

(1) A map, at scale no smaller than 1" = 100' indicating the location of the property and all proposed improvements thereon and their geographic relationship tot he township's Carbonate District. The applicant shall utilize the carbonate area boundaries depicted on the township's Carbonate District Map.

(2) For areas proposed for grading, construction of buildings, and other improvements, the applicant shall submit information for such areas, indicating the presence of any of the following carbonate features:

Depressions;

Fissures, lineaments, faults, or air photo fracture traces;

"Ghost Lakes" occurring after rainfall events;

Outcrops of bedrock;

Seasonal high water tables;

Sinkholes;

Soil mottling, as defined by a soil scientist;

Springs;

Surface drainage entering the ground.

Such information may be based upon field surveys and/or published data, but in either case shall be supported by an explanation of its source including the qualifications of the individuals directly responsible for preparing such information.

[City of West Whiteland Township, Pennsylvania, Zoning Ordinance, Section 917.6. 1986]

Site plans and supporting documents shall be provided and contain sufficient information to show compliance with the site development and management criteria of these regulations. All applications for a special exception in the Aquifer Protection Zone shall

include at least the following:

(a) Engineering plan prepared by a registered civil engineer showing existing and proposed contours, proposed site drainage, sanitary sewers, public water supply and hydrants, including the location of the nearest existing fire hydrant at the time of application, at a scale of not less than 1" = 40' and on 24" x 36" sheets unless a smaller scale is approved by the Director of Planning in writing.

(b) Layout plan showing the location of all buildings, parking areas, entrance and exit drives, hazardous materials/waste storage areas and facilities, loading areas, disposal facilities and containment areas at a scale of not less than 1" = 40' and on 24" x 36" sheets unless a smaller scale is approved by the Director of Planning.

(c) A building floor plan for all buildings showing the location of all storage or containment areas and facilities, process areas, and building exits. Storage areas shall be identified according to their use and material stored. The location of emergency equipment related to each storage area shall be shown. Building plans shall be at an appropriate scale on 24" x 36" sheets.

(d) Construction details shall be provided at an appropriate scale for all containment facilities, drainage facilities including detention basins, water and sewer facilities, and hydrants. Calculations, details, and profiles shall be provided for all drainage design systems. All storage and containment facilities shall be described by the type of materials stored, the quantity of the containers, and the volume of containment areas.

(e) A comprehensive description of the amount and composition of any and all hazardous materials that are manufactured, generated, stored, discharged, used, or transported on, to or from the site.

[City of Manchester, Connecticut, Zoning Ordinance, Section 21.07.02, 1988]

For new activities located in WHPA 1, or WHPA 2, or WHPA 3 and regulated by the above "Applicable Land Uses or Activities" Table, the applicant for a Site Plan Review has the burden of proof that the proposed activity will not adversely affect groundwater. All applications shall be prepared and considered as per Norway's existing Site Plan Review Ordinance and shall include written information and plan (map) information. In addition, certain land uses or activities may require Site Plan Reviews with additional information as...required by the Planning Board.

[Town of Norway, Maine, Wellhead Protection Ordinance, Section F, 1993]

An application for an Aquifer Protection Overlay Zone review shall include, in addition to the other requirements set forth in the Zoning Regulations and Subdivision and Other Land Use Regulations, the following information:

(1) The amount and composition of any hazardous materials that will be handled, stored, generated, treated, or disposed of on the property.

(2) Provisions for treatment, storage, and/or disposal of any hazardous materials. "Hazardous Materials" means hazardous materials as defined in 40 CFR 171.8 and includes those materials listed in 40 CFR 172.101, "hazardous materials table for any "hazardous substance" as defined in 40 CFR 302.4 and listed in Table 302.4, "list of hazardous substances and reportable quantities," or any" hazardous waste" as defined in Section 22a-115, CGS.

(3) Distance to nearest public or private drinking water supply well or AA streams (tributary to public drinking water supply).

(4) Whether public sanitary sewers are available or proposed at the location.

(5) Septic tank location, size, and capacity, and/or sewage lift stations, force mains, and grease traps.

(6) Expected types and amount of discharge to sewers, to the ground and to surface water.

(7) Emergency plan to detect and control hazardous materials leaks and spills, including but not limited to inspections, notification of official emergency containment and clean-up procedures.

[Town of Cheshire, Connecticut, Zoning Ordinance, Section 47.4, January 1994]

Some communities include funding costs and other revenue-related provisions as part of the wellhead protection ordinance. These provisions describe how costs associated with the administration of this ordinance along with any costs associated with emergency response and remediation measures necessary in the event of contamination will be recovered. Funding provisions include specific conditions for collection of fees, disbursement and use of funds, and details pertaining to the powers and conduct of an oversight board or committee.

(A) Establishment of the Well Field Protection Fund

(1) The Well Field Protection Fund is hereby established to remediate pollution that could affect the public water supply and/or to pay the costs of acquiring interests in property necessary to reduce the risk of pollution of the public water supply. The Well Field Protection Fund can be used only for Well Field Protection Activities within the Well Field Protection Overlay District and within the one (1) year capture zones of the well fields.

(2) The City of Dayton Water Rates shall be amended to include a Well Field Protection Charge applicable to the entire rate base. This Charge is to generate revenue for the Well Field Protection Fund.

(3) All interest and payments resulting from Well Field Protection Fund activities will be paid to the Well Field Protection Fund. All directly related administrative costs of the Well Field Protection Fund are reimbursable from the Well Field Protection Fund.

(4) Costs for Well Field Protection activities advanced from the water Fund or any other City source of funds are reimbursable from the Well Field Protection Fund.

(B) Well Field Protection Board

(1) The Well Field Protection "Board" is hereby established. The Board shall consist of the Directors of Water, Finance and Planning. The Board shall determine the Well Field Protection Charge to be part of the City of Dayton Water Rates subject to approval by the City Commission.

(2) The Board shall reduce the Well Field Protection Charge if the Well Field Protection Fund exceeds the limitations as set forth in Section 53.05(C)(1) subject to approval by the City Commission.

(3) The Board shall, subject to approval by the City Commission, develop rules, regulations, and procedures for the administration of the Well Field Protection Fund.

(C) Limitations

(1) The Well Field Protection Fund shall be limited to $10,000,000.00.

(2) Interests in private property will not be acquired with funding under the Well Field Protection Fund in order to compensate the owner for compliance with

a) a lawful order, requirement or declaration from any regulatory agency; or

b) a requirement to obtain or maintain insurance coverage.

[City of Dayton, Ohio, Zoning Ordinance, Section 53.05.1988]

Appendix L

The Board of Supervisors of East Marlborough Township specifically finds that it is equitable and in the public interest for the Township to bear a portion of the costs associated with the review field testing, and reporting procedures prescribed in Section 1205A. Hence, the costs thereof shall be borne as follows:

(A) The cost of data study and site inspection by the Township engineer and the subsequent report as specified in Section 1205A C, D, and E shall be equally divided between the Township and the landowner.

(B) The cost of any additional testing and reports as specified in Section 1205A, F, and G, shall be divided so that the Township will bear 20% of the cost and the landowner shall bear 80% of the cost.

(C) East Marlborough Township shall not be responsible or bear any of the cost of any other engineering or testing expenses and in the event that the landowner wishes to engage his own engineer, the landowner shall be responsible for all costs thereof.

[City of East Marlborough Township, Pennsylvania, Zoning Ordinance, Section 1208A, 1979]

Appendix L

8. Definitions

Purpose: To define key words used in the ordinance.

Key Issues:

- Define all major terms used while drafting the ordinance
- Use definitions from federal and State statutes, where applicable
- Modify or amend existing definitions in other local ordinances for consistency.

Notes: It should become clear which terms require definition as the ordinance is drafted. Communities have found it necessary to define terms such as well, wellhead, groundwater, etc. The following are some of the common definitions of terms and concepts found in wellhead protection ordinances. Note that not all definitions listed below are directly related to wellhead protection and may be more appropriate in other sections of the zoning ordinance. Such definitions include those related to groundwater protection (for use in other ordinances dealing with water quality) and others related to zoning administration. The sample definitions are divided into four groups:

Wellhead and Wellfield Definitions

Definitions of Geologic and Natural Forms Related to Groundwater Protection

Hazardous Materials Definitions

Other Zoning and Miscellaneous Definitions

Wellhead and Wellfield Definitions

Aquifer *A geologic formation, group of formations or part of a formation capable of storing and yielding groundwater to wells or springs.*
[Brookings County, South Dakota, Zoning Ordinance, Section 1106, 1989]

Aquifer *A permeable geologic formation, either rock or sediment, that when saturated with groundwater capable of transporting water through the formation.*
[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Conified Aquifer *Conified aquifer means (1) An Aquifer overlain and underlain by impermeable layers or (2) An aquifer in which the groundwater is under pressure greater than atmospheric pressure and which will rise in a well above the point at which it is first encountered.*
[Southwest Kansas Groundwater Management District #3, Kansas, General Ordinance, Section 5-23-1(c). 1981]

Containment Device *A device that is designed to contain an unauthorized release, retain it for cleanup and prevent released materials from penetrating into the ground.*
[City of Renton, Washington, Draft Aquifer Protection Ordinance, Section 4.F. 1991]

Drawdown Contour, one-foot *A one-foot drawdown contour is the locus of points around a well*

or well field where the free water elevation is lowered by one foot due to a specified pumping rate of the well or well field.

[Palm Beach County, Florida, Wellhead Protection Ordinance, Section 3.t. 1991]

Groundwater *The water contained within the earth's surface that has penetrated from precipitation and from infiltration by streams, ponds and lakes.*

[Wetlands Protection, A Local Government Handbook, 1991]

Groundwater Contamination *Presence of any substance, designated by the U.S. EPA or the State of Maine as a primary or secondary water quality parameter, in excess of the maximum allowable containment level (MCL).*

[Town of Norway, Maine, Wellhead Protection Ordinance, Section J.2, 1993]

Groundwater, High Seasonal *High seasonal groundwater shall mean the minimum depth at any season of the year to the upper surface of the zone of saturation, as measured from the ground surface.*

[City and County of Missoula, Montana, Subsurface Sewage Treatment and Disposal Systems Ordinance, Section XII, 1988]

Indirect Recharge Area *The area contributing water to surface water courses up gradient of the aquifer or Well field area of contribution.*

[Connecticut Department of Environmental Protection, A Guide for Drafting Local Aquifer Protection Regulations. Bureau of Water Management, Planning and Standards Division, Section III, 1988]

Leachable Material *Material, including salt and certain components of concrete, asphalt, tar, coal, etc. which is readily soluble in water and thus easily removed and transported in solution by meteoric and/or groundwater.*

[Town of Norway, Maine, Wellhead Protection Ordinance, Section J.2, 1993]

Percolation Rate *The rate at which water flows or trickles through porous soils, as determined by a percolation test.*

[City of Anchorage, Alaska, Wastewater Disposal Regulations, Section 15.65.010 V, 1990]

Permitting Pumping Capacity *Refers to the amount of water authorized by the South Florida Water Management District to be pumped from a well, expressed as gallons per day.*

[Broward County, Florida, General Ordinance, Section 27-376, 1984; 1989]

Pollutant Travel Time *Is the time required by pollutants to travel from one point to another.*

[Broward County, Florida, General Ordinance, Section 27-376, 1984; 1989]

Potable Water *Is that water that is satisfactory for drinking, culinary, and domestic purposes, meeting current state and federal drinking water standards.*

[Broward County, Florida. General Ordinance. Section 27-376. 1984: 1989]

Potable Water Supply *Any water used or intended to be used for drinking, bathing, culinary or other personal purposes.*

[Ocean County, New Jersey. Ordinance 87-1, Section 1, 1999]

Primary Recharge Area (for stratified drift aquifers) *The area overlying the aquifer and adjacent*

stratified drift in which groundwater flows directly into the aquifer. (The contact line between the stratified drift and adjacent till or bedrock is the boundary line).

[Connecticut Department of Environmental Protection, A Guide for Drafting Local Aquifer Protection Regulations, Bureau of Water Management, Planning and Standards Division. Section III. 1989]

Secondary Recharge Area *Till and bedrock areas which provide direct groundwater inflow to the primary recharge area.*

[Connecticut Department of Environmental Protection, A Guide for Drafting Local Aquifer Protection Regulations. Bureau of Water Management, Planning and Standards Division. Section III. 1989]

Shallow/Surficial Aquifer *An aquifer in which the permeable media (sand and gravel) starts at the land surface or immediately below the soil profile. The main shallow/surficial aquifer in Brookings County is the Big Sioux Aquifer.*

[Brookings County, South Dakota, Zoning Ordinance. Section 1106. 1989]

Stormwater Drainage *A sewer or other system for conveying surface runoff due to storm events and unpolluted groundwater or surface water, including that collected by cellar drains, but excluding sanitary sewage and industrial waste.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Stormwater Impoundment *Any structure designed and constructed to contain stormwater runoff.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Subsurface Disposal System *A collection of treatment tank(s), disposal area(s), holding tank(s) and pond(s), surface spray system(s), cesspool(s), well(s), surface ditch(es), alternative toilet(s), or other devices and associated piping designed to function as a unit for the purpose of disposing of wastes or wastewater on or beneath the surface of the earth.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Surface Runoff *That part of the precipitation that passes over the surface of the soil to the nearest surface stream without first passing beneath the surface.*

[City of West Whiteland Township, Pennsylvania. Zoning Ordinance. Section 917.3. 1986]

Ten-Year Time of Travel Distance *The distance that groundwater will travel in ten years. This distance is a function of the permeability and slope of the aquifer.*

[Brookings County, South Dakota, Zoning Ordinance, Section 1106, 1989]

Time of Travel Boundary *A boundary beyond which groundwater will take more than a set period of time (i.e., 200 days) to travel to a given point (i.e. a pumping well).*

[Town of Norway, Maine, Wellhead Protection Ordinance, Section J.2, 1993]

Transfer Station; Recycling Facility *Facility designed for temporary storage of discarded material intended for transfer to another location for disposal or re-use: facility which processes discarded material for reuse.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Travel Time Contour *Locus of points from which water takes an equal amount of time to reach a given destination such as a well or wellfield.*

Appendix L

[Broward County, Florida, General Ordinance. Section 27-376. 1984: 1989]

Travel Time Zones *The areas bounded by travel time contours.*
[Broward County, Florida, General Ordinance. Section 27-376. 1984: 1989]

Wastewater *Any combination of water-carried wastes from institutional, commercial, and industrial establishments, and residences together with any storm, surface water, or groundwater, as may be present.*
[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Wastewater Treatment Plant *Any arrangement of devices and structures used for treating wastewater.*
[Town of Norway, Maine, Wellhead protection Ordinance. Section J.2. 1993]

Water Supply System, Individual *An individual water supply system means a single system of piping, pumps, tanks, or other facilities utilizing a source of groundwater to supply water to a single lot.*
[Montgomery County, Maryland, Individual Water Supply and Sewage Disposal Ordinance. Section 3.2. 1988]

Watershed *Land lying adjacent to water courses and surface water bodies which creates the catchment or drainage area of such water courses and bodies; the watershed boundary is determined by connecting topographic high points surrounding such catchment or drainage areas.*
[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Well, Active *An active well is a well that has been utilized at least once I the preceding 12 months for the extraction of groundwater.*

Well, Inactive *An inactive well or standby well means a well that has not been used for a period of one year or more for the production of groundwater, but is maintained in such a condition that it could be so used, or a monitoring well maintained for such use, or a cathodic protection well maintained for such use.*

Well, Abandoned *An abandoned or unused well may be defined under one or more of the following:*

a. *A well, other than a monitoring well, which has been out of service continuously for one year or more, and does not meet the definition of a standby well.*

b. *A monitoring well from which no measurement or sample has been taken for a period of three years.*

c. *A well which is in such a state of disrepair that it cannot be made operational for its intended purpose.*

d. *A test hole or exploratory boring 24 hours after construction and testing work has been completed.*

e. *A cathodic protection well that is no longer functional for its original purpose.*

f. Any boring that cannot be satisfactorily completed as a well.

[Santa Clara County, California, Ordinance Regulating Classification, Construction and Destruction of Wells, Section 2, 1990]

Wellfield *A tract of land which contains a number of existing or proposed wells for supplying water as specified in the wellfield protection maps.*

[Broward County, Florida, General Ordinance, Section 27-376, 1984; 1989]

Wellfield Area of Contribution *Area of the aquifer where groundwater flow is diverted to a pumping well due to a lowering of the water table.*

[Connecticut Department of Environmental Protection, *A Guide for Drafting Local Aquifer Protection Regulations*. Bureau of Water Management Planning and Standards Division. Section III. 1989]

Wellfield Recharge Area *The area from which groundwater flows directly to the wellfield area of contribution.*

[Connecticut Department of Environmental Protection, *A Guide f or Drafting Local Aquifer Protection Regulations*. Bureau of Water Management, Planning and Standards Division. Section III. 1989]

Wellhead *The specific location of a well (a hole or shaft dug or drilled to obtain water) and/or any structure built over or extending over a well.*

[Town of Norway, Maine, Wellhead protection Ordinance. Section J.2. 1993]

Wellhead Protection Area *The surface and subsurface area surrounding a water well or wellfield supplying a public water system, through which contaminants are reasonable likely to move toward and reach such well or wellfield.*

[U.S.C. Safe Drinking Water Act. 1986 Amendments]

Wastewater *Wastewater or sewage means the combination of the liquid and water carried wastes from residences, commercial buildings, industrial plants and institutions.*

[City of Denver, Colorado, Industrial and Prohibited Wastewater Discharges Ordinance. Section 11-3-3 (43). 1991]

Water Table *The upper surface of a zone of saturation except where that surface is formed by an impermeable body.*

[City of West Whiteland Township, Pennsylvania, Zoning Ordinance. Section 917.3. 1986]

Zone of Contribution *The entire area around a well or wellfield that is recharging or contributing water to the well or wellfield.*

[Brookings County, South Dakota, Zoning Ordinance. Section 1106. 1989]

Zone of Contribution *The area from which groundwater flows to a pumping well.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Zones of Influence *Refers to zones delineated by isotravel time contours around existing or proposed wellfields as specified in the wellfield protection maps, as amended, approved by the Broward County Board of Commissioners, within which hazardous materials are regulated to protect the quality of the groundwater.*

Appendix L

Zone 1: The land area situated between the well(s) and the ten-day travel time contour.

Zone 2: The land area situated between the ten-day and the thirty-day travel time contours.

Zone 3: The land area situated between the thirty-day and the 210-day travel time contours, or the thirty-day and the one-foot drawdown contours, whichever is greater.

[Broward County, Florida, General Ordinance, Section 27-376, 1984; 1989]

Definitions of Geologic and Natural Forms Related to Groundwater Protection

Carbonate *A sedimentary rock formed by the organic or inorganic precipitation of mineral compounds characterized by the fundamental chemical ion CO_3, e.g., limestone and dolomite.*

[City of West Whiteland Township, Pennsylvania, Zoning Ordinance, Section 917.3. 1986]

Depression *A low place of any size on a plane surface with drainage underground or by evaporation hollow completely surrounded by higher ground and hazing no natural outlet for surface drainage.*

[City of West Whiteland Township, Pennsylvania, Zoning Ordinance. Section 917.3. 1986]

Drainage *The movement of water from an area by stream or sheet flow and removal of excess water from soil by downward flow.*

[City of West Whiteland Township. Pennsylvania. Zoning Ordinance. Section 917.3. 1986]

Fault *A surface or zone of rock fracture along which there has been noticeable movement.*

[City of West Whiteland Township, Pennsylvania, Zoning Ordinance. Section 917.3. 1986]

Fissure *An extensive crack, break, or fracture in the rock.*

[City of West Whiteland Township, Pennsylvania, Zoning Ordinance. Section 917.3. 1986]

Ghost *Lakes* *Transient surface water bodies formed in sinks after heavy precipitation, due to poor internal drainage, residual clay remaining after solution of limestone minerals, or other causes.*

[City of West Whiteland Township, Pennsylvania. Zoning Ordinance. Section 917.3. 1986]

Outcrop *The exposure of bedrock or strata projecting through the overlying cover of detritus and soil.*

[City of West Whiteland Township, Pennsylvania. Zoning Ordinance. Section 917.3. 1986]

Overland Flow *Storm water runoff that is not confined by any natural or man-made channel such as a creek, drainage ditch, storm sewer, or the like.*

[City of Austin, Texas, Zoning Ordinance. Article 1, Section 101.4(b). 1981]

Sinkhole *A funnel-shaped depression in the land surface generally in a limestone region associated with a subterranean passage developed by solution.*

[City of West Whiteland Township, Pennsylvania. Zoning Ordinance. Section 917.3. 1986]

Soil Mottling *A soil irregularly marked with spots or patches of different colors, usually indicating poor aeration or lack of good drainage.*

[City of West Whiteland Township, Pennsylvania, Zoning Ordinance, Section 917.3. 1986]

Spring *A place where, without the agency of man, water flows from rock or soil upon the land*

or into a body of surface water.

[City of West Whiteland Township, Pennsylvania. Zoning Ordinance, Section 917.3, 1986]

Stratified Drift *Predominantly sorted sediment deposited by glacial meltwater consisting of gravel, sand silt or clay in layers of similar grain size.*

[Connecticut Department of Environmental Protection, *A Guide for Drafting Local Aquifer Protection Regulations.* Bureau of Water Management, Planning and Standards Division, Section III. 1989]

Hazardous Materials and Related Definitions

Containment Facility, Primary *A tank, pit, container, pipe, or vessel of first containment of a liquid or chemical.*

[Brookings County, South Dakota, Zoning Ordinance, Section 1106, 1989]

Containment Facility, Secondary *A second tank, catchment pit, pipe, or vessel that limits and contains liquid or chemical leaking or leaching from a primary containment area; monitoring and recovery are required.*

[Brookings County, South Dakota, Zoning Ordinance. Section 1106. 1989]

Chemical Bulk Storage *Storage of a chemical or chemical in a container or containers larger than those intended for normal homeowner or retailer purposes. Proper, non-commercial, homeowner use of chemicals is not included.*

[Town of Norway, Maine, Wellhead protection Ordinance. Section J.2. 1993]

Chemigation *The process of applying agricultural chemicals (fertilizer or pesticides) using an irrigation system by injecting the chemicals into the water.*

[Brookings County, South Dakota, Zoning Ordinance. Section 1106. 1989]

Contaminate_*To have unwanted chemicals or bacteria mixed into a water system formerly void of such substances.*

[City and County of Missoula, Montana, Subsurface Sewage Treatment and Disposal Systems Ordinance. Section XII. 1988]

Contingency Plans *Detailed plans for control, recontainment, recovery, and clean up of hazardous materials released during fires, equipment failures, leaks, and spills.*

[Brookings County, South Dakota, Zoning Ordinance. Section 1106.1989]

Critical Material *Any liquid, semi-liquid, flowable, or water soluble solid that is listed on the most current Superfund amendments and Reauthorization Act, Title III (SARA III List of Lists published by the Office of Toxic Substances, U.S. Environmental Protection Agency, Washington, D.C., or is required by the U.S. Occupational Safety and Health Administration to have a material safety data sheet (MSDS).*

[Panhandle District #1, Coeur d'Alene, Idaho, Environmental Health Code. Section 41.1.400.02(a). 1990]

Discharge *To release by any means to the surface waters, groundwaters, surface of the ground, below ground, the air and living resources. Discharge also includes, but is not limited to, any spilling, leaking, pumping, pouring, emitting, emptying or dumping except those activities duly permitted by any state or federal agency.*

Appendix L

[Town of Owego, New York, General Ordinance, Protection of Wells. Section (b). 1985]

Fuel Oil Distributor; Fuel Oil Storage *The storage of fuel for distribution or sale. Storage of fuel oil not for domestic use (i.e., not in tanks directly connected to burners).*

[Town of Norway, Main, Wellhead Protection Ordinance. Section J.2. 1993]

Grey Water *All domestic wastewater except toilet discharge water.*

[Brookings County, South Dakota, Zoning Ordinance. Section 1106. 1989]

Hazardous Materials *A material which is defined in one or more of the following categories:*

(a) Ignitable: A gas, liquid, or solid which may cause fires through friction, absorption of moisture, or which has low flash points. Examples: white phosphorous and gasoline.

(b) Carcinogenic: A gas, liquid, or solid which is normally considered to be cancer causing or mutagenic. Examples: PCB's in some waste oils.

(c) Explosive: A reactive gas, liquid, or solid which will vigorously and energetically react uncontrollably if exposed to heal, shock, pressure, or combinations thereof. Examples: dynamite, organic peroxides, and ammonium nitrate.

(d) Highly Toxic: A gas, liquid, or solid so dangerous to man as to afford an unusual hazard to life. Examples: parathion and chlorine gas.

(e) Moderately Toxic: A gas, liquid, or solid which, through repeated exposure or in a single large dose, can be hazardous to [humans]. Example: atrazine.

(f) Corrosive: Any material, whether acid or alkaline, which will cause severe damage to human tissue, or in case of leakage might damage or destroy other containers of hazardous materials and cause the release of their contents. Examples: battery acid and phosphoric acid.

[Brookings County, South Dakota. Zoning Ordinance. Section 1106. 1989]

Hazardous Material *Any gaseous, liquid, or solid materials, or substances designated as hazardous by the U.S. Environmental Protection Agency and/or the Maine Department of Environmental Protection.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Hazardous Waste *Any substance identified under Chapter 850, Identification of Hazardous Wastes, of the rules of the State of Maine, Department of Environmental Protection, effective date July 1, 1980, including revisions or amendments thereto, and any radioactive waste material, which means any solid, liquid, or gas residue, including, but not limited to, spent fuel assemblies prior to processing, remaining after the primary usefulness of the radioactive material has been exhausted, and containing nuclides that spontaneously disintegrate or exhibit ionizing radiations.*

[Town of Norway, Maine, Wellhead Protection Ordinance, Section J.2. 1993]

Heating Oil Storage (Consumptive Use) *Storage for heating of heating oil in excess of 660 gallons. Tanks with capacity between 50 gallons and 660 gallons are regulated by the Oil and Solid Fuel Board.)*

Appendix L

[Town of Norway, Maine, Wellhead Protection Ordinance, Section J.2. 1993]

Industrial Waste *Wastes resulting from the processes employed in industrial manufacturing, trade, or business establishments.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Inert Fill *Material placed on or into the ground as fill: the material will not react chemically with soil, geologic material, or groundwater that may be present at the site.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Intensive Open Space Uses *Uses of open space, such as gold courses and power lines, which have the potential, because of their duration, frequency, or nature to significantly alter the environment, particularly the groundwater quality and quantity, associated with the open space.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Junk, Salvage Yard *A yard, field, or other area used as a place of storage for:*

(1) Discarded, worn-out, or junked plumbing, heating supplies, household appliances, and furniture;

(2) Discarded, scrap and junked lumber;

(3) Old or scrap copper, brass, rope, rags, batteries, paper trash, rubber or plastic debris, waste and all scrap iron, steel, and other scrap or ferrous or nonferrous material;

(4) Used tires, discarded tires, or worn-out tires which may or may not be usable now or in the future;

(5) Town garbage dumps, waste dumps, and sanitary fills will not be considered junkyards for the purpose of this Ordinance.

(6) Three or more unserviceable, worn-out vehicles.

[Town of Norway, Maine, Wellhead Protection Ordinance, Section J.2. 1993]

Landfill *An area used for the placement of solid waste, liquid waste or other discarded material on or in the ground.*

[Town of Norway, Maine, Wellhead Protection Ordinance, Section J.2. 1993]

Leaks and Spills *Any unplanned or improper discharge of a potential contaminant, including any discharge of a hazardous material.*

[Brookings County, South Dakota. Zoning Ordinance. Section 1106. 1989]

Pesticide, Herbicide Bulk Storage *Storage of herbicides or pesticides intended for sale or intended for application on commercial premisses or intended for application on cash crops. Homeowner storage or storage related to non-commercial gardeners is not included.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Salt or Sand/Salt Piles (covered) *Storage of salt or sand/salt mix intended for municipal, commercial, or other use except for homeowner sidewalks, steps, or driveways beneath a roof or other structure capable of preventing precipitation from reaching the salt or sand/salt.*

Appendix L

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Salt or Sand/Sale Piles (uncovered) *Storage of any amount of salt or sand/salt for any purpose, without a roof or other structure capable of preventing precipitation from reaching the salt or sand salt.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Sludge *Residual material produced by water or sewer treatment processes, industrial processes, or domestic septic tools.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Sludge Utilization *The spreading of sludge on the ground or other use of sludge which might expose surface or groundwater to the sludge.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Snow Dump *A location to which snow is transported and dumped by commercial, municipal, or State snow-plowing operations.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Solid Waste *Discarded solid material with insufficient liquid content to be free flowing. This includes but is not limited to rubbish, garbage, scrap materials, junk, refuse, inert fill materials, and landscape refuse. For the purposes of this Ordinance, solid waste includes recyclable materials.*

[Town of Norway, Maine, Wellhead Protection Ordinance, Section J.2. 1993]

Spill Prevention Control and Countermeasure (SPCC) Plan *Spill Prevention Control and Countermeasure Plan as described in 40CFR, Part 112 of Federal Oil Pollution Prevention Regulations.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Underground Storage Tank *Any one or a combination of nonportable containers, excluding all pipes connected thereto, which is used to store an accumulation of toxic or hazardous substances, and the volume of which is ten percent or more beneath the surface of the ground.*

[Elkhart County, Groundwater Protection Ordinance, Section 3.P. 1988]

Other Zoning Definitions Appropriate to Wellhead Protection Ordinances

Best Management Practices *Measures contained in Soil Conservation Service South Dakota Technical Guide, either managerial or structural, that are determined to be the most effective, practical means of preventing or reducing pollution inputs from nonpoint sources to water bodies.*

[Brookings County, South Dakota, Zoning Ordinance. Section 1106. 1989]

Best Management Practices *Operational Procedures for handling, storage, and disposal of regulated substances and procedures which are designed to minimize the impact of certain activities or land uses on groundwater quality and quantity.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Conforming *A building, structure, activity, or land use which complies with the provisions of this Ordinance.*

Appendix L

[Town of Norway, Maine, Wellhead Protection Ordinance, Section J.2. 1993]

Construction *Includes building, erecting, moving, or any physical operations on the premises which are required for construction. Excavation, fill, paving, and the like shall be considered part of construction.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Construction and Commercial Equipment and Vehicle Storage *Storage of construction equipment or other commercial vehicles in excess of 30 consecutive days in which the equipment is not used.*

[Town of Norway, Maine, Wellhead Protection Ordinance. Section J.2. 1993]

Continuous Transit *Continuous Transit is the nonstop movement of a mobile vehicle.*

[Broward county, Florida, General Ordinance, Section 27-376, 1984; 1989]

Existing Activity *Existing activity [or use for which] a building permit or occupational license has been issued by the appropriate jurisdiction prior to the effective date of this ordinance, or for which a completed building permit or occupational license application had been filed and accepted with the appropriate jurisdiction prior to the effective date of this ordinance. All other activities or uses shall be deemed"new."*

[City of Jacksonville, Florida, Wellhead Protection Ordinance, Part VI, Section 366.603, 1991]

Gas Station, Service Station *Any place of business at which gasoline, other motor fuels, or motor oil are sold to the public for use in a motor vehicle, regardless of any other business on the premises.*

[Town of Norway, Maine, Wellhead protection Ordinance. Section J.2. 1993]

Lineament *Any line on an aerial photograph that is structurally controlled, including any alignment of separate photographic images, such as stream beds, trees, or bushes, that are so controlled. The term is widely applied to lines representing beds, mineral bandings, veins, faults, joints, disconformities, and rock boundaries.*

[City of West Whiteland Township, Pennsylvania, Zoning Ordinance, Section 917.3. 1986]

Nonconforming Use *A building, structure, use of land, or portion thereof, existing at the effective date of adoption or amendment of this Ordinance which does not conform to all applicable provisions of this Ordinance.*

[Town of Norway, Maine, Wellhead Protection Ordinance, Section J.2., 1993]

Utility Corridor *Right-of-way easement, or other corridor for transmission wires, pipes, or other facilities for conveying energy, communication signals, fuel, water, wastewater, etc. Municipal water supply distribution mains, operational, or maintenance facilities, are excluded from restrictions in the Wellhead Protection Table.*

[Town of Norway, Maine, Wellhead Protection Ordinance, Section J.2. 1993]

Appendix M

1995 COUNTY EMERGENCY MANAGEMENT COORDINATORS
(Subject to Change)

Albany County
Laramie, WY 82070
Glenn Moriz
721-5397 (wk)
745-4711 (hm)

Big Horn County
Cowley, WY 82420
Don McCracken
548-7647 (hm)

Campbell County
Gillette, WY 82716
Tom Johnson
682-5319 (wk)

Carbon County
Rawlins, WY 82301
Nick Casson
327-5333 (hm)

Converse County
Douglas, WY 82633
William Meehan, Jr.
358-6133 (hm)

Crook County
Sundance, WY 82729
Cheryl Williams
283-2390 (wk)
283-2361 (hm)

Fremont County
Riverton, WY 82501
Kim Lee
856-2374 (wk)
856-7422 (hm)

Goshen County
Torrington, WY 82240
Melvin Eaton
532-2788 (hm)

Hot Springs County
Thermopolis, WY 82443
Jerry Langbehn
864-3421 (wk)
864-5602 (hm)

Johnson County
Buffalo, WY 82834
Steve Apgar
684-9058 (wk)
684-9032 (hm)

Laramie County
Cheyenne, WY 82001
David Guille
637-6406 (wk)
638-3541 (hm)

Lincoln County
Kemmerer, WY 83101
Charles Young
877-9835 (wk)
877-6707 (hm)

Natrona County
Casper, WY 82601
Lt. Stewart Anderson
235-9205 (wk)
237-3016 (hm)

Niobrara County
Lusk, WY 82225
Kester Akers
334-3622 (wk)
334-2674 (hm)

Park County
Cody, WY 82414
Duane Sharp
587-5601 (587-2204) (wk)
587-4844 (hm)

Platte County
Wheatland, WY 82201
Jane Carlson
322-2140 (wk)
322-3018 (hm)

Sheridan County
Sheridan, WY 82801
Thomas Ringley
674-8945 (wk)
674-4812 (wk)

Sublette County
Pinedale, WY 82941
Scott Thompson
367-2284 (wk)
276-5320 (hm)

Sweetwater County
Rock Springs, WY 82
Jack Zimmerman
352-6820 (wk)
875-3564 (hm)

Teton County
Jackson, WY 83001
Jim Stone
733-3392 (wk)
733-4348 (hm)

Uinta County
Evanston, WY 82930
Brent Morris
789-1780 (wk)

Washakie County
Worland, WY 82401
Roy Johnson
347-2741 (wk)
347-4832 (hm)

Weston County
Upton, WY 82730
Vonda Rothleutner
468-2656 (wk)
468-2300 (hm)

Appendix N

SUMMARY OF EXISTING SOURCE CAPACITY AND DEMAND
(Form V-1)

EXISTING SOURCE PRODUCTION CAPACITY	Wet Year Winter (gpd)	Dry Year Winter (gpd)	Wet Year Summer (gpd)	Dry Year Summer (gpd)
(Source A)				
(Source B)				
(Source C)				
TOTAL SOURCE PRODUCTION CAPACITY (gpd)				
TOTAL SOURCE STORAGE CAPACITY (gal)				
EXISTING DEMAND (gpd)				
NUMBER OF SUPPLY DAYS IN STORAGE				

Appendix O

CONTINGENCY PLANNING TEAM ROSTER
(Form V-2)

POSITIONS	NAME	ROLE	WORK PHONE	HOME PHONE
Wyoming DEQ Herschler Bldg. Cheyenne, WY 82002		Respond/ Guidance	(307)777-7781 (24-hour)	Notify in case of hazardous substance release
National Response Center Washington, D.C.		Respond/ Guidance	(800) 424-8802 (24-hour)	Notify NRC or EPA in case of hazardous substance release
US EPA Region VIII Emergency Response Branch One Denver Place 999 18th Street, Suite 500 Denver, CO 80202		Respond/ Guidance	(303) 564-1788 (24-hour)	Notify NRC or EPA in case of hazardous substance release
County Emergency Management Coordinator (see Appendix M)		Respond/ Guidance		
Local Emergency Planning Committee		Respond/ Guidance		
Hazard Assessment Coordinator		Respond/ Guidance		
Public Relations Coordinator		Guidance		
City Engineer or Technical Consultant		Guidance		
Public Works Director		Guidance		
Asst. Public Works Director		Guidance		
Water Superintendent		Respond/ Guidance		
Assistant Water Superintendent		Respond/ Guidance		
Fire Department				

Continued on Next Page

Appendix O

Police Department		Respond		
Mayor		Guidance		
Priority water users				
Emergency Contractors (Heavy equipment, bottled water, etc.)		Respond		
News Media				

Appendix P

EMERGENCY PROBABILITY AND SEVERITY CHART
(Form V-3)

TYPE OF EMERGENCY	PROBABILITY (10-High - 1-Low)	SEVERITY (10-High - 1-Low)	REMARKS
Natural			
Drought			
Flood			
Ice & Snow Storm			
Wind			
Earthquake			
Fire			
Man-Made			
Spills/Chemical Contamination			
Sabotage			
Power Outage			
Operator Error			
Equipment Failure			
Explosion			
Vandalism			

Appendix Q
WHP Plan Submittal Checklist

Does the WHP Plan Contain or Address the Following?	Yes	No
1 ***Institutional Roles: (see Section I of Wyoming's Wellhead Protection Guidance Document)***		
1.1 Has a listing of members of the Wellhead Protection Management Committee, including resolutions, if any, and descriptions of public participation efforts been included in the WHP Plan?		
2 ***Delineation of the Wellhead Protection Areas: (see Section II of Wyoming's Wellhead Protection Guidance Document)***		
Have you followed the Flow Chart in Table II-1 to appropriately determine the type of flow (i.e. porous, diffuse or conduit)		
As identified in Table II-2 of *Wyoming's Wellhead Protection Guidance Document*, a Wellhead Protection Area (WHPA) shall be delineated for each PWS well:		
2.1 Zone 1 - Does the radius (i.e. 50' or 100') of Zone 1 for each well meet the requirements specified?		
2.2 Zone 2 - Has the appropriate delineation method been applied, given the *aquifer media* type and *flow* type of the aquifer supplying your well(s)? See Table II-1, II-2, Appendix D and Part IV of Appendix G.		
2.3 Zone 3 - Has the appropriate delineation method been applied, given the *aquifer media* type and *flow* type of the aquifer supplying your well(s)? See Table II-1, II-2, Appendix D and Part IV of Appendix G.		
2.3.1 Are alternative criteria or methods required due to the presence of one or more of the conditions identified in Section II - *'Special Considerations'*, or in Part IV of Appendix G?		
2.4 Have aquifer/pump tests been performed?		
2.4.1 Have any of the delineated wells been constructed with state agency funding?		
2.4.2 Has rehabilitation of existing wells or the water distribution system been performed with state agency funding?		

Appendix Q
WHP Plan Submittal Checklist

		Yes	No
2.5	(*Community PWSs Only*) Have the WHPAs been delineated and has the *'Susceptibility Assessment Form'* (Appendix F) been completed for each well?		
2.6	Do the WHPAs of the wells overlap?		
2.6.1	If 'Yes': Have the overlapping WHPAs been properly 'nested' or 'clustered' into one WHPA for the wellfield WHPAs (see Figure II-4);		
	If modeled, does computer modeling of the WHPA incorporate well interference?		
2.7	WHPA *'Delineation Report'* (see Section II):		
2.7.1	Does the report contain the required information on the following:		
	- Geologic Data?		
	- Aquifer Data?		
	- Well Data?		
	- Pump Data?		
	- WHPA Delineation Information?		
	- Map Showing Boundaries of the WHP Areas or Zones?		
	- City/County Zoning and Land Use Map?		
	- Confined Aquifer Conditions?		
	- *'Susceptibility Assessment Form'* (Appendix F) for each PWS in the WHP Plan?		

Appendix Q
WHP Plan Submittal Checklist

		Yes	No
3	***Inventory of Potential Contamination Sources: (see Section III of Wyoming's Wellhead Protection Guidance Document)***		
	Have the following steps been completed in developing an inventory of 'existing' and 'potential' contaminant sources within each WHPA?		
3.1	Indicate which of the following steps have been taken and completed for completing the contaminant source inventory:		
3.1.1	Local, state and/or federal databases have been accessed and source information for known (i.e. 'existing') sources has been included in the contaminant source inventory; 'existing' sources have been located and identified on the base map.		
3.1.2	Information has been collected on unknown (i.e. 'potential') sources and included in the contaminant source inventory; 'potential' sources have been located and identified on the base map. Indicate which method (or methods) was followed to collect information on 'potential' sources: - Mail Survey - Telephone Survey - Door-to-door Survey - Field Survey - Windshield Survey - Personal Interviews		
3.1.3	Has the accuracy and reliability of sources of information been verified?		
3.1.3.1	Indicate which method (or methods) was followed to verify information on 'existing' sources: - Mail Survey - Telephone Survey - Door-to-door Survey - Field Survey - Windshield Survey - Personal Interviews		

Appendix Q
WHP Plan Submittal Checklist

	Yes	No
3.1.3.2 Indicate which method (or methods) was followed to verify information on 'potential' sources: - Mail Survey - Telephone Survey - Door-to-door Survey - Field Survey - Windshield Survey - Personal Interviews		
3.2 Have the 'existing' and 'potential' sources within the WHP area been described by:		
3.2.1 Completing Source Identification forms (Form III-1)? -or- Other forms that contain: - Source owner/operator name and location? - Source type and WHPA 'Zone' in which it is located? - Source Priority Method and Rank?		
3.3 Has the Source Inventory <u>list</u> been completed from the Source Identification forms?		
3.3.1 Does the Source Inventory list contain the following?		
- Minimum information that is on the Source Identification forms which is grouped by WHPA Zones?		
- Description of WHPAs to which the inventory applies?		
- Date of Completion of Source Identification data collection and survey(s)?		
- Statement describing the timing of completion of the Source Identification forms with respect to WHPA delineations and identifying the status of the Source Inventory (i.e., 'Preliminary' or 'Final')?		
- Upon completion of the above, have Parts V and VI of the '*Susceptibility Assessment Form*' (Appendix F) been completed?		

Appendix Q
WHP Plan Submittal Checklist

		Yes	No
3.4	Have the 'existing' and 'potential' sources been ranked (prioritized) according to one (or more) of the following: - Distance or TOT to nearest public drinking water well? - 'Sensitivity' of the uppermost aquifer underlying the source? - Number of residents served by public drinking water well? - Ranking from EPA's "*Managing Ground Water Contamination Sources in Wellhead Protection Areas: A Priority Setting Approach*"?		
3.5	Have 'existing' and 'potential' contaminant source locations and information been plotted on a base map for use as an overlay on WHPA delineation maps? - Are 'existing' and 'potential' sources distinguished? - Are the souces on the map linked to the Source Inventory list by a source identification number? - Do different symbols or numbers differentiate between types of sources? - Is the Source Overlay identified as 'Preliminary' or 'Final'?		
3.6	Does the WHP Plan contain provisions for updating, refining, and expanding the source inventory information?		
3.7	Does the WHP Plan include provisions to update the Source Inventory at least every two years using the methods described in Section III?		
4	***Potential Contaminant Sources - Management Strategies: (see Section IV of Wyoming's Wellhead Protection Guidance Document)***		
4.1	Does the WHP plan describe the techniques that will be employed to manage and minimize the threats posed by the 'existing' and 'potential' contaminant sources identified in the Source Inventory?		

Appendix Q
WHP Plan Submittal Checklist

		Yes	No
4.2	Has the contaminant source priority ranking information been used to develop management strategies that are appropriate for the priority rank of the 'existing' and 'potential' contaminant sources identified within the WHPA?		
4.3	Has a 'Potential Source, Hazards, Controls, Assessment, and Management Form' (Form IV-1; Appendix J) been completed for each potential contaminant source in the 'Source Inventory List'?		
4.4	Have ordinances, Memorandum of Understanding or Agreement, land use agreements, and other source management instruments been appended to the WHP plan?		
5	***Planning for the Future - Contingency Plans and Plans for Siting New Wells: (see Section V of Wyoming's Wellhead Protection Guidance Document)***		
5.1	Has the WHP Management Committee, or its designate, addressed and included the following requirements in the Contingency Plan?		
5.1.1	Existing system conditions (Form V-1; Appendix N) and copies of maps and/or construction plans, specifications, and drawings of water distribution and storage system?		
5.1.2	Chain of command and description of individual roles and responsibilities during an emergency (Form V-2; Appendix O)?		
5.2	Emergency responses planned for 'high' probability and 'high' severity events (Form V-3; Appendix P), which includes:		
	- procedures to shut down or isolate a contaminated well?		
	- source of emergency water for drinking and other household uses as well as sources of equipment to treat, transport, and distribute water?		
	- procedures to decontaminate the distribution system and well(s)?		
	- procedures to coordinate with county and state emergency response agencies?		
	- procedures to effectively communicate with the water users?		

Appendix Q
WHP Plan Submittal Checklist

		Yes	No
	- a plan of action for siting a new permanent water supply to replace contaminated supply?		
	- sources of emergency funds and equipment, and procedures for requesting and dispersing funds and equipment?		
	5.2.1 Provisions for obtaining, distributing, and funding *temporary* alternate drinking water supplies?		
	5.2.2 Provisions for developing and financing new drinking water sources in case of long-term shortages due to contaminated supplies?		
	- An inventory of alternative water supply sources (quantity, quality, and ownership)?		
	5.2.3 A plan and schedule for updating the Contingency Plan?		
6	***Plans for Updating and Revising the WHP Plan (see Section VIII of Wyoming's Wellhead Protection Guidance Document):***		
	6.1 Are there provisions to update and revise the WHP plan at least every two years?		
	6.1.1 Do the provisions describe how the following will be updated and revised?		
	6.1.2 Hydrologic characteristics of producing aquifer.		
	6.1.3 Changes in the water supply, or pumping volumes.		
	6.1.4 New potential sources of contamination.		
	6.1.5 New management strategy development or implementation.		
	6.1.6 Contingency planning and emergency response.		
	6.1.7 Planning or developing new water supplies.		
	6.2 Does the WHP Plan include provisions for submitting revisions (i.e., delineations, Source Inventory lists and Identification forms, 'Source Overlays', source management strategies, Contingency Plans, and plans for siting new well(s)) to WDEQ/WQD at least every two years?		
	6.3 If there are no changes (as described above) in two years, are there provisions for having a representative of the local		

Appendix Q
WHP Plan Submittal Checklist

		Yes	No
	government or the manager of the PWS send a letter to WDEQ/WQD documenting that the WHP Plan was reviewed and that no changes have occurred?		
6.4	Are there provisions to have any revisions or updates amended to, or incorporated into the WHP Plan?		

Appendix R

***** FACT SHEET 1*****

Economic Benefit Potential From Implementation of a Wellhead Protection Program in Wyoming

Background:

Wellhead Protection Programs are implemented by states to assist and guide communities in the development of local Wellhead Protection Plans. These plans are designed to protect Public [drinking] Water System *(PWS)* wells from potential contamination resulting from past, present and future practices.

Wellhead Protection Plans may provide economic benefits to a community in three ways: 1) using core elements (i.e., Wellhead Delineation, Contaminant Source Inventories, Source Management Approaches, Contingency Plans) of Wellhead Protection Plans as a basis for obtaining *susceptibility [vulnerability] monitoring waivers*, potentially allowing PWSs to avoid portions of the costly monitoring currently required by EPA under the Safe Drinking Water Act (SDWA); 2) avoiding the need to install a costly system to treat contaminated drinking water, and; 3) avoiding the cost of having to replace a well due to contamination.

Use of Wellhead Protection Plans to Obtain Monitoring Waivers:

Table 1 presents estimated annual costs for Synthetic Organic Compound (SOC) and Volatile Organic Compound (VOC) monitoring tests that PWSs presently must perform to meet SDWA requirements. In the event that a community's local Wellhead Protection Plan were utilized in obtaining monitoring waivers, these costs, or a portion of them, may be eliminated (and realized as a savings).

Costs at the state level are assumed to be approximately $150,000 per bi-ennium ($75,000/yr) or $300,000 over a four year period for one Full Time Equivalent (FTE) position (plus related expenses) to administer the program. *Savings* illustrated would accrue as a result of using Wellhead Protection Plans to aid in obtaining *monitoring waivers for either or both tests.*

Table 1

*Annual Monitoring Costs Per Sample**

Method	Price
SOCs	$5,760
VOCs	900
Total	**$6,660**

* Quarterly Sampling Required

Source: Division of Drinking Water, State of Utah

Based upon Utah's experience where 1,000 PWSs saved approximately $3.8 million per year in monitoring costs, the 600 Wyoming PWSs could reasonably experience a proportional

savings of roughly $2.28 million per year or $9.12 million over a four year period[1] and the benefit/cost ratio would be 30:1, meaning that for each dollar spent by the state to administer the program, $30 in savings would be realized by communities. As illustrated in Table 3, assuming that 44% (265) of the Wyoming PWSs should qualify for monitoring waivers based upon vulnerability to contamination, as has been found in Texas where wellhead protection is likewise a *voluntary program*, savings would be roughly ***$1 million per year*** or *$4 million over a four year period* and the benefit/cost ratio would be ***13:1***.

Use of Wellhead Protection Plans to Potentially Save on Treatment Costs:

Implementation of Wellhead Protection Plans at the local level may benefit both the *Farm Loan Program* and the *Wyoming Water Development Commission* from the reduced need for emergency funding to *replace contaminated wells* or *provide for water treatment facilities*.

As an example, in 1995 the Rock Springs-Green River Joint Powers Board approached the legislature seeking state funding for a drinking water treatment plant due to site contamination. The expected cost of the proposed system is roughly *$30 million*. Since most communities do not have the financial means to fund an emergency water system improvement, it is reasonable to expect that resources will continue to be requested from state funding mechanisms if/when similar situations arise in the future.

Use of Wellhead Protection Plans to Potentially Save on Replacement Costs:

Table 2 contains a summary of potential costs associated with replacement of a contaminated drinking water supply well. When a well becomes contaminated, there are usually two options available to deal with the problem: 1) the well can be replaced, or: 2) the contaminants can be removed through treatment.

In locations where another drinking water source (aquifer) is non-existent, or prohibitively deep, treatment may be the only viable option.

Table 2
Potential Cost of Replacing Contaminated PWS Well

Item	Cost
Well Drilling	$50-150/ft $100-120/ft (avg)
Trans. Pipeline (size dependant)	$200,00/mi (low) $375,000/mi (high)
Storage Tank (maintains pressure)	$.38/gal (low) $2/gal (high)
Water Treatment	$1/gal capacity

Source: Wyoming Water Development Commission

[1] Utah's WHP program is mandatory and all groundwater based PWSs must develop and implement wellhead protection plans. The estimated $1.6 million is based upon figures from the Texas Natural Resource Conservation Commission (Water Utilities Division) where 44% of PWSs obtained monitoring waivers through its Vulnerability Assessment Program, similar to a wellhead protection program.

Appendix R

An example well of 300 feet in depth ($110 per foot) drilled 2.5 miles ($247,000 per mile) from the system intake would result in a development cost of approximately $650,500.

Summary of Potential Savings:

Table 3 illustrates the potential savings which could potentially accrue to Wyoming communities through successful use of Wellhead Protection Plans. As illustrated in Table 3, in the event that replacement of one similar well could be avoided through the implementation of a Wellhead Protection Plan, *savings to the state would amount to roughly $2 for every $1 spent* by the state to administer the program over a period of four years. As illustrated in Table 3, in the event that implementation of a Wellhead Protection Plan prevented the need for just one similar drinking water treatment plant, the *savings to the state would amount to $100 for every $1 spent* by the state to administer the program over a period of four years.

Table 3

Cost/Benefit Accruing From Implementation of Wellhead Protection Plans

Benefit (Savings)	Period	Cost	Ratio
$4 Million*	4 Yrs.	$300,000	13:1
$30 Million**	Once	$300,000	100:1
$650,000***	Once	$300,000	2:1

* Monitoring Waivers
** Treatment Plant
*** Replace Well

Source: WDEQ

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Appendix R

***** FACT SHEET 2 *****

Potential Economic Benefits and Cost-Avoidance to Wyoming Communities (or Public Water Systems) When Wellhead Protection Plans are Implemented

Background:

This fact sheet presents the potential economic benefits and cost savings that can be achieved when a community or its Public [drinking] Water Systems (PWSs) develop and implement local Wellhead Protection (WHP) Plans. The cost-benefit ratio is obtained by comparing the average cost of developing wellhead protection plans to EPA monitoring costs, and to the avoided costs of either providing a new drinking water supply or a water treatment system in the event that a PWS well becomes unuseable due to contamination. Implementation of Wellhead Protection Plans at the local level may benefit both the *Farm Loan Program* and the *Wyoming Water Development Commission* from the reduced need for emergency funding to *replace contaminated wells* or *provide for water treatment facilities*.

Costs of Developing and Implementing Wellhead Protection Plans:

As illustrated in Table 1, the majority of groundwater-supplied PWSs in Wyoming serve fewer than 500 people, and all but 8 serve fewer than 3300 people.

Table 1: Wyoming (Groundwater) Public Water Systems (PWSs) by Class and Size

Type (Class) of PWS[2]	Number of PWSs	Number of PWSs per Population Served					
		<100	>100 <500	>500 <1000	>1000 <3300	>3300 <10000	>10000
Community	186	81	81	6	12	4	2
Transient, Non-Community	319	232	72	8	5	2	0
Non-Transient, Non- Community	82	53	26	2	1	0	0
TOTAL	**587**	**366**	**179**	**16**	**18**	**6**	**2**

Source: Data collected from the EPA Safe Drinking Water Program Database; (1/23/96).

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2 As classified by EPA, a **'community'** water system serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents. A **'non-community'** water system may be classified as either (1) **'transient non-community'** (does not regularly serve at least 25 of the same persons over six months per year), or (2) **'non-transient non-community'** (regularly serving at least 25 of the same persons over six months per year).

Appendix R

Actual and projected costs for development of Wellhead Protection Plans are provided for two small towns (Elk Mountain, WY and Gilbert, LA) and for three small (Utah) public water systems of differing sizes in Table 2:

Table 2: Cost to Develop Wellhead Protection Plans[3]

Factors	Gilbert, LA (1994)	Elk Mountain, WY (1996)	3 Small PWSs; Utah (1995)		
Population Served	700	186	>25 <100	>100 <175	>175 <2500
Number of Wells	2	2	1 - 2	1 - 2	2 - 3
Delineation of Wellhead Protection Areas	$3347 (Incl. Contam. Source Inventory, Public I & E)	$1100 (Incl. Consultant Fees - WHPA Model)	(Calculated Fixed Radius Method)		
Contaminant Source Inventory	$36 (Overlay Map)	$250			
Management Plan	$571	$1155			
Contingency Plan/Siting New Wells	$231	$130			
Forming WHP Committee	$0	$165			
Public Information/ Education (I & E)	(See Above)	$800			
Road Signs	$231	NA			
Total WHP Development Costs (1st year)	$4416	$4790	$400	$1800	$4200
Annual Contaminant Source Inventory & Inspections	$125	$200	$25	$50	$200
Total WHP Costs (5 years)	$5041	$5790	$500	$2000	$5000

3 The costs in Table 2 have not been adjusted for inflation and are based upon the dollars in the specified year. Future cost estimates for developing wellhead protection plans should be adjusted accordingly.

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Fact: ***92% of all Wyoming Public Water Systems serve fewer than 3300 people.***
Fact: ***All but 18 of Wyoming's communities have populations less than 3300 people.***

Since most Public Water Systems in Wyoming serve communities similar in size to those illustrated in Table 2 (i.e. <2500), the cost to the majority of Wyoming communities (or PWSs) to develop a Wellhead Protection Plan should approximate the costs depicted in Table 2, or roughly:

* **$500 for the 366 PWSs serving <100 people**
* **$2000 for PWSs serving between 100 and 175 people**
* **$5000 for PWSs serving between 175 and 2500 people**

As mentioned earlier, 92% of all Wyoming Public Water Systems serve fewer than 3300 people and all but 22 of Wyoming's communities have populations of less than 2500 people. The cost estimates above would therefore reasonably apply to the majority of communities (and PWSs) within the state.

Potential Economic Benefits and Cost-Avoidance to Wyoming Communities When Wellhead Protection Plans are Implemented:

Wellhead Protection Plans may provide economic benefits to a community in three ways: **1)** using core elements (i.e., Wellhead Delineation, Contaminant Source Inventories, Source Management Approaches, Contingency Plans) of Wellhead Protection Plans as a basis for obtaining *susceptibility [vulnerability] monitoring waivers*, potentially allowing PWSs to avoid portions of the costly water quality sampling currently required by EPA under the Safe Drinking Water Act (SDWA); **2)** avoiding the need to install a costly *system to treat contaminated drinking water*, and; **3)** avoiding the cost of having to *replace a well* due to contamination.

Appendix R

The economic benefit (avoided cost) and (avoided) cost-benefit ratio of each of the above 'factors' is presented in Table 3:

Table 3: Potential Avoided Costs and Cost/Benefit Ratios

Factor	Total Cost (Avoided)	Population Served	WHP Costs (5 yrs)	(Avoided) Cost/ Benefit Ratio
Monitoring Costs - 5 years (SVOCs and VOCs)	$18,875 " "	<100 100 -175 175-2500	$500 $2000 $5000	38:1 9:1 4:1
Replacement Costs of New Well (300 ft. deep and 2.5 mi. from the system intake)	$650,500 " "	<100 100 -175 175-2500	$500 $2000 $5000	1300:1 325:1 130:1
Treatment Costs (Reverse Osmosis at Wellhead)	$23,600 $222,200 $505,800	<100 100-175 175-2500	$500 $2000 $5000	47:1 110:1 100:1

Avoidance of Monitoring (Sampling) Costs:

Based upon Utah's experience where 1,000 PWSs saved approximately $3.8 million per year in monitoring costs, the 600 Wyoming PWSs could reasonably experience a proportional savings of roughly $2.28 million per year. Assuming that 44% (265) of the Wyoming PWSs should qualify for monitoring waivers based upon vulnerability to contamination (as has been found in Texas, where wellhead protection is likewise a voluntary program) savings would be roughly *$1 million per year* or ***$3,775* per system, per year**.

Avoidance of Cost to Replace Drinking Water Supply:

An example well of 300 feet in depth ($110 per foot) drilled 2.5 miles ($247,000 per mile) from the system intake would result in a development cost of approximately ***$650,500***. These costs do not include the remediation costs required to remove the source of contamination and restore the groundwater as a viable drinking water source. In many cases, since the source will continue to threaten new PWS wells or existing private drinking water wells, active remediation of the groundwater is necessary. As documented in many case studies of existing PWSs across

the country, the cost of remediation significantly increases the total costs of replacing a water supply. Most small PWSs need outside sources of funding to pay for drilling new wells, remediation costs, and treatment systems.

Avoidance of Cost to Treat Contaminated Drinking Water:

Estimated costs to install a relatively simple reverse osmosis treatment system at the wellhead range from as little as ***$23,000 to more than $500,000***, depending upon the volume of water required to treat. Capital costs and the 5-year operation and maintenance costs are included in these estimates. Depending on the location of the water well(s), additional water transmission lines may be needed, thereby increasing the capital costs even higher.

Summary:

The cost/benefit ratios illustrated in Table 3 demonstrate that from ***$7 to $1300 might be saved (or avoided) for every $1 spent*** by a community (or PWS) to develop a Wellhead Protection Plan. ***As illustrated in Table 3, in most cases it is the smaller communities that stand to gain the most by developing Wellhead Protection Plans.*** Very small PWSs (< 100 people served) could possibly save (or avoid) as much as $1300 for every $1 spent if development and implementation of a Wellhead Protection plan prevented the contamination of one drinking water supply well. For all sizes of PWSs (or communities) illustrated in Table 3, the cost savings that might be achieved by obtaining monitoring waivers *alone* can justify the cost involved in developing the Wellhead Protection Plan.

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