WELLHEAD PROTECTION: INFORMATION AND GUIDELINES FOR WYOMING MUNICIPALITIES

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FINAL REPORT

This final report contains a listing of the tasks to be performed by the project followed by the results obtained from the project in terms of these tasks. Several other items of interest which were developed from the project are also contained in the report and its appendices.

It was the purpose of this project to (1) inventory all the public water supplies in the State of Wyoming that use groundwater as one of their sources for their public water supply; (2) develop basic information on these groundwater resources in so far as possible in terms of aquifer characteristics, types of pollutants already present in the aquifers and vulnerability of the aquifers to possible contamination; and (3) suggest possible wellhead protection strategies for Wyoming public groundwater supplies.

Task One: Information Inventory and Database Development

The specific objectives under Task 1 were (1) development of a database design in cooperation with the DEQ that will interface with the Water Resources Data System (WRDS) and contain information that is necessary to help develop a wellhead protection strategy for an area; and (2) collect data from all possible sources for the major municipalities in the state and others as are available through a mail survey and the State Engineer's Office.

Task Two: Aquifer Characteristics and Water Quality

The specific objectives under Task 2 were: (1) classify the different public water supplies as to their degree of vulnerability to possible contamination; and (2) provide more detailed information on those municipal systems that are most vulnerable to contamination.

Task Three: Research Methods for Wellhead Protection

The specific objectives under this task were: (1) development of different alternatives for regulation of wellheads indicating advantages and disadvantages of the alternatives; and (2) developing an encompassing list of actual and

potential sources of groundwater pollution and the specific contaminants from these sources that might be expected in Wyoming.

Task Four: Public Meetings and Final Report

The specific objectives of this task were: (1) in cooperation with and under the direction of the Water Quality Division of DEQ, hold a series of public meetings for Wyoming municipalities on the findings of this study and (2) prepare a final report on the project.

RESULTS OF THE PROJECT BY TASK:

Task 1 Results:

The design, development and implementation of a database was completed. The design has been developed with a database system software package called "Superbase" which is compatible with most other database packages. Superbase does require a Windows environment to run. The system design was based on the format of a preliminary USEPA Office of Groundwater Protection document entitled Minimum Set of Data Elements for Groundwater: DEFINITIONS AND FORMATS. It was agreed between DEQ and the project principal investigators to use this document as the guide in the development and design of the database system. Testing of the database design was completed in December of 1990 and data loading and testing of the database system was completed during the spring and summer of 1991. A copy of the database design and input requirements writeup is contained in Appendix A.

The system has been set up to be compatible with the design of the WRDS system. The WRDS system will be using the ORACLE database system and will contain essentially (almost exactly) the same structure designed into the Superbase system for this project so that it will be compatible with EPA data requirements for this type of information in the future. Once the ORACLE database system is running under the WRDS new microcomputer system (which will be occurring during 1992) and the Superbase designed well database system used with this project is implemented into the ORACLE database system, the Superbase file will be transferred directly through an ASCI file to the WRDS system and will then be available for access by users of WRDS across the state and by the state agencies. A GIS mapping system for groundwater vulnerability is also being developed for a number of areas of the state at the Wyoming Water Resources Center which also houses WRDS and will use ARC/INFO as its main database management system. Discussions have occurred with ARC/INFO and ORACLE and they agree that files in one system can be handled compatibly with each other. This idea has not been tested but all indications are that it will work. The two

database systems will be housed on the same computer at the Water Resources Center and will be accessible by state agencies.

The Federal Reporting Data System (FRDS) for public water supplies was inventoried for the State of Wyoming to determine the public water supplies that exist in the state (Appendix F). The FRDS database was further utilized to help determine if wells were one of the sources for the indicated public water supply entity. The FRDS records indicated that some 242 public water supplies exist in the State of Wyoming which utilize groundwater as one of their sources of supply. A questionnaire (Appendix A) was developed and sent to each of these entities to obtain information about each of their individual wells (location of the well, well permit number, depth to water, well diameter, etc.) and the aquifer properties (well or drillers log, permitting information furnished the state, etc.) within which the well was drilled. The main focus of the survey was with respect to municipal water supplies that come from wells. Little or no data information of value to this project on municipal water supply wells in Wyoming were found in the DWS (violations), USGS or STORET databases when they were reviewed.

A total of 155 responses were received from two separate mailings. Detailed information received or researched on each of the public water supplies was prepared and loaded into the database. There were 86 municipal systems in the state that utilize groundwater for at least a portion of their water supply and at the end of the project we had received information from 77 of these systems. Research of records from the State Engineer's Office on each of the wells was done to verify and add to the data obtained through the questionnaire. The research verified the location of over 340 wells from the 77 municipal systems and provided additional information for the database in terms of aquifer characteristics and physical features of the wells. A copy of the actual data file itself on floppy disk is contained as a part of Appendix A. A legally purchased copy of the Superbase program bought with project funds and the questionnaire data sheets collected and other pertinent information from the State Engineer's Office along with a hard copy of information in the database is contained in a file box labeled Appendix F.

Task 2 Results:

All of the major cities and towns within Wyoming were encouraged to submit information through the questionnaire indicated under Task 1. A total of 86 municipal supplies were identified for which information would be of interest as a part of this project. There were 77 municipalities that responded to the questionnaire. Nine indicated that they did not use groundwater as a source of supply. Table 1 indicates the 86 municipal supplies that were of interest to the project, where they are located, the

Table 1. Municipal Systems and Their Vulnerability Ranking.

Municipal System	System #	County	Pop. Served	Pop. Sub.	# Wells Drastic (Rel. Vuln.)	Vuln. Ranking
Bairoil, Town of	13	Sweetwater	250		3[1]	1
Bedford Water and Sewer	14	Lincoln	300		1[1]	1
Big Piney, Town of	15	Sublette	520	169	5[1]	1
Burlington Town Water Sys	20	Big Horn	100		2[1]	1
Burns Board Public Util	21	Laramie	268		4[1]	1
Byron, Town of	22	Big Horn	633		1[1]	1
Casper Board Public Util	24	Natrona	51016	2049	25[1]	1
Cheyenne Board Pub Util	32	Laramie	50000	1354	32[3],11[1]	1
Chugwater Mun. Water Sys	44	Platte	243		3[1]	1
Clearmont Water Supply	45	Sheridan	127		3[1]	1
Dubois Water Sys., Town of	58	Fremont	1067		3[1]	1
Elk Mtn., Town of	61	Carbon	225		3[1]	1
Ft. Laramie Mun. Water Sys	72	Goshen	350		3[1]	1
Freedom Pipeline Inc.	74	Lincoln	100		1[1]	1
Glendo, Town of	113	Platte	367		1[1]	1
Glenrock Mun. Water Sys	114	Converse	2000		4[1]	1
Hartville Water Sys	120	Platte	149		2[1],2[4]	1
Hudson Mun. Water Sys	121	Fremont	514		13[1]	1
Hulett, Town of	122	Crook	406		3[1]	1
Jackson, Town of	126	Teton	7000	2248	3[1],1[4]	1
U.S. Ergy Corp(Jeffrey Cty)	187	Fremont	36		3[1]	1
Laramie, City of	146	Albany	25000	366	5[1],1[6]	1
Lingle, Town of	152	Goshen	475		2[1]	1
Lyman, Town of	155	Uinta	2203		1[1]	1
Manderson, Town of	156	Big Horn	110		2[1]	1
Marbleton, Town of	158	Sublette	600		4[1]	1
Medicine Bow, Town of	160	Carbon	500		4[1]	1
Mills, Town of	162	Natrona	2139	240	6[1]	1
Moorcroft, Town of	165	Crook	1100		6[1]	1
Opal Water Sys	175	Lincoln	175		3[1]	1
Pavillion, Town of	177	Fremont	287		6[1]	1
Pine Bluffs, Town of	178	Laramie	1077		6[1]	1
Powell, City of	181	Park	6000	300	6[1]	1
Riverton, City of	186	Fremont	10000	1577	15[1],2[6]	1
Shoshoni, Town of	219	Fremont	615		4[1]	1
Split Rock Townsite	187	Fremont			1[1]	1
Thermopolis, Town of	229	Hot Springs	3500		3[1]	1
Torrington Mun. Water Sys	230	Goshen	6000		12[1]	1
Teton Village Wtr & Sewer	225	Teton	200		2[2]	2
Albin, Town of	8	Laramie	128		4[3]	3
Evanston, City of	63	Uinta	12177	1168	3[6],3[3]	3
Guernsey, Town of	119	Platte	1512		3[3]	3
Lance Creek Util. Inc.	143	Niobrara	96		3[3]	3
Lusk Water System	154	Niobrara	1650		5[3]	3
Yoder Water Sys., Town of	242	Goshen	110		6[3]	3
Sundance, City of	223	Crook	1100		3[4],1[9]	4
Rolling Hills, Town of	115	Converse	443		3[5],2[6]	5
Wheatland Mun. Water Sys	235	Platte	3795		8[5]	5
Gillette, City of	75	Campbell	20943	7303	14[6],8[8]	6
Ten Sleep, Town of	224	Washakie	350		2[6]	6
Wright Water & Sewer Dist	240	Campbell	1800		4[6]	6
Cowley Mun. Water Sys	52	Big Horn	455		1[8]	8
Edgerton, Town of	60	Natrona	650		4[8]	8
Kaycee, Town of	140	Johnson			2[8]	8
Newcastle, City of	172	Weston	3800	899	3[8],1[12]	8
Pine Haven, Town of	179	Crook	180		1[8]	8
Rawlins Wtr Sup., City of	183	Carbon	11547	175	1[8],3[12]	8
Superior, Town of	222	Sweetwater	330		2[8]	8
Worland Board of Pub. Util.	239	Washakie	6000		2[8]	8
Wamsutter, Town of	234	Sweetwater	250		3[10]	10
Blk Hills Pwr & Lgt(Osage)	176	Weston	350		4[12]	12
Upton, Town of	233	Weston	1183		5[12]	12
Afton Board of Pub. Util.	1	Lincoln	1481	315	NA	

Table 1. Municipal Systems and Their Vulnerability Ranking. (Cont.)

Municipal System	System #	County	Pop. Served	Pop. Sub.	# Wells Drastic (Rel. Vuln.)	Vuln. Ranking
Osmond Pipeline Co.	3	Lincoln	250		NI	
Fairview Pipeline	5	Lincoln	200		NA	
Alpine, Town of	10	Lincoln	275	27	NI	
Cokeville, Town of	51	Lincoln	550		NA	
Douglas, Town of	53	Converse	6000	100	NA	
Alta Community Pipeline	56	Teton	130		NI	
Etna Pipeline Co.	62	Lincoln	200		NI	
Evansville, Town of	68	Natrona	2500		NI	
Frannie Mun. Water Sys	73	Big Horn	138		NA	
Grover Dom. Water Works Co.	118	Lincoln	200		NI	
Hyattville Water Co.	124	Big Horn	50		NI	
Kirby Water Sys., Town of	243	Hot Springs	84		NA	
LaBarge, Town of	141	Lincoln	742		NI	
LaGrange	142	Goshen	232		NI	
Linch Utility	151	Johnson	100		NI	
Manville, Town of	157	Niobrara	104		NI	
Incline Res. Inc.(McFadden)	159	Carbon	48		NI	
Mountain View, Town of	169	Uinta	1360	100	NA	
N. Riverton Water & Sewer	188	Fremont	120		NI	
Ward Ck. Landowners(Rozette)	212	Campbell	27		NI	
Smoot Farmers Pipeline	220	Lincoln	50	30	NI	
Thayne, Town of	227	Lincoln	335		NA	
S. Torrington Water Dist.	231	Goshen	600		NA	

NA - Not Applicable
NI - No Information

Table 2. Ranking Order of Map Units Included on the Pollution Vulnerability Index Map for Wyoming (Plate 1 of the Class V Injection Well Report).

Relative Ranking	Drastic Index Range	Map Unit	Map Symbol
1	128-138	Alluvium	Qa, Qt
2	140-188	Mountain Glacial Deposits	Qg
3	43-138	Upper Cenozoic Deposits	UC
4	83-196	Paleozoic-Age Sedimentary Rocks	PALEO
5	86-125	Dune Sand and Loess	Qs
6	43-116	Lower Cenozoic Deposits	LC
7	83-110	Igneous and Volcanic Rocks of Mesozoic and Quaternary Ages	Qx
8	49- 92	Mesozoic Sandstone Aquifers	Mss
9	62- 70	Igneous and Metamorphic Rocks of Precambrian Ages	Ig, Mt
10	55-101	Playa Lake and Other Lacustrine Deposits	Ql
11	51- 63	Landslides	Qls
12	30- 62	Mesozoic Shales	Msh

population served by the municipal system and the areas surrounding the municipality served by the system (Pop. Sub.). The last two columns of the Table 1 indicate the number of wells located within a given groundwater unit or aquifer and its relative vulnerability ranking. The numbers in the next to last column (32[3], 11[1]) are respectively the number of wells (32 and 11) located in each particular groundwater unit or aquifer that belong to the municipality and the relative vulnerability ranking (3 and 1) of the aquifer associated with those wells. The values in the last column are the same as those in the next to last column for relative vulnerability ranking using the highest vulnerability ranking (a 1 is highest and a 12 would be the lowest) to sort the data by municipality.

Each of the 77 municipal systems wells that were received through the questionnaire and verified at the State Engineer's Office have been located on general highway maps produced by the Wyoming Highway Department which cover all or portions within each county of the state (Appendix F). Relative vulnerability ranking and Drastic index ranges have been determined for each general well area and indicated on the maps and in Table 1. The vulnerability ranking and Drastic index values were obtained from the Class V injection well study completed by Western Water Consultants, Inc. for DEQ in 1986.

Table 2 indicates the way in which the relative vulnerability rankings were obtained for this project. The rankings and associated drastic ratings for the different municipal wells were obtained using the reports Assessment of Class V Injection Wells in the State of Wyoming (Western Water Consultants, Inc., 1986) and DRASTIC: A Standardized System for Evaluating Ground Water Pollution Potential Using Hydrologic Settings (EPA/600/2-87/035; National Water Well Association, 1987), respectively. Information gathered for each of the wells in a municipality was used with the Class V injection well rating system. Appendix B contains a summary description of the way in which values were arrived at for the Class V injection well project. The vulnerability map (Plate 1 of the Class V Injection Well report) developed for the entire state as a part of the Class V project was used to help establish the rankings indicated for each of the municipal wells in Table 2 using location, aquifer information and drillers log information obtained from the questionnaire and research at the State Engineer's Office along with the information presented in Appendix B.

A listing of underground storage tanks, landfills, herbicides, pesticides and Class V injection wells for Wyoming were obtained and were investigated for those municipal systems using ground water sources for their supply. Appendix C contains listings of landfills in Wyoming, pesticide and herbicide use information for the state by county in pounds sold, fertilizer usage in pounds and pounds per acre by county, and the number of underground storage

tanks in and surrounding each community which has groundwater as a part of its supply. Class V injection wells can be obtained from the report referenced above if they are needed by someone.

Appendix F contains information found on water quality for different areas of the state. It is not a large amount of information but is helpful in some instances to understand the types of potential problems that could exist in a certain area of the state.

Task 3 Results:

Wellhead protection plans from surrounding states and delineation methods have been researched for different protection strategies. Advantages and disadvantages of different options for different conditions have also been researched. Management approaches have been investigated utilizing Wellhead Protection Programs: Tools for Local Governments developed by the EPA. The applicable laws and regulations have been obtained for the state and were utilized with respect to deciding the options available under different wellhead protection plans. Results of this investigation are given below.

The delineation of wellhead protection areas is a complex process which must protect the drinking water resource and at the same time consider the use, value, and vulnerability of the aquifer. Currently, over 75 percent of the population in Wyoming relies on groundwater for part or all of their drinking water supply. It is likely that this percentage will grow in the future. A total of 242 Wyoming communities or small public water supply systems obtain their drinking water at least in part from groundwater. Threats to drinking water wells from septic tank leaching fields, various classes of injection wells, leaching of agricultural chemicals, other agricultural activities such as feedlots, seepage from tailings ponds and in situ mining activities, leaking underground storage tanks, and a whole host of legal and illegal waste disposal operations must be addressed if the resource is to be protected. The 1986 Safe Drinking Water Act in establishing State Wellhead Protection Programs recognized the threat and instituted a means for local governments to defend their water supplies against potential contamination.

Several program elements will be highlighted in this report. The wellhead protection program(WHP) should delineate the WHP area for each wellhead based on reasonably available hydrogeologic information on groundwater flow, recharge, and discharge, and on other information the State deems necessary to adequately determine the WHP area. Some of this other information may be political, economic, or social and will need to be considered in developing WHP programs for Wyoming communities, particularly if the program is to be voluntary. Potentially competing community needs, such as

the desire for economic development and the demand for safe water supplies,must be examined if the program is to achieve acceptance. The plan should also develop management approaches which include implementation of control measures.

The purpose of this portion of the report is to review the programs that various States have established for wellhead protection, to evaluate the elements of these programs, and to suggest possible ways in which communities which may be at risk can evaluate their problems and develop possible protection strategies. Methods of delineating wellhead protection areas will be discussed briefly so that the selected State plans may be better understood. In addition, a discussion of the elements needed in a wellhead protection plan for the State of Wyoming will be indicated along with possible management alternatives and implementation plans. The Town of Torrington will be referred to as an example of the type of studies that may be necessary to institute a wellhead protection plan. Torrington's water supply is derived from wells located within the Town limits. These wells penetrate the upper alluvial aquifer which is fed by the Platte River and by several irrigation canals in the area. Protecting these wells from contamination presents a particularly thorny problem since they are in well established commercial and residential areas, and the land uses are already in place. This type of problem is not unique to Torrington, however. Torrington's problem extends into the county where agricultural practices may also be affecting the quality of the alluvial aquifer. Solving this type of problem will require cooperative efforts by several levels of government, a sometimes daunting prospect.

Methods For the Delineation Of Wellhead Protection Areas

The Environmental Protection Agency(EPA) has recognized a wide variety of techniques to determine wellhead protection areas ranging from very simple non-analytical methods to complex numerical transport models. 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 wellhead protection program will determine the type and quantity of data required for delineation. The techniques which EPA has identified for WHP are:

1) Arbitrary Fixed Radius(AFR)
2) Calculated Fixed Radius(CFR)
3) Simplified Variable Shapes(SVS)
4) Analytical Methods(AM)
5) Hydrogeologic Mapping(HM), and
6) Several Numerical Flow/Transport Models(NM).

These methods are listed generally in order of increasing complexity and not all of these methods may be applicable in every case. Each has limitations and strengths and each requires differing amounts of data.

EPA suggests in Guidelines for Delineation of Wellhead Protection Areas that several zones might be used by States to meet statutory goals of protecting recharge areas and groundwater from contaminants which may have an adverse effect on the health of users. These zones might be established using different delineation methods. Examples of these zones are a remedial action zone which might be designed to protect wells from an unexpected contaminant release. An attenuation zone might provide time to bring the contaminant concentrations down to an acceptable level before they reach a well-field. A well-field management zone could cover all or part of a well-field's recharge area. An understanding of these methods and their related requirements for data and resources are essential in establishing a WHP plan.

Arbitrary Fixed Radius (AFR)

The AFR method sets a fixed distance from a well, circumscribing a zone around the well generally based on sound judgement and knowledge of the aquifer characteristics. It has frequently been used as a remedial action zone or an emergency response zone where certain land uses or certain risks are prohibited. The AFR method is simple to apply and normally inexpensive. It may well be the method of choice of small Wyoming communities where financial resources are lacking to carry out detailed studies of the local aquifer.

The use of such an exclusionary zone has obvious benefits in protecting the water supply. However, if the size of the zone is not based on some rational criterion, such as time of travel(TOT), then the zone may be burdensome for regulating landowners because no reasonable technical data is provided to point at for delineation and, at the same time, it will make it difficult to ensure that an adequate degree of groundwater protection is actually being provided. As the name implies, the AFR technique is not based on in depth knowledge of aquifer properties and contaminant transport potential, but rather on arbitrary standards. This gives the technique its virtue (simplicity), and its weakness (It may not protect the desired areas without including areas which do not need protective restrictions in land use). Since it is not based on any scientific criteria, the method has a great deal of uncertainty attached to it.

Calculated Fixed Radius (CFR)

The CFR technique establishes a cylinder down into the aquifer where the radius of the cylinder is based on the time of travel to the well. The TOT is selected based on the required response time

for any detected threats to the groundwater resource. TOT is an operationally defined measure of the rate of groundwater flow to the well-field. Input data requirements are limited, usually consisting of the pumping rate, the selected TOT, and a short list of hydrologic parameters (storativity, transmissivity).

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. For example, the aquifer may be anisotropic due to stratified soils or a result of past erosion of portions of the subsurface strata. This would lead to different hydrologic properties depending on which part of the aquifer is being analyzed for protection. If the WHP area being delineated varies in hydrological parameters either vertically or horizontally, then an assumed hydrologic homogeneity could lead to serious errors. The result would be that the degree of protection being sought might not be met. Wyoming aquifers are frequently very heterogeneous even on a relatively small geographic scale. An alluvial aquifer, such as the one at Torrington, 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 Torrington's wells may not completely protect the wellfield from contamination arising from surface activity. On the other hand, it may do a very adequate job. There is uncertainty and error involved. Any of the WHP delineation techniques which rely on assumptions of aquifer homogeneity will be subject to this same error.

Simplified Variable Shapes (SVS)

The SVS procedure creates shapes which purportedly better represent the zone of contribution(ZOC) of the well than the circular shape used in the AFR or the CFR. The ZOC is the entire area recharging or contributing flow to the well or well-field. The size of the ZOC is not fixed and will change as pumping progresses. Any pollutants introduced into the aquifer within the ZOC are capable of reaching the well and ,thus, contaminating it. The ZOC generally does not correspond to the cone of depression. Its shape is affected by groundwater flow boundaries, any retardation of contaminants by the aquifer materials, and by advection of the groundwater. The upgradient side of the shape is calculated from a preselected TOT criterion while the downgradient and lateral extent of the shape are established from the groundwater flow boundaries surrounding the well (i.e. ZOC). The resultant shape is a somewhat rounded shield with the blunted point facing downgradient.

The method is fairly easy to apply and requires little sophistication on the part of the modeler. The need for data input is only slightly more involved than the CFR. It 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. Flow in many Wyoming aquifers is affected by geologic and hydrologic boundary conditions. For example, the hydrology of Torrington's water supply is influenced by the Interstate Canal upgradient and the Platte River downgradient. The degree of influence of these boundaries varies seasonally as the water levels from these features change.

Analytical Methods (AM)

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 do require a number of input hydrologic parameters which are generally assumed to be homogeneous throughout the saturated depth of the aquifer. It 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. The modeler must have some familiarity with the site being delineated and be able to use sound judgement 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 SVS technique.

Hydrogeologic Mapping (HM)

HM works well in regions where subsurface geology is variable, and where near surface boundaries occur. This is the situation encountered in the Torrington wellhead protection study where groundwater flow characteristics are dominated by outcroppings of the Brule formation and by the presence of the Platte River and Interstate Canal. Flow boundaries are mapped using a combination of geological and geophysical techniques. Piezometric maps are included to establish any groundwater divides present. Some sophistication is required on the part of the modeler to interpret all mapping data. The mapping data may not be sufficiently detailed to accurately reflect the subsurface conditions. In the Torrington study, a bedrock geology map available for the area, reflected the large scale used in establishing it. A more detailed map using a smaller scale showed components of the bedrock which were not detailed in the original mapping. Costs accrued in obtaining required hydrologic knowledge will vary with the complexity of the subsurface lithology. Some of this information may be available from various governmental agencies (e.g. State and Federal geologic or soil surveys, State Engineer's Office, Department Of Environmental Quality) for little or no cost.

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 model to the numerical model which will include advection and dispersion in 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 modelling 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 would not have people on staff with sufficient expertise to readily and accurately apply the NM technique, and an outside consultant would have to be hired in order to carry out numerical WHP delineation studies.

WHPA, version 2, is a semi-analytical groundwater flow model that consists of four computational modules designed to delineate wellhead protection areas (WHPA's). This model was developed for the EPA Office of Groundwater Protection to assist cities and towns in delineation of wellhead protection areas. 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 this unconfined, shallow aquifer. It requires that a numerical model of flow already exist for the aquifer being evaluated.

Each module of this software will be discussed individually; but to summarize, 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 postprocessor 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 WHPA's 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.

State Wellhead Protection Programs

EPA has reviewed wellhead delineation efforts in Florida, Massachusetts, and Vermont in the publication Guidelines for Delineation of Wellhead Protection Areas. The document does not discuss the management aspects of WHP programs in these States.

Several additional wellhead protection plans were reviewed and critiqued. Plans for the States of Rhode Island, Connecticut, Louisiana, Texas, North Dakota, South Dakota, and Utah were obtained. Those plans in the region surrounding Wyoming (indicated under Western Wellhead Protection Programs) were given the greatest weight in the review process since they consist largely of rural areas, have similar recharge rates, and are generally non-industrial. Public attitudes towards government regulation of land use and voluntary versus mandatory programs are comparable throughout the area.

Florida

Florida law establishes two protective zones around community supplies that withdraw more than 100,000 gpd of groundwater. The first is an AFR of 200 feet around the well or wellfield and the second is a 5 year TOT zone. New discharges into the groundwater of a variety of named contaminant sources are prohibited in the inner zone. Outside this zone discharges are controlled and must be monitored. Discharges from industry that contain hazardous wastes are prohibited in all cases. Discharge of **treated** domestic wastewater is conditionally allowed. Dade Co., Florida has instituted its own groundwater protection program which is centered around numerical modeling of the recharge areas of the Counties' well-fields. The program is extensive with elements covering land use management, wastewater treatment, water management including conservation, and land use policy. The County restricts and otherwise regulates over 900 substances considered hazardous by the government unit. Three concentric zones representing 30, 210, and 500 year TOT's are defined by a numerical model.

It is important to recognize that the Florida plan does little to address existing sources in either of the delineated zones. If

these are not regulated in some other way (e.g. environmental or zoning regulations), it is possible that these existing sources may not be controlled at all. A way needs to be devised to address this problem in Wyoming (promulgation of needed local or state WHP regulations) so that potential contaminant sources which are established at the time will be fair to all and protect the public health as well.

Massachusetts

The Massachusetts Department of Environmental Protection (formerly the Department of Environmental Quality and Engineering) has established three zones where land uses may have deleterious effects on drinking water sources utilizing groundwater. The first zone is a 400 foot AFR region where State drinking water regulations must be met. The second zone uses the area that results when the most severe recharge and pumping conditions that could be reasonably expected to occur are applied to a given well-field. Industrial, commercial, agricultural, and residential uses in this zone must be mapped. A land purchase program is available under some restrictions to allow communities to obtain vulnerable recharge areas. The third zone is the area outside of Zone II where surface water and groundwater may contribute to Zone II. Often this constitutes a total surface drainage basin. Zone III is mapped only for those land uses which are considered to be significant threats to the groundwater supply.

The delineation methods required are not specified but would require hydrologic mapping for Zones II and III at the least. The Massachusetts program emphasizes identification of the location of potential threats to groundwater and does not attempt to establish methods to exercise control over recognized contaminant sources except in Zone I. The cataloging of sources without a plan to do something about them is a weak approach.

The land purchase program is an intriguing method to obtain rights over land the community wishes to protect. The funding method in Wyoming could be by use of monies from the Water Development Fund. Communities which could demonstrate a clear threat to their water supply would be able to purchase land outright which would provide the wellfield or recharge area with a buffer or protective zone. For example, in Torrington several of the municipal wells are located adjacent to property where agricultural chemicals are used extensively. If Torrington could purchase land abutting the well locations, some of the danger of contamination of the well with pesticides and nitrates would be removed or reduced. In Wyoming, land purchase might be more acceptable to landowners than highly restrictive zoning. On the other hand, the cooperation of contiguous property owners might be obtained to avoid certain crops which require high levels of fertilizer or pesticides in the vicinity of the wells. Chemical management and optimization of application rates and frequency,

along with better irrigation practices, could also be achieved through education. Education would also be necessary for other types of activities which require scrutiny in a WHP program.

A potential pitfall would occur in cases where it became necessary to obtain land through the exercise of eminent domain rights. This method of land acquisition is often looked upon by landowners as grossly unfair and despotic. The WHP needs the cooperation of the citizenry to work optimally and every effort should be made to avoid alienating the public.

Vermont

The State of Vermont's program consisted (at the time the EPA document was prepared) largely of recharge area mapping efforts for community water supplies.

Rhode Island

The Rhode Island plan addresses elements which EPA has suggested in guidance documents ought to be included in state WHP programs. It delineates the roles and responsibilities of the State and water suppliers. Interrelationships with the Federal Government and with local governmental units are described. The State, for example, is responsible for providing data on state regulated pollution sources, for giving technical assistance with source inventories, management approaches, and contingency planning. Requirements differ for community and non-community systems. The WHP delineation takes a two tiered approach which uses an initial delineation effort followed later by a more refined method.

The initial delineation uses readily available data which is already in existence. Community wells completed in stratified drift yielding more than 10 gpm are delineated using uniform flow equations and hydrogeologic mapping. For community and noncommunity system wells completed in bedrock with a yield of more than 10 gpm, analytical modeling using the Theis equation is employed. Relatively simple methods are used because information is often not available on flow directions in fractured bedrock. Noncommunity wells with yields less than 10 gpm use the Theis analytical method since there is little existing data for these wells. Refined delineation is to be done after the initial phase, using newly generated data.

It should be noted that the Theis analytical method requires the ability to determine the storativity and transmissivity of the aquifer in question. This assumes that data from pump tests for the aquifer are available. The Torrington study clearly demonstrated that this may not be the case in Wyoming, even in a

very thoroughly studied aquifer such as the North Platte alluvial aquifer. Some data was obtainable for the aquifer but the data were not detailed and did not give a high degree of confidence that they represented the situation on the small scale required to evaluate the Torrington wells. Furthermore, the use of an analytical method does require a degree of experience on the part of the operator in evaluating the accuracy of the input data and in assessing the reliability of the results. The method assumes that the aquifer is uniform and isotropic. This may be a suitable assumption for an aquifer like Torrington's where the matrix material has been deposited by the River. In stratified or many sedimentary aquifers this would not be the case. In addition, the Theis method assumes that the drawdown is small in comparison to the saturated thickness of the aquifer which is difficult to verify if only existing data are being utilized. If a confined aquifer is being studied, the confining layers must be nonleaky. This is also difficult to confirm from historical information. Lastly, the method assumes zero recharge during the pumping period which is often hard to substantiate. While it does obviously have weaknesses, as do all analytical methods, it may very well be useful as a first cut at estimating wellfield potential head properties. This is how Rhode Island intends to use it.

Another feature of the Rhode Island plan is a detailed source identification effort, including field surveys, site identification (e.g. from aerial photographs), and researching directories which are combined with known pollution problems and information on chemicals being used within the State. Management approaches used are the identification of existing programs for the control of groundwater contamination and determination of uncontrolled pollution sources not presently being addressed. Management options available to the supplier include land acquisition, groundwater quality monitoring and education. A five year plan is part of the management program. Contingency planning should be part of the overall management plan so that responses to contamination events can be well thought out in advance. New wells should be subjected to aquifer tests and piezometric surface mapping. The source identification program for Rhode Island has features which could be helpful to Wyoming such as the use of aerial surveys in studying remote recharge areas.

Louisiana

The State of Louisiana WHP program must deal with five state level departments which have responsibility for various aspects of groundwater protection. The WHP plan establishes the Department of Environmental Quality as the lead agency in the effort. The delineation of WHP areas are to be based on distance. In confined and semi-confined aquifers a one mile AFR is used while a two mile AFR is employed for alluvial and other water table aquifers. The State felt that these values are conservative and therefore should provide a measure of protection (and perhaps over-protection). The

choice was driven by a desire to rapidly map the WHP areas in a way that the regulated public could easily understand. The development of a database of potential contamination sources, groundwater quality information, and other relevant information in the possession of the various cooperating agencies and departments is a key goal. DEQ is responsible for coordination of the groundwater protection activities and to ensure that each unit exercises its regulatory authority. Contingency plans have also been developed based on a plan from Palmer, Ma.

It is fortunate that groundwater protection efforts in Wyoming are housed in one portion of one agency of the State government.

Texas

The Texas Water Commission and the Texas Department of Health have formulated the Texas WHP program which defines the roles and duties of State and local governments. For example, the Texas Water Commission(TWC) is responsible for the delineation of WHP areas while the Texas Department of Health(TDH) reviews community developed contingency plans for alternate drinking water supplies for each public water system in case the normally used supply becomes contaminated. The TWC is designated as the lead agency and both the TWC and the TDH provide technical assistance and public education to local governments concerning the WHP program. Development of an inventory of all anthropogenic sources of contaminants which could have an adverse effect on public health is the responsibility of the local government entities. The TWC and TDH can provide assistance to the local units. The State agencies have learned through experience that community participation results in more and better wellhead protection efforts.

WHP areas are delineated based on a five year TOT criterion at the maximum pumpage rate. This criterion was selected to give an adequate response time to react to threats to the groundwater resource. The minimum radius for each WHP is one quarter of a mile. A consultant to the TWC recommended that a CFR method be used for single wells or for two wells that are nearly contiguous. Protection zones for three or more wells in a field should be delineated using numerical models. It is not at all clear what the reasoning behind this recommendation is. There is substantial difference between the two methods in the level of data required, cost, and knowledge needed by the modeler in applying the methods. It would seem to place a burden on small communities, which for reasons of economy or other considerations, have chosen to group their wells in a concentrated field. Perhaps having the wells close together is viewed as increasing their risk of contamination by creating a strong gradient towards the field. Conceivably, a contaminant plume moving towards a multi-well system could pollute a substantial portion of a community's supply, putting the population at risk, or leaving them without an adequate supply.

Western Wellhead Protection Programs

The western states which have established wellhead protection programs are summarized below in some detail. These states include North Dakota, South Dakota, and Utah. Nebraska has a plan in place but the program write-up was not obtained for discussion since it uses only a distance criteria under the arbitrary fixed radius approach.

North Dakota

The North Dakota WHP program first addresses those public water supplies that are considered to be most vulnerable to contamination. The criteria used to determine those systems most vulnerable are depth of primary wells in the system, population served, and level of community interest in the program. An analytical ZOC is used to describe the protection zone. The State has examined several criteria for WHP areas with differing thresholds for the criteria. They are:

1. Time of Travel: A 10 year TOT on the upgradient side of the ZOC was used for a pilot study (Rolla,N.D.) and is recommended for systems choosing TOT as the criterion for their WHP plan. The purpose of the criterion is to permit an adequate response time in the event of a contaminant threat to the aquifer;

2. Drawdown, Flow Boundaries/Aquifer Boundaries: These criteria thresholds are site specific;

3. Distance: A minimum distance of 500 feet is designated as the distance threshold. Confined aquifers with sufficient site-specific information would use the CFR method. If no data exists the AFR would be used.

The State asserts that the analytical ZOC allows the incorporation of a number of site specific hydrogeological parameters, provides excellent protection of the water supply, and is the most accurate of the analytical methods available. On the other hand, it can be moderately costly to implement due to the significant amount of hydrogeological data required. Some mapping is required to carry out this method. The plan recommends a secondary zone or arbitrary buffer zone such as the 500 feet suggested above if there is a particularly threatening source near the wells or if there is significant doubt as to the accuracy of the delineation.

The North Dakota plan follows EPA guidelines rather closely but is not very detailed. For example, the CFR is recommended for confined aquifers but no definition is given as to what the State considers to be a confined aquifer nor is any mention made of the need to protect recharge areas. The drawdown criterion is advanced

with no caveats about using it with sloping water tables.

South Dakota

The South Dakota WHP plan requires that the WHP area be delineated using a method or combination of methods described in the plan or another technically sound method of delineation approved by the State Groundwater Program. The plan states that "ideally, the WHP area should: be an area in all or a portion of the current or future recharge and contributing area for the water supply; provide an area for contaminant attenuation to maintain groundwater at the South Dakota Groundwater Quality Standards; protect the wells from unexpected contaminant releases; and allow time for remediation to minimize the likelihood of contaminants reaching the well. No criteria, threshold or method is appropriate statewide or even for all wells 100 feet deep or less. A value or set of values must be selected to represent the degree of protection desired." This statement would seem to fit Wyoming's situation since the very size and variability of the geology of the state would make it unlikely one technique would fit all needs. The State of Wyoming should therefore determine what degree of protection should be required by the method of delineation to be used for its municipal groundwater systems based on aquifer vulnerability, and population at risk.

The South Dakota plan requires that each community program include the following:

1.A statement showing how the main objective of the plan (i.e. a remedial action zone) is to be met;

2.The method, criteria, and thresholds selected and a rationale showing that the selections are technically sound;

3. The institutional process for developing the WHP area delineation;

4. The institutional process by which the WHP areas will be implemented, monitored, and refined; and

5. The WHP delineation be shown on a map.

The criteria and thresholds for delineation are very similar to those of North Dakota. It emphasizes flexibility since the hydrogeological conditions vary widely across the State. An AFR may be useful when the well is deep and the recharge area remote from the well vicinity. Shallow or alluvial aquifers are more vulnerable and may require more sophisticated techniques. The criteria depend on drawdown or zone of influence which may not be an appropriate approach with sloping water tables. Modeling of 70 public water supplies showed that the water contributed to shallow wells in the State generally are derived from waters within 500

feet of the well independent of the aquifer or population. The State provides radius of influence to the community for their use in establishing WHP areas at the local level. This individualized approach with State assistance seems to be an approach that would be adaptable to many Western states. As pointed out earlier, local involvement is essential if a high level of participation is to be realized.

Utah

The State of Utah WHP plan is perhaps the most detailed and well thought out of those reviewed for this project. As suggested by EPA, the Utah plan is based on the delineation of three zones around each well and/or spring. In addition to the three zones, a public water system may choose to use an overprotective two mile AFR method if this is submitted along with a drinking water source protection plan. The three zones are as follows:

Zone One: (accident prevention zone) -the criterion is a 100 foot AFR from the wellhead. The purpose of this zone is to protect the well from contaminant leakage due to an imperfect seal between the well casing and the bore hole.

Zone Two: (Attenuation Zone) -the criterion is a 250 day groundwater TOT to the well. The purpose of this zone is to reduce concentrations of contaminants to established levels before contaminated groundwater reaches the well.

Zone Three: (Remedial Action Zone) -the criterion is a 15 year groundwater TOT to the well. The purpose of this zone is to be provide an effective groundwater management area and to provide time for public water systems to implement action in case of a spill.

Appropriate formulas are to be used to calculate groundwater velocity and then determine the TOT to delineate the protection area using a CFR. The program recommends that in addition to the three zone delineation, the supplier should determine the total recharge area for each well and treat it as part of the protection area.

An alternative elective method is suggested for confined aquifers. The aquifer must meet the following conditions:

1. An effective confining layer, with lower hydraulic conductivity than the producing aquifer must exist above the producing aquifer.

2. There must be an upward hydraulic gradient through the confining layer regardless of changes in the potentiometric surface (i.e. due to seasonal fluctuations, etc.)

3. No evidence of downward leakage into the confined aquifer between the well casing and the well bore.

The program requires suppliers using this method to monitor the potentiometric surface of the producing aquifer and the overlying aquifer within a 25 foot radius of the well. The suppliers' wells must continue to meet these options or abandon this method. If the aquifer and well meet the specified criteria, then only the unconfined areas within Zones 2 and 3 must be delineated as protected areas. The delineation and protection of Zone 1 is still required.

A two mile AFR is offered as an optional delineation method in Utah's program. Before management methods to control potential sources can be determined, hydrogeologic impacts must be evaluated. Therefore, this method is most useful where few or no potential sources of contamination exist near the well. In areas with many potential sources, the three zone delineation method would be more economical. The plan also gives specific guidelines for springs. The drinking water source protection delineation report is required for all options except the two mile AFR and must provide geologic data(e.g. formation name), aquifer data(e.g. conductivity), well data(e.g. driller's log), hydrogeologic methods and procedures, and mapped boundaries of the WHP area.

Summary

A summary of delineation techniques is presented in Table 3 for several states for which a plan had been implemented at the time of this review. As can be seen, a variety of methods have been applied in the states included in the EPA study and the additional state plans which were added from the investigation associated with this study with some jurisdictions combining methods.

Elements for Development of a State Wellhead Protection Program

A comprehensive State Wellhead Protection Program should be comprised of at least the following seven elements as a minimum:

1. Specify the roles and duties of state agencies, local government entities, and public water suppliers in development of WHP Programs for each public water supply in the state.

2. Delineate the WHPA for each wellhead of a public water supply following guidelines outlined by the state in their plan.

3. Identify sources of contaminants within each WHPA including all potential anthropogenic sources that may have any adverse effect on health.

Table 3. State Wellhead Protection Area Methodologies and Criteria.

Method	Criteria Relied On	Selected Locations Where Used
Arbitrary Fixed Radius	Distance	Nebraska Florida Edgartown,Ma Duxbury,Ma
Calculated Fixed Radius	Distance Time of Travel	Florida
Simplified Var. Shapes	Time Of Travel Drawdown	Southern England
Analytical Flow Model	Drawdown Physical Features	Cape Cod,Ma Duxbury,Ma Edgartown,Ma West Germany Holland
Hydrogeologic Mapping	Physical features	Vermont Connecticut Duxbury,Ma
Numerical Flow/ Transport Models	Time of Travel Drawdown	Dade Co.,Fla Broward Co., Fla. Palm Beach, Fla.

4. Develop management approaches which include technical assistance, financial assistance, control measures, education and training to protect the water supply of the WHPA from contamination.

5. Develop contingency plans for each public water supply system indicating the location and provision of alternate supplies in the event of well contamination.

6. Site new wells properly to maximize yield and minimize potential contamination.

7. Ensure public participation by incorporating processes for appropriate involvement in the WHPA for a community or public water supply entity.

Each of these elements will be discussed below and comments made with regard to what might be most appropriate for Wyoming. EPA has provided several publications to help assist states and local governments with suggestions on ways to establish wellhead protection. Two of these publications were used extensively in the discussion that follows.

Roles and Duties of Government Entities

The EPA guidebook entitled Developing A State Wellhead Protection Program: A User's Guide to Assist Agencies Under the Safe Drinking Water Act has outlined the considerations that should be given with respect to roles and duties of government entities. It is necessary to specify duties of each participating agency in a wellhead protection program and develop the mechanisms for coordination and integration so that the program can be accomplished in an efficient and reasonable manner through an agreed upon coordinated effort. Discussion of roles, responsibilities, duties and coordination are indicated in the guidebook. It is important to identify a lead agency for WHPA activities.

In Wyoming, it is helpful that at the State level, the main agency responsible is the DEQ in terms of contaminate protection of the water supply. Issues, however, can be more difficult at the local level where the wellhead protection area(s) extent into the surrounding county area. This requires sorting out the overlapping roles and responsibilities of each and how they can be coordinated to make a WHPA Program work. This will be difficult to handle in many instances where the city and county do not coordinate well together. Local governments may wish to consider resources available to them for implementation before adopting a management strategy. It would be very helpful for most cities and counties in Wyoming to develop a city-county planning office which could handle problems which extent between entities. Local community plans should take care not to restrict a WHPA Program unnecessarily.

To assist in the evaluation of the authority which cities and towns could exercise with respect to a wellhead protection program, the DEQ solicited an opinion from the State of Wyoming's Attorney General's Office. A copy of the letter from DEQ and the response received are given in Appendix C.

Delineation of Wellhead Protection Areas

This subject has been covered in a previous section of this report in some detail.

Identification of Sources of Contamination

As should be the case with any groundwater which is to be used as a public drinking water supply, the existing quality and any potential sources of contamination to the groundwater should be known or identified and inventoried. It is important to involve knowledgeable state and local technical personnel who can help identify what sources of contamination should most probably be on the list of contaminant items that might exist within the WHPA. It is important to utilize local agencies and service groups as part of the inventory and updating process since many of these individuals will remember past activities in the area which no longer exist but could have or may cause pollution of the aquifer.

The source identification program for Rhode Island indicated features which could be helpful to Wyoming such as the use of aerial surveys in studying remote recharge areas. The State has a considerable wealth of information held by various governmental agencies and private organizations which document commercial and industrial activities which would be helpful in recognizing point and nonpoint contaminant sources. For example, maps showing cropping patterns are available for many parts of the State through the Department of Agriculture. Mining is controlled through Federal and State permits which are on file. Industrial Siting has information on some commercial and industrial endeavors. State and local historical organizations may be able to furnish data on past actions that relate to threats to groundwater. These organizations may have access to old telephone directories which can pinpoint the location of commercial ventures which may be of interest. Senior citizens could be invaluable in identifying historic land uses such as the site of an old gasoline service station or dry cleaner. These and others could be a valuable means of obtaining source identification information.

Communities must evaluate both existing and potential sources of contamination. These sources should be categorized by type or by degree of potential harm (or by degree of local authority over the source). Once a complete survey has been completed of all potential sources of contamination, a locally may wish to prioritize the sources based on degree of threat and need for controls. Rock County, Wisconsin (Page 7, EPA: Wellhead Protection

Programs: Tools for Local Governments) created an interesting system for indexing potential risk of groundwater pollution. The system assigns risk factors to sources based on considerations such as toxicity, concentration, natural protection, level of controls, and distance from water supplies.

As a part of this project, a listing of actual and potential sources of contamination to groundwater in the State of Wyoming has been developed. Appendix D contains this listing. Also a list of particular elements (chemicals, metals, etc.) that result from these potential pollution sources around the state are contained in this appendix.

Management Approaches for Contaminant Source Control

EPA suggests in Developing a State Wellhead Protection Program that the lead agency consider locations, institutional settings, and type of source in the selection of management approaches. Flexibility should be emphasized in establishing methods of source control. Risk based criteria should be used in developing phased management approaches. In Wyoming, with sparse population and limited financial resources, this would seem to be particularly important. Many communities may opt for low cost solutions which provide a small degree of protection, but allows some time for recognition of and response to an existing threat to occur. Several of the reviewed plans highlighted vulnerability of the aquifer or population at risk in deciding which systems to phase in first.

A variety of management tools are available in establishing WHP programs. The State can take the age-old "carrot or the stick" approach with financial and/or technical assistance on the one hand and regulation on the other. Use of existing programs at all levels of government is a wise management method if those programs are suitable to the purposes of the plan. Local governments have more options available.

1. Zoning Ordinances-these may be used to restrict or regulate certain land uses within WHP areas. It is important to have comprehensive land use requirements designed to direct development of an area where a WHPA is to be established now and in the future. There may be a conflict between levels of government in areas where municipalities have zoning ordinances and the rural areas of the county do not. For example, the city of Laramie does have zoning ordinances, but Albany County does not. The City and County have been trying to reach agreement on zoning and land use management in the area within two miles of the City Limits for nearly ten years and have been unable to do so. There is a great deal of opposition to rural land use management in the State. If a community has public water supply wells located outside of community boundaries, as does Laramie, it may be difficult to control land use by zoning

alone. Several zoning approaches are given in Wellhead Protection Programs: Tools for Local Governments which include down-zoning, phase-ins, large-lot zoning, conditional zoning, floating zones, cluster zoning and planned unit developments, incentive or bonus zoning and overlay zoning.

The practicality, political feasibility and legal issues associated with zoning changes will have to be addressed with respect to effective utilization of zoning or it could develop into a real problem for the community.

2. Subdivision Ordinances-these may be used to protect water well and recharge areas in situations where ongoing development is causing a threat to the resource. This type of ordinance is primarily useful for controlling future development. In Torrington, two of the municipal wells are located within a new subdivision, where lawn chemicals may pose a concern regarding water quality. Again, the necessary ordinances must be in place to allow this wellhead protection approach to be effective. This is perhaps simpler with subdivisions which are in the planning stage where the community can exert control prior to development.

3. Site Plan Review-the purpose of a site plan review is to determine whether a proposed project is compatible with existing land uses and whether the infrastructure is sufficient to support the new development. New uses which may threaten subsurface water supplies can be modified or prohibited if the community has the proper regulatory tools in place to require site plan reviews at several stages of development.

4. Design Standards-these are typically used to regulate the design, construction, and ongoing operation of various land use activities. For example, many communities have stormwater catchment systems to prevent water pollution. Hazardous waste or hazardous materials containment or storage systems could likewise be required to install spill/leak containment systems. The recent underground storage tank regulations promulgated under the Resource Conservation and Recovery Act require leak detection systems and other risk reduction measures which should reduce the threat from fuel dispensers and other businesses which store petroleum in underground tanks. Recharge areas could be protected by limiting the extent and percent of impervious surfaces. The standards should be specific enough to allow consistent evaluation and ensure that requirements are appropriate and genuine.

5. Operating Standards-regulations that apply to ongoing land use activities to promote safety or environmental protection. These along with design standards could be used to protect wellheads and recharge areas by regulating handlers of hazardous materials, or by controlling releases of contaminants. Agricultural Best Management Practices (BMP's) are probably the most useful operating standard that could be applied to non-point contaminant sources in many

parts of Wyoming.

6. Source Prohibitions- using the management approach, the storage or use of potential contaminant materials could be prohibited within established wellhead protection areas. Source prohibitions can be combined with zoning to prevent the siting of junk yards, machine shops, landfills, septic systems, and other potential contaminant sources within the wellhead protection area. Specific materials such as heavy metals, solvents, petroleum products, or radioactive materials may also be prohibited within the wellhead area.

When sources are being considered for prohibition, phase-in requirements of the regulations may be required in order to help resolve problems and make the effort cost effective and lasting.

7. Purchase of Property or Development Rights- in order to protect the wellhead area, some control over the activities occurring on lands overlying an aquifer is sometimes needed. An obvious problem is that wellhead areas may encompass large areas of land which can create a drain on financial resources if this tool is used. Several alternatives to outright purchase exist which include acquisition of partial interests, and negative easements. Negative easements convey to the holder the right to prevent the landowner from taking specified actions on the property. Other methods to purchase partial land use control may also be available depending on the locality as indicated in the following paragraph.

Recently, a Water Quality Protection Program, mandated by the 1990 Farm Bill legislation, is targeting areas such as land surrounding public water supply wells (wellhead protection areas) and land with geologic "sinkholes." Program participants working on source reduction of agricultural pollutants may receive up to $5,000 in annual incentive payments and cost-sharing assistance for implementing USDA-approved water quality protection plans. In addition, the Conservation Reserve Program (CRP) in the bill allows farmers in states with approved wellhead protection programs to "bid" for federal payments to leave land in wellhead protection areas uncultivated. To be eligible, land must lie within 2,000 feet of a public well.

The problem with this approach is that it can be costly to local governments and thus cooperation with landowners and zoning may be a more effective method. Then, only those areas where cooperation is not forthcoming or the land is inexpensive should this approach be utilized.

8. Public Education-these programs can be used to build support for regulatory efforts and to implement voluntary programs for groundwater protection. Examples include water conservation or proper disposal of household wastes. Agricultural Best Management Practices can be encouraged to aid in the control of the use of

pesticides and fertilizers. Approaches to use include press releases to newspapers and radio, group speaking presentations (Rotary, Lion's Club, etc), committees and brochures. Considerations which should be given this type of activity are local conditions and target audiences as well as the requirements for time and resources.

9. Groundwater Monitoring- this is the early warning system for the detection of contaminant plumes. A study of the groundwater hydrology of the wellhead area would be required under this protection scheme in order to place monitoring well effectively. A regular program of testing public and private wells for contaminants could be used in addition to monitoring wells for detection of plumes. This program will require technical expertise and sufficient funding to pay for monitoring and analysis costs.

10. Household Hazardous Waste Collection- this tool is useful in areas where landfills and septic systems may threaten the water resource due to proximity to the wellhead area or its recharge zone. It can be costly to implement and may entail problems with disposal of these wastes once they are collected. However, elimination of this potential source of contamination is important.

11. Water Conservation- this tool reduces groundwater velocity (and contaminant movement) as well as reducing the quantity of wastewaters produced. It requires time to educate users and as a result changes may be slow. An effective tool in this regard is to increase water rates for users in a step fashion as their consumption increases.

It is important to provide flexibility in any management program so that the program can match the local circumstances. Local government and concerned citizens should be involved early in the proceedings to build support for the program. Objectives and priorities must be established early in the development phase. At the local level, communities may wish to provide complete protection against any contamination or they may wish to give highest priority to current or future problems arising from particular sources. Initial goals may have to be expanded or reduced as the planning and implementation phases progress. Foreseeing problems before they occur, such as new contaminant sources, has the advantage of avoiding disruptions to existing land use and possible legal challenges. It cannot be overemphasized that the WHP process involves many factors and complexities. An effective program can best be achieved through multiple methods which are organized such that they lead to cooperation and harmony, and not dissension.

Contingency Plans

It is very important that each major public water supply system in the State or the State as a whole develop contingency

plans for their water supply(s) in the case where contamination results which would affect a given water supply. These plans should include short and long-term alternatives in case of contamination while the clean-up occurs along with coordination mechanisms and financial resources to address the alternatives developed as a part of the contingency plan. The contingency plan should contain such items as emergency response teams at the State and/or local level for certain types of spills to other water sources available adjacent or at distance for use during clean-up efforts to financial funds set aside for such a situation.

New Wells

Anticipated new wells for the future water supply of a community as it grows should be a part of the overall WHPA Program. Areas for new wells should be sited in the WHPA Program Plan for a community to maximize yield and minimize potential contamination and a coordinated planning effort developed as a part of the management plan so that the wellhead protection area for these new wells will have minimal potential for contamination when constructed.

Public Participation

Throughout the entire process of development of a WHPA Program for the State and an individual community, public involvement and participation in each step of the process is absolutely necessary in Wyoming. Information and brochures should be developed which will help the public understand the benefits of a WHPA Program and why it is in the best interest of each community to invest in the program. As the process of development occurs, the more people that are allowed to be involved with different steps of the WHPA Program will only result in better public acceptance of such a program within a community or area. Some suggestions have been indicated in other portions of this report.

Task 4 Results:

A schedule of public meetings on wellhead protection was developed with the project officer from DEQ. The public meetings were planned mainly for the month of July 1991. Public meetings were held in Cheyenne, Wheatland and Torrington at the end of June. A listing of the public meetings held is attached as part of Appendix E along with dates. A public meeting was also held in Evanston on August 5, 1992 but is not indicated on the list. A questionnaire was developed to be used with the public meetings along with an extension bulletin on wellhead protection. The results of the questionnaire survey, the survey instrument and the wellhead protection bulletin are included as a part of Appendix E.

This report constitutes the final report for this project.

APPENDICES

APPENDIX A

Database Design and Input Requirements
Public Water Supply Questionnaire

1.0 Wellhead Design Criteria

The wellhead database is designed to hold data associated with municipal water supply systems that use ground water. The following assumptions were made in the design:

- Multiple systems are to be stored in the database.
- One system can have multiple wells.
- One well in a system can have multiple aquifers, drillers log locations, water quality data locations and point/non-point pollution sources.
- The wellhead database should be compatible with WRDS. The degree of compatibility with WRDS will be determined as the database design matures.

2.0 Wellhead Dependencies

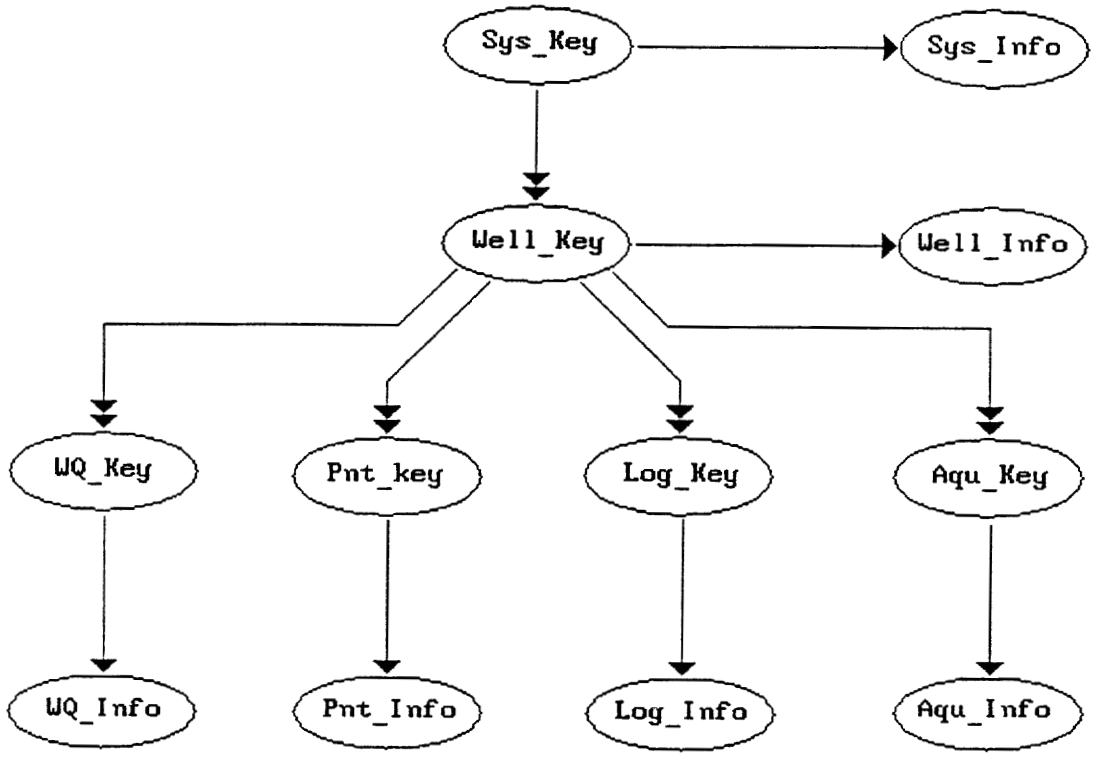


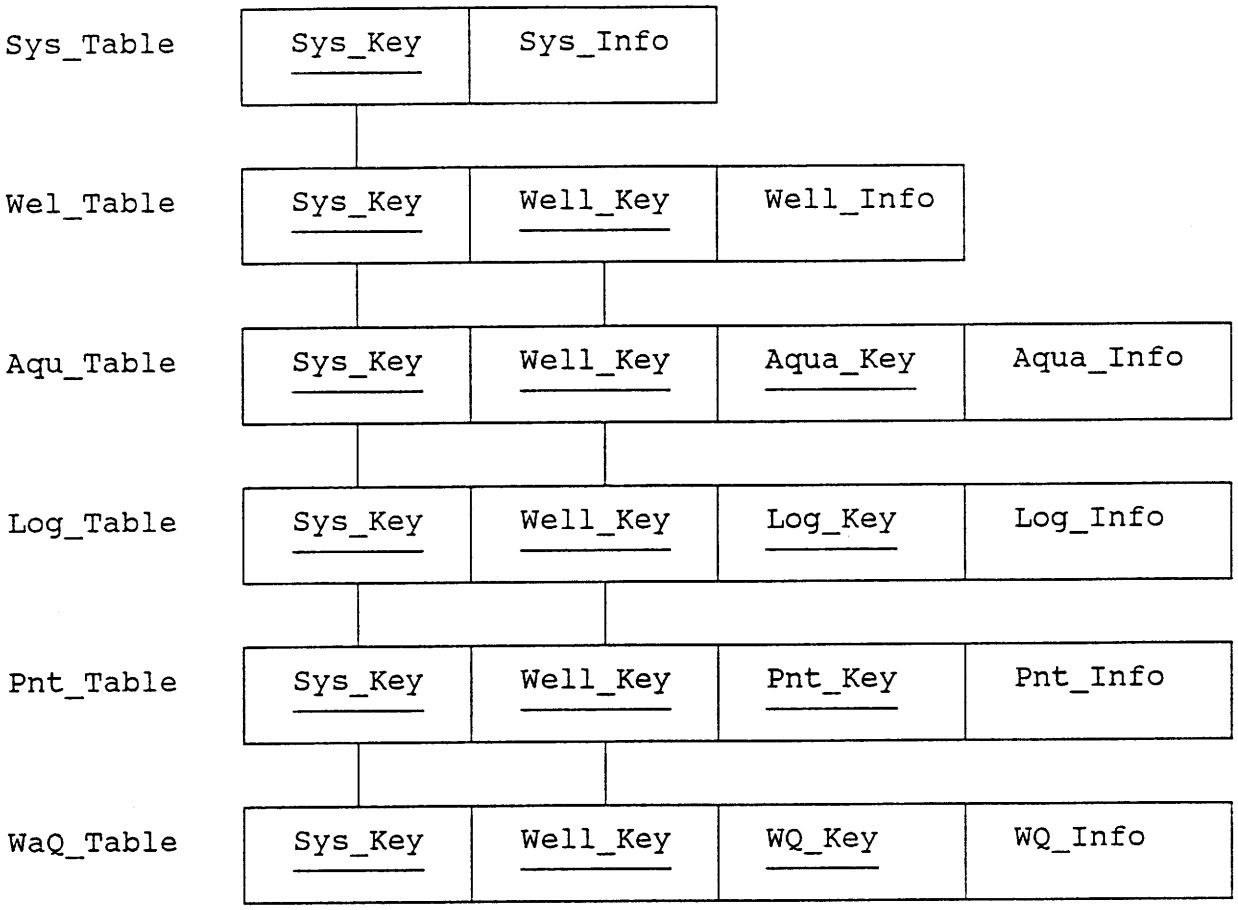
Figure 1: Wellhead Dependency Diagram

The above dependency diagram shows the relationships between the entities of the well head database. Any entity suffixed by "_Key" is a primary key. An example of a primary key is "Sys_Key".

An entity suffixed by "_Info" represents all attributes of an entity that are not part of a primary key. For example, Sys_Info symbolizes all the fields that describe an individual system that are not primary keys.

The single headed arrows in the dependency diagram symbolize a single valued relation between entities. For example, the single headed arrow between Sys_Key and Sys_Info symbolizes the fact that there is only one set of attributes which describe a system.

The double headed arrows indicate a multiple valued relation between entities. For example, to illustrate the fact that one system can have multiple wells contributing to the system, a double head arrow is drawn from Sys_Key to Well_Key.



The above set of tables was derived from the dependency diagram on the previous page.

Each underlined field symbolizes a primary key that will be used to access the non-primary attributes in the table. For example, in Sys_Table the primary key Sys_Key is used to access the non-primary attribute Sys_Info.

The lines between the tables and attributes indicate alternative ways for retrieving information about a system. Other ways of accessing the data will be developed as the database design matures.

3.0 Wellhead Table-Definitions

TABLE **Database : WELLHEAD**

DEFINITION **Table Name: SYS_TABLE**

Key	Field Name	Type	Units	Values/ Range	Description
PK	SYS_KEY	i5		10000-99999	System Key
	name	c30			Name of the system
	address	c30			Address of the system
	city	c15			City for the system
	county	c20			County for the system
	zip	c9			Zip Code for the system
	phone	c10			Phone number of the system
	status	***			**********
	owner_ty	***			The type of the owner
	prim_src	***			**********
	pop_serv	i6		0-999999	Population served by the system
	cur_fut	c6		'HIGH' 'MEDIUM' 'LOW'	Current or future demand on the system
	com_1	c60			1st line of comments
	com_2	c60			2nd line of comments
	com_3	c60			3rd line of comments

TABLE **Database : WELLHEAD**

DEFINITION **Table Name: WEL_TABLE**

Key	Field Name	Type	Units	Values/ Range	Description
PK	SYS_KEY	i5		10000-99999	System Key
PK	WELL_KEY	i2		10-99	Well Key
	name	c30			Name of this well in the system
	elev	i5	feet	9000-15000	Elevation of this well
	lat	c6			Latitude for this well
	lon	c7			Longitude for this well
	town	c3		0-99	Township for this well
	range	c3		0-999	Range for this well
	sect	c2		1-36	Section for this well
	qqq-sect	c2		'NE' 'SE' 'SW' 'NW'	QQQuarter Section for this well
	qq-sect	c2		'NE' 'SE' 'SW' 'NW'	QQuarter Section for this well
	q-sect	c2		'NE' 'SE' 'SW' 'NW'	Quarter Section for this well
	huc	c8			Hydo. Unit code for for this well
	county	c25			County in which this well is located

TABLE DEFINITION

Database : WELLHEAD

Table Name: WEL_TABLE

Key	Field Name	Type	Units	Values/ Range	Description
	state	c2		'WY' 'MT' 'CO' 'UT' 'ID' 'SD' 'NE'	State in which this well is located
	per_num	c10			The states permit number for this well
	tcb_lsd	f5.2	inch.	0.00-99.99	Top of casing below LSD
	cas_diam	f5.2	inch.	0.00-99.99	Casing diameter
	cas_mat	c10			Casing material
	tot_dep	f6.1	feet	0.0-9999.9	Depth of well below ground level
	flo_rate	f6.1	gal/ min	0.0-9999.9	Flow rate of well
	vul_indx	c3			Vulnerability index for this well
	avail	c9		permanent or emergency	Usage characteristics of this well
	st_level	f6.1	feet	0.0-9999.9	Static water level of this well
	si_ty_us	c30			This wells site type or use

TABLE **Database : WELLHEAD**

DEFINITION **Table Name: AQU_TABLE**

Key	Field Name	Type	Units	Values/ Range	Description
PK	SYS_KEY	i5		10000-99999	System Key
PK	WELL_KEY	i2		10-99	Well Key
PK	AQUA_KEY	i2		10-99	Aquifer Key
	name	c30			Aquifer Name
	lith	c20			Lithology of this aquifer
	thick	f6.1	feet	0.0-9999.9	Thickness of this aquifer
	perm	****	****		Permeability of this aquifer
	trans	****	****		Transmissivity of this aquifer
	stor_coe	****	****		Storage coefficient of this aquifer
	perf_len	f6.1	feet	0.0-9999.9	Perforation length in this aquifer

TABLE DEFINITION

Database : WELLHEAD

Table Name: LOG_TABLE

Key	Field Name	Type	Units	Values/ Range	Description
PK	SYS_KEY	i5		10000-99999	System Key
PK	WELL_KEY	i2		10-99	Well Key
PK	LOG_KEY	i2		10-99	Drillers Log Key
	location	c30			Location where the drillers log can be obtained

TABLE DEFINITION

Database : WELLHEAD

Table Name: PNT_TABLE

Key	Field Name	Type	Units	Values/ Range	Description
PK	SYS_KEY	i5		10000-99999	System Key
PK	WELL_KEY	i2		10-99	Well Key
PK	PNT_KEY	i2		10-99	Point/Non-Point
	point_1	c60			Possible Point and Non-Point pollution sources - line 1
	point_2	c60			Possible Point and Non-Point pollution sources - line 2
	point_3	c60			Possible Point and Non-Point pollution sources - line 3

TABLE DEFINITION

Database : WELLHEAD

Table Name: WAQ_TABLE

Key	Field Name	Type	Units	Values/ Range	Description
PK	SYS_KEY	i5		10000-99999	System Key
PK	WELL_KEY	i2		10-99	Well Key
PK	WAQ_KEY	i2		10-99	Water Quality Key
	location	c30			Location of water quality information
	station	c20			Station number of the well at same location
	source	c30			Collecting Agency of the water quality data

WELLHEAD PROJECT

Introduction

The following document explains how to use the Wellhead System and the actions preformed by the various pushbuttons.

Main Screen

The main screen is divided into two areas:

1. The System area.

   This area of the main screen alllows access to all information associated with the controling agent. To modify a system's information, you select the appropriate system area pushbutton located in the top part of the main screen.

2. Well area

   This area of the main screen allows access to all information associated with the individual well. To modify a well's information you select the appropriate well area pushbuttion located in the top part of the main screen.

Access to all information contained in the Wellhead System is through these two areas in the main screen.

The System Area

A system is defined to be the controlling agent of one or more wells. The following explains the actions of the pushbuttons in the system area on the main screen.

ADD	- is used to enter additional systems.
DELETE	- is used to delete a system. Make sure the system you want deleted appears on the screen.
VIEW	- allows you to look at a system that has been entered.
FIRST	- displays the first system entered and its wells.
NEXT	- displays the subsequent system entered and its wells.
PREVIOUS	- displays the preceding system entered and its wells.
LAST	- displays the last system entered and its wells.

The Well Area

Wells belonging to a system are displayed in the well area of the main screen. These wells belong the system that is shown in the system area of the main screen. The following explains the use of the pushbuttons in the well area of the main screen.

VIEW	- displays the information pertaining to a specific well. You must select the well you wish to view.
ADD	- is used to enter additional wells.
DELETE	- is used to delete a well. You must select the well you wish to delete.
NEXT	- displays the next page of wells for a specific system.
PREVIOUS	- displays the preceding page of wells for a system.
EXIT	- will take you to the main screen.

System Screen

This screen displays all of the information for the system that was displayed on the main screen. You get to this system screen by choosing one of the push buttons in the system area of the main screen. The following explains the pushbuttons available within the systems screen.

EDIT	- allows you to add information to an already existing system.
SAVE	- must be used after you edit any system.
CANCEL	- ignores any changes that have been made but not saved.
FIRST	- displays the first system entered.
NEXT	- displays the subsequent system entered.
PREVIOUS	- displays the preceding system entered.
LAST	- displays the last system entered.

Well Screen

This screen displays the basic information for the well that was selected on the main screen. You get to this well screen by choosing one of the pushbuttons in the system area of the main screen. The following explains the pushbuttons available within the wells screen.

EDIT	- allows you to add or change information on the well.
CANCEL	- ignores changes to a well that have not been saved.
SAVE	- must be used after you edit any well.
EXIT	- will take you to the main screen.
OPEN SECTIONS	- used for well perforation lengths.
AQUIFER	- is available for aquifer information.
LOG LOCATIONS	- are used for information on the location of the log.
POINT/NON-PT	- is used for point/non-pt information.
WATER QUALITY	- is used for water quality information.

Lower Level Well Screens

The pushbuttons for accessing the open section, aquifer, log locations, point/non-point, and water quality data are located on the well screen. Clicking one of these pushbuttons will display the open section, aquifer, log location, point/non-point or water quality data. All of the screens have the following pushbuttons in common.

ADD	- is used to enter additional information.
DELETE	- is used to remove information. You must click on the line of information to be deleted.
EDIT	- is used to change existing information or add new information. Click on the line of information to be edited.
EXIT	- will take you to the well screen.

UNIVERSITY OF WYOMING

Wyoming Water Research Center
P.O. Box 3067
Room 152, Vocational Annex
13th and Lewis Streets
Laramie, Wyoming 82071-3067
(307) 766-2143

TO: Public Water Supply Agencies or Groups

FROM: Victor Hasfurther, Associate Director, WWRC
Victor Hasfurther

DATE: November 5, 1990

RE: Wellhead Protection Survey

On July 25, 1990 we contacted you and other public water suppliers, throughout the State of Wyoming, that use groundwater for their water supply by letter (copy attached). To date, we have not received a reply to our letter. It is very important to you and to the Wyoming Department of Environmental Quality (DEQ) that we receive the information that we requested.

The purpose of this study, for the DEQ, is to determine a groundwater wellhead aquifer's vulnerability to pollution so that a plan can be developed to help you prevent contamination to the aquifer rather than the expensive and possibly futile options that occur once your aquifer has been contaminated. To accomplish this task, it is necessary to obtain the well information on your public water supply system so that potential sources of pollution to your groundwater well system area can be identified and a strategy developed to protect your wellhead(s).

The location of your well(s) is necessary before your systems vulnerability can be determined. Since time is becoming crucial to the completion of this study, it would be greatly appreciated if you would try and complete the indicated information and mail it to us on or before November 19, 1990.

Please contact me at the above address or telephone number if you have any questions. Thank you for your assistance in obtaining this information, it should be beneficial to you and the people you serve with water.

UNIVERSITY OF WYOMING

Wyoming Water Research Center
P.O. Box 3067
Room 152, Vocational Annex
13th and Lewis Streets
Laramie, Wyoming 82071-3067
(307) 766-2143

TO: Public Water Supply Agencies or Groups

FROM: Victor Hasfurther, Associate Director, WWRC
Victor Hasfurther

DATE: July 25, 1990

RE: Wellhead Protection Survey

Regardless of whether you supply water for a metropolitan area or for a small trailer court, it is important to know that the drinking water supply being used is not adversely affecting public health. The University of Wyoming is presently preparing a plan in cooperation with the Department of Environmental Quality to suggest methods and strategies for protection of groundwaters and wells that supply drinking water. The purpose of this plan is to help prevent contamination rather than the expensive and possibly futile options that occur once an aquifer has been contaminated.

As a part of this plan, it is necessary to locate as nearly as possible all wells in the state that provide public drinking water. Your assistance in the collection of this data would be appreciated. It would help if you would please take a few minutes to supply us with the information on the attached sheet for each of your public water supply wells. For large municipal systems or those systems with a number of wells used as the supply, a copy of your municipal or area map which indicates the locations of all your municipal wells would also be very helpful along with the information indicated on the attached form.

Thank you in advance for your help with this important piece of information to our study. If you have any questions, please contact me at the address or telephone number listed above.

rd

WELLHEAD PROTECTION SURVEY

NAME: _____

ADDRESS: _____

CITY: _____

COUNTY: _____

PHONE: _____

Contact:
Victor Hasfurther
Wyoming Water Research Center
P.O. Box 3067, University Station
Laramie, WY 82071 (307) 766-2143

Name/# of Ea. Well Serving System - (1 well per line)	Location of Well* (T,R,S, 1/4S)	Well Permit # (if known, optional)	Other Information, Optional (depth, dia. of well, etc.)

*If township, range and sections for well location is not known please describe location as technically as possible.

APPENDIX B

Vulnerability Ranking Methodology

Methodology for Determination of Vulnerability Ranking

This appendix was taken directly from the report "Assessment of Class V Injection Wells in the State of Wyoming" by Western Water Consultants of Laramie, Wyoming for the Department of Environmental Quality, Water Quality Division, of the State of Wyoming.

Relative Pollution Vulnerability Ranking of DRASTIC Map Units

To provide a clear picture of the pollution vulnerability of each group of geologic formations evaluated and mapped using the DRASTIC method, the 12 groups were ranked through comparison of characteristics pertinent to pollution vulnerability. These characteristics are listed below.

1. The DRASTIC Index, i.e. both the index range for the map unit and typical indices for aquifers and aquitards contained in the map unit. The number and relative importance of aquifers in the unit was considered by giving the typical aquifer DRASTIC Index more weight for units containing significant sensitive aquifers.

2. The geographic distribution of the unit. Certain map units, such as glacial and playa lake deposits, are very limited in areal extent and are therefore less likely to be subjected to most types of contamination. Other map units, such as the Cenozoic-age units, are exposed over large areas of the State and are therefore more likely to experience contamination.

3. The proximity of human populations and industrial development in areas where the unit is present at shallow depth. Human populations and industrial development are sources of contaminants introduced through Class V injection wells. Consequently, aquifers proximal to the contaminant sources are the most probable recipients of contaminants.

4. Typical water quality and ground-water development in areas where the unit is present at shallow depths. It was necessary to consider the ambient quality of ground waters in aquifers that might be subjected to fluid injection through Class V wells, and also to consider the present and potential uses of those ground waters. Aquifers with higher ambient water quality are more easily harmed by even slight water-quality degradation and are susceptible to potentially greater loss with respect to water use. Highly developed aquifers are subject to the same effects.

5. Known occurrences of resources whose development could cause or result in ground-water contamination. Because certain mineral resources, such as uranium, coal, oil shale, and trona (which can be extracted through Class V wells) are conspicuously present only in certain map units, their presence and possible development was considered in the ranking.

The results of the ranking, along with a summary of the geologic formations included in the DRASTIC map units, the DRASTIC Indices, and comments regarding the characteristics described above, are presented in Table 2-3. The map units are listed in Table 2 of the text of this report in order of their ranking.

In Wyoming areas most vulnerable to ground-water contamination are those underlain by Quaternary-age alluvium. Their vulnerability stems from the fact that, 1) development in terms of population and industrial/commercial facilities, is more heavily concentrated along the alluvium of major water courses, 2) the alluvial aquifers of the major watercourses are generally quite permeable, which permits high ground-water contamination, and 3) the major alluvial aquifers have shallow water tables and consequently, the opportunity for attenuation of contaminants introduced into the vadose zone is minimized. Because the alluvial ground water is available at shallow depth and to a large number of people, contamination of an alluvial aquifer could have potentially severe consequences.

Although the areas underlain by mountain glacial deposits received a higher ranking than did alluvial areas, the probability for pollution of the glacial aquifers is much less than for alluvial aquifers. The areas underlain by glacial deposits are all in or adjacent to mountain ranges, and are for the most part federally owned and managed. Development would probably be associated with recreational use and could result in the installation of septic system wells, return flow wells for heat pumps, or drainage wells. The low population density would tend to reduce the impact of ground-water contamination.

Shallow bedrock aquifers that are used to provide domestic and stock water occur throughout most of Wyoming's basins. They fall predominantly into the Cenozoic units as mapped for this report, and are generally quite susceptible to pollution. The low population density and lack of other development employing Class V wells makes these aquifers unlikely to be the victims of widespread pollution. Contamination by Class V wells could, however, lead to the loss of ground-water resources in numerous small areas and eventually to significant damage of these aquifers. The Upper Cenozoic deposits have been ranked third most vulnerable of the twelve map units. The Lower Cenozoic deposits, because of their smaller permeability and less ubiquitous aquifers, have been ranked sixth.

The Paleozoic-Age aquifers have been ranked as relatively vulnerable to pollution, largely because the highly permeable aquifers are capable of providing large amounts of good-quality water for municipal, domestic, stock, irrigation, and other uses. The areas of greatest vulnerability area the outcrops and areas where the aquifers are present at shallow depths; both generally occur near basin margins. In the basin interiors, the aquifers are present at greater depth and generally contain poor-quality water. There the aquifers exhibit a much lower pollution vulnerability.

Dune sand and loess, which extends in a belt across central Wyoming and is present in isolated areas in southeastern Wyoming, is ranked fifth in relative pollution vulnerability. The most likely areas to be affected include the area north of Casper which is experiencing industrial and commercial development, and the areas in southeastern Wyoming which may receive contaminants from agricultural activities. The generally large permeability of the sands would allow the rapid spread of introduced contaminants, but the silt and clay included in these deposits would provide sorptive capacity and tend to attenuate the contaminants.

The lower-ranked half of the map units include generally much-less-permeable formations that are infrequently used as sources of ground water. Locally, the igneous, metamorphic and volcanic rocks (map units Qx and Ig,Mt) may be vulnerable to contamination from Class V wells, particularly septic system and cesspool wells. These could be expected in areas developed for recreation, primarily in the Precambrian cores of Wyoming's mountain ranges. The Mesozoic Sandstone (Mss) map unit contains aquifers that provide stock water and occasionally domestic water in areas where shallow wells can be drilled (generally near outcrops). However, the small permeability would limit contaminant migration and the silt and clay in the aquifers would allow a high rate of attenuation of most contaminants. The remaining map units are permeable to a very small degree and do not usually produce ground water that can be used for domestic, stock or agricultural purposes. They are primarily aquitards, and consequently received a low vulnerability ranking.

APPENDIX C

Letters on Local Authority

THE STATE OF WYOMING

MIKE SULLIVAN
GOVERNOR

1890-1990 WYOMING CENTENNIAL A LASTING LEGACY.

Department of Environmental Quality

Herschler Building ● 122 West 25th Street ● Cheyenne, Wyoming 82002

Administration (307) 777-7937	Air Quality Division (307) 777-7391	Land Quality Division (307) 777-7756 FAX (307) 634-0799	Solid Waste Management Program (307) 777-7752	Water Quality Division (307) 777-7781 FAX (307) 777-5973

MEMORANDUM

TO: Steve Jones and John Coppede

FROM: Kevin Frederick KF

DATE: April 24, 1991

SUBJECT: Statutes Governing Municipality Authority to Develop, Implement, and Enforce Zoning Ordinances and Subdivision Ordinances for Wellhead Protection

This purpose of this memo to elaborate upon my request (memo of April 19) for your interpretation of the authority given to municipalities to develop, implement and enforce zoning ordinances etc. for the purpose of restricting or regulating certain land uses within the municipality or surrounding area.

We are specifically interested in learning what authority, if any, municipalities and/or other water and sewer districts have to promulgate or adopt zoning regulations to further the protection of aquifer recharge areas, groundwater quality, and public drinking water supplies to promote the public health and welfare through:

* land use regulation, to:
  - direct the development of an area
  - restrict or regulate certain land uses within a given area
* industrial and residential facility siting

Tools often used in both land use regulation and facility siting, and which are of interest to me include:

* health ordinances
* zoning ordinances
* subdivision ordinances
* site plan regulations
* design standards regulations
* operating standards regulations
* pollution source prohibition regulations (e.g. agriculture, junk yards, machine shops, landfills, storage of hazardous materials, and septic systems)

Also:

What authority do municipalities have to exercising the right of eminent domain and property condemnation? establishing conservation easements?

Naturally, we're working on a rather tight deadline for this information. Is it possible for you to provide us the information by May 15?

Thanks for your assistance.

/jt

xc: William Garland
Jake Strohman

Enclosures

- Ground-Water Management Areas - Washington State's Department of Ecology will designate areas that have identified concerns over ground-water quality; a management plan is tailored to suit the local needs.

- Ground-Water Standards - Many States have adopted standards to protect their ground water. Standards may be either numeric, specifying a maximum concentration for a particular contaminant (see, e.g., Alaska, New Hampshire, Texas), or narrative, specifying a general prohibition on types of discharges or identifying a general quality goal (see, e.g., Arizona, Michigan, North Carolina). Some States have adopted both types of standards to ensure comprehensive protection of the resource.

- Ground Water Classification - Several States (e.g., Connecticut, South Carolina, Vermont) have classified their ground water and specified differential protection measures according to the classification.

A number of States, such as Illinois and Wisconsin, have enacted legislation to authorize adoption of ground-water protection measures by local government. Illinois' legislation includes provisions that authorize the creation of setback zones around wells and an inventory of facilities and activities surrounding the wellhead (Illinois Municipal Code, Section 11-25-4). Wisconsin municipalities were given authority to adopt zoning ordinances "to encourage the protection of groundwater resources" by legislation passed in 1984 (Wisconsin Assembly Bill 595).

> The town of Rib Mountain in Marathon County, Wisconsin, adopted land-use regulations to protect its ground-water supplies. The ordinance uses overlay zoning to create two districts within the recharge basin for municipal wells. Lands overlying the sand and gravel aquifer have greater restrictions imposed on use than more upgradient areas in the watershed. Commercial and industrial uses are prohibited in Zone A, which is in close proximity to the wells. In Zone B, these uses are allowed as conditional uses, if they meet certain requirements to protect ground water.

Local governments have other sources of regulating authority in addition to ground-water specific State legislation; police powers have been delegated to local government in most States. This authority can be implemented to protect ground-water supplies by means of direct or indirect controls, such as land-use plans, zoning ordinances, site plan review, and design standards. **Health ordinances are an effective means for communities to regulate potential contaminants through their police powers.** This approach controls materials use regardless of the location of the facility, as opposed to regulating the location of the facilities.

> In 1979, the Cape Cod Planning and Economic Development Commission (CCPEDC) developed a model health ordinance for use by towns on the Cape to control the use, storage, and disposal of toxic and hazardous materials. The model ordinance has three major components:
>
> - Prohibition - Discharges of toxic or hazardous materials are prohibited.

CHOOSING APPROPRIATE TOOLS FOR WELLHEAD PROTECTION

Overview

A number of commonly used land-use controls, source controls, and other tools have been found to be useful for protecting wellhead areas. Although most of these tools have been used traditionally for other purposes, many are now being used to protect ground water.

This section describes briefly some tools used successfully by local governments throughout the country for ground-water protection. The purpose here is to introduce these tools, explain how they have been used in the past, how communities can find innovative ways to apply them to wellhead protection areas, and what considerations communities should be aware of in adapting and implementing them. This discussion is not an exhaustive review, but simply an introduction to what is available and what to look for. For more information, check the written sources listed in Section 5 or contact EPA or State ground-water protection agencies.

The management tools described here are:

Zoning Ordinances (page 12). Zoning ordinances typically are comprehensive land-use requirements designed to direct the development of an area. Many local governments have used zoning to restrict or regulate certain land uses within wellhead protection areas.

Subdivision Ordinances (page 18). Subdivision ordinances are applied to land that is divided into two or more subunits for sale or development. Local governments use this tool to protect wellhead areas in which ongoing development is causing contamination or there is inadequate well recharge.

Site Plan Review (page 19). Site plan reviews are regulations requiring developers to submit for approval plans for development occurring within a given area. This tool ensures compliance with regulations or other requirements made within a wellhead protection area.

Design Standards (page 21). Design standards typically are regulations that apply to the design and construction of buildings or structures. This tool can be used to ensure that new buildings or structures placed within a wellhead protection area are designed so as not to pose a threat to the water supply.

Operating Standards (page 23). Operating standards are regulations that apply to ongoing land-use activities to promote safety or environmental protection. Such standards can minimize the threat to the wellhead area from ongoing activities, such as the application of agricultural pesticides or the storage and use of hazardous substances.

Source Prohibitions (page 25). Source prohibitions are regulations that prohibit the presence or use of chemicals or hazardous activities within a given area. Local governments have used restrictions on the storage or handling of large quantities of hazardous materials within a wellhead protection area to eliminate the threat of contamination.

Purchase of Property or Development Rights (page 26). The purchase of property or development rights is a tool used by some localities to ensure complete control of land uses in or surrounding a wellhead area. This tool may be preferable if regulatory restrictions on land use are not politically feasible and the land purchase is affordable.

Public Education (page 29). Public education often consists of brochures, pamphlets, or seminars designed to present wellhead area problems and protection efforts to the public in an understandable fashion. This tool promotes the use of voluntary protection efforts and builds public support for a community's protection program.

Ground-Water Monitoring (page 31). Ground-water monitoring generally consists of sinking a series of test wells and developing an ongoing water quality testing program. This tool provides for monitoring the quality of the ground-water supply or the movement of a contaminant plume.

Household Hazardous Waste Collection (page 32). Residential hazardous waste management programs can be designed to reduce the quantity of household hazardous waste being disposed of improperly. This program has been used in localities where municipal landfills potentially threaten ground water due to improper household waste disposal in the wellhead area.

Water Conservation (page 34). Water conservation can encourage individual or commercial/industrial users to limit their water use. This tool

THE STATE OF WYOMING

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CRIMINAL DIVISION 777-6743, 777-7874
CIVIL DIVISION 777-7886, 777-7876, 777-6397
TORT LITIGATION 777-6886
CRIME VICTIMS COMPENSATION 777-5984

M E M O R A N D U M

TO: Kevin Frederick
Department of Environmental Quality
Water Quality Division

FROM: John A. Coppede
Assistant Attorney General

DATE: May 20, 1991

RE: Municipal authority to pass health ordinances related to well head protection issue.

ISSUE

WHETHER MUNICIPALITIES HAVE AUTHORITY TO PASS ORDINANCES NECESSARY FOR THE HEALTH, SAFETY AND WELFARE OF THE CITY.

ANSWER: Yes.

As a followup memorandum to my May 8, 1991 memorandum on this issue, additional research reveals that municipalities have specific legislative authority to adopt ordinances, resolutions and regulations designed to protect the health, safety and welfare the city. Specifically, this authority is found at W.S. 15-1-103(a)(xli) (July 1990). That statute provides as follows:

> (a) The governing bodies of all cities and towns may:
>
> > (xli) adopt ordinances, resolutions and regulations, including regulations not in conflict with this act

> and necessary for the health, safety and welfare of the city or town, necessary to give effect to the powers conferred by this act and enforce all ordinances by imposing fines not exceeding seven hundred fifty dollars ($750.00), or imprisonment not exceeding six (6) months, or both;
> . . .

Id.

This statute provides an additional source from which cities derive power to pass health ordinances for well head protection. Such ordinances could be an effective means by which communities could protect their well head areas.

Further, and more specifically, cities have the power to "regulate or prevent the storage, use and transportation of any combustible or explosive material within the corporate limits or within a given distance thereof." W.S. 15-1-103 (a)(xxviii) (July 1990) (emphasis added). Additionally, cities may appoint a board of health, prescribing its powers and duties. Subdivision (a)(xxix).

Finally, municipalities have the power to "divide the city into suitable districts for establishing a system of drainage, sanitary sewers and water mains . . . " Subsection (a)(xxx).

This statutory authority gives a municipality tremendous power to protect its water supply. The general power of municipalities also includes the power to "take any action to establish . . . public water sources or supplies within the city." Subsection (a)(xxxi). Without any specific grant of statutory power, the statutory subsections to which this memorandum refer provide sufficient power for a city to adopt a whole series of ordinances aimed at protecting well heads.

Kevin, if you have any additional questions, please advise.

THE STATE OF WYOMING

Attorney General

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MEMORANDUM

TO: Kevin Frederick
Department of Environmental Quality

FROM: John A. Coppede
Assistant Attorney General

DATE: May 8, 1991

RE: Statutes governing municipal authority to develop, implement and enforce zoning ordinances and subdivision ordinances for well head protection.

QUESTION #1: Do municipalities in Wyoming have the power to enact and enforce land use ordinances to protect their groundwater supplies?

ANSWER: Yes.

QUESTION #2: May municipalities in Wyoming use their powers of eminent domain to protect water supplies?

ANSWER: Yes.

FACTS

Kevin, you have asked what authority do municipalities have to adopt ordinances designed to protect their groundwater supplies. Specifically, the question is whether local governments can use zoning to restrict or regulate certain land uses within a well head protection area. As will be shown, municipalities have statutory authority to pass zoning laws. Municipalities also have power to determine their local affairs which is derived from the "Home Rule" amendment to the Wyoming constitution.

You have also inquired of the authority of municipalities to exercise the right of eminent domain for this purpose. My research indicates that, although the State of Wyoming has not specifically delegated power to municipalities and counties authorizing them to adopt groundwater protection measures, there is nonetheless sufficient authority granted to them by the legislature to achieve this objective.

DISCUSSION

Municipalities, like counties, are creatures of the legislature and have only those powers granted to them, either expressly or impliedly, by the legislature. Coulter v. City of Rawlins, 662 P.2d 888, 894-95 (Wyo. 1983); Schoeller v. Board of County Commissioners, 568 P.2d 869, 876 (Wyo. 1977). In this sense, the Wyoming Supreme Court has recognized that municipalities possess certain implied powers, which arise from those powers expressly granted and necessary to give effect to those expressly granted powers. Coulter, 662 P.2d at 895.

By statute, municipalities have the power to zone which, as a particular exercise of the municipality's police power, "involves the division of land into zones and within these zones the regulation of both the nature of land usage and the physical dimensions of these uses . . . . " Cheyenne Airport Board v. Rogers, 707 Pl.2d 717, 726 (Wyo. 1985). The relevant statutory provision give municipalities the following general powers:

> (a) The governing bodies of all cities and towns may:
>
> > (xxx) Divide the city into suitable districts for establishing a system of drainage, sanitary sewers and water mains . . .
> >
> > (xxxi) Take any action to establish, alter and regulate as deemed necessary the channels of streams, water courses and other public water sources or supplies within the city . . . .

W.S. § 15-1-103(a) (Jul. 1980). The Wyoming Supreme Court has interpreted the above statutory provisions as "expressly confer[ing] upon [municipalities] power . . . to take 'any

action to establish, alter and regulate if deemed necessary' a public water supply. Coulter, 662 P.2d at 896.

Municipalities in Wyoming have been granted the powers to enact and enforce zoning regulations to promote and protect the general welfare of their inhabitants, including constructing, maintaining and providing for water facilities. Id. Specifically, municipalities in Wyoming have the power to zone for the purpose of "facilitat[ing] adequate provisions for transportation, water, sewage, schools, parks and other public requirements." W.S. § 15-1-601(d)(i) (1980 Replacement). The powers of municipalities to zone is very comprehensive. For example, with respect to regulating a system of water works, a municipality has the following powers:

> (a) In addition to all other powers provided by law, any city or town may make public improvements as follows . . . :
>
> > (ii) Establish, construct, purchase, extend, maintain and regulate a system of water works, for the purpose of supplying water for extinguishing fires and for domestic, manufacturing and other purposes. To carry out this power, or to prevent pollution or injury to the streams, springs or source of supply of its water works, ditches or reservoirs, any city or town may go beyond its corporate limits and take, hold and acquire property by purchase or otherwise and may take and condemn all necessary land and property in the manner provided for the condemnation of real estate by railroad companies. Jurisdiction of a city or town shall extend up and along the stream or source of supply for the entire distance occupied by such water works, ditches or reservoirs. Cities or towns may enact ordinances and make all necessary rules and regulations for the government and protection of their water works, ditches and reservoirs, and fix water rates and provide for their collection.

(iii) Take any action necessary to establish, purchase, extend, maintain and regulate a water system for supplying water to its inhabitants and for any other public purposes.

W.S. § 15-7-101 (1980 Replacement) (emphasis added).

Thus, although the Wyoming legislature has not specifically granted municipalities the authority to adopt ordinances designed to protect groundwater, it is nevertheless clear that such municipalities have been granted the authority to enact zoning ordinances designed to protect such sources of water. Additionally, municipalities have the power to establish, construct and, among other things, maintain and regulate their water works. This power also includes the power of eminent domain which may be exercised whenever it is necessary for a municipality to prevent pollution or injury to its sources of water. From this, it can be argued that municipalities have both the explicit and implicit authority to take by eminent domain any property threatening municipal water supplies. W.S. § 15-7-101(a)(ii) and (iii). These provisions give municipalities the power to condemn property whenever it is necessary to maintain and regulate their water systems.

By these statutes, Wyoming municipalities have the same power of eminent domain as do railroads in this state. This power is found at W.S. § 1-26-810 (June 1988). It would appear that such power would allow a municipality to obtain easements for any of the purposes enumerated in subsection (ii) of W.S. § 15-7-101(a)(ii) and (iii). More specifically, however, it would also appear to allow municipalities to obtain such easements for the purpose of preventing pollution or injury to their streams, springs or source of supply of its water works.

"Home Rule" is another potential source from which a municipality may derive authority to pass ordinances designed to protect well head areas. The Wyoming constitution contains a Home Rule amendment. Art. 13, Section 1(b). The amendment allows all municipalities to pass ordinances to determine their local affairs and government. The amendment permits municipalities to legislate on all subjects, as long as such legislation is not in conflict with statutes uniformly applicable to all cities and towns. The legislation must also be subservient to such statutes. Home Rule could be used to pass municipal ordinances designed

specifically to protect water supplies. Laramie Citizens for Good Government v. City of Laramie, 617 P.2d 474, 483 (Wyo. 1983).

Counties also have the power to pass zoning ordinances. W.S. § 18-5-102 (1977). By statute, the board of county commissioners are required by resolution to provide for the regulation of, among other things, domestic water supplies and sewage disposal. W.S. § 18-5-105(a). This statute specifically gives the board of county commissioners the power to zone such facilities for the purpose of promoting the public health, safety and welfare of the citizens of the county.

CONCLUSION

Both municipalities and counties have the statutory authority to enact zoning legislation that may be used to protect groundwater supplies. Further, cities have power granted to them by the constitution through the Home Rule amendment. This amendment would appear to allow cities to pass health legislation designed to prevent pollution of water sources. Finally, municipalities have eminent domain powers which they can use specifically to protect their water sources.

APPENDIX D

Potential Sources of Contamination

CATEGORIES OF SOURCES AND ACTIVITIES THAT MAY IMPACT GROUNDWATER QUALITY

gas/service stations/auto repair
truck terminals
rust proofers
small engine repair
machine shops

dry cleaners
printers
photo processors
metal platers

painters/finishers
furniture strippers
auto body shops
wood preservers
heat treaters/smelters/anealers/descalers

laundromats
car washes
beauty salons

medical/dental/veterinary offices
mortuaries/funeral homes
research laboratories

food processors
meat packing/slaughter houses

graveyards
animal burial

feedlots
ag chemical storage
fertilizer storage
manure piles
ag chemical application
fertilizer application

stormwater impoundment

urban runoff
wastewater impoundment
lift stations
municipal water treatment
municipal waste treatment
construction sites
industrial waste disposal

landfills/dumps
gravel pits
junk/salvage yards

hazardous waste

individual residences
subdivisions
golf courses/parks
nurseries

underground storage tanks
above-ground storage tanks

fuel oil distributors
oil pipelines
heating oil storage

concrete/asphalt/tar companies
coal mines/companies
industrial manufacturers
sand and gravel mining
power plants
coal gasification plant
chemical reclamation

snow cleanups
salt/sand piles
roads
railroads

monitoring wells
injection wells
production wells-oil
water supply wells
exploration wells
geothermal/heat recovery wells
abandoned wells
irrigation wells

wholesalers/retailers:
herbicide/pesticide
fertilizers
auto chemical supplies
painting supplies

water softener brines
septage lagoons
septic tank leach fields
cesspools
sewer lines
industrial pipelines

airports
- fuels
- deicing
- waste oils
- solvents

educational facilities
- science laboratories
- automotive repair shops
- industrial arts

solution mining
seismic holes

APPENDIX 3. POTENTIALLY HARMFUL COMPONENTS OF COMMON HOUSEHOLD PRODUCTS

Product	Toxic or Hazardous Components
Antifreeze (gasoline or coolant systems)	methanol, ethylene glycol
Automatic transmission fluid	petroleum distillates, xylene
Battery acid (electrolyte)	sulfuric acid
Degreasers for driveways and garages	petroleum solvents, alcohols, glycol ether
Degreasers for engines and metal	chlorinated hydrocarbons, toluene, phenols, dichloroperchloroethylene
Engine and radiator flushes	petroleum solvents, ketones, butanol, glycol ether
Hydraulic fluid (brake fluid)	hydrocarbons, fluorocarbons
Motor oils and waste oils	hydrocarbons
Gasoline and jet fuel	hydrocarbons
Diesel fuel, kerosene, #2 heating oil	hydrocarbons
Grease, lubes	hydrocarbons
Rustproofers	phenols, heavy metals
Car wash detergents	alkyl benzene sulfonates
Car waxes and polishes	petroleum distillates, hydrocarbons
Asphalt and roofing tar	hydrocarbons
Paints, varnishes, stains, dyes	heavy metals, toluene
Paint and lacquer thinner	acetone, benzene, toluene, butyl, acetate, methyl ketones
Paint and varnish removers, deglossers	methylene chloride, toluene, acetone, xylene, ethanol, benzene, methanol
Paint brush cleaners	hydrocarbons, toluene, acetone, methanol, glycol ethers, methyl ethyl ketones
Floor and furniture strippers	xylene
Metal polishes	petroleum distillates, isopropanol, petroleum naptha
Laundry soil and stain removers	petroleum distillates, tetracholoethylene
Spot removers and dry cleaning fluid	hydrocarbons, benzene, trichloroethylene, 1, 1, 1 trichloroethane
Other solvents	acetone, benzene
Rock salt (Halite)	sodium concentration
Refrigerants	1, 1, 2 trichloro - 1, 2, 2 trifluoroethane
Bug and tar removers	xylene, petroleum distillates
Household cleansers, oven cleaners	xylenols, glycol ethers, isopropanol
Drain cleaners	1, 1, 1 trichloroethane
Toilet cleaners	xylene, sulfonates, chlorinated phenols
Cesspool cleaners	tetrachloroethylene, dichlorobenzene, methylene chloride
Disinfectants	cresol, xylenols
Pesticides (all types)	napthalene, phosphorus, xylene, chloroform, heavy metals, chlorinated hydrocarbons
Photochemicals	phenols, sodium sulfite, cyanine, silver halide, potassium bromide
Printing ink	heavy metals, phenol-formaldehyde
Wood preservatives (creasote)	pentachlorophenols
Swimming pool chlorine	sodium hypochlorite
Lye or caustic soda	sodium hydroxide
Jewelry cleaners	sodium cyanide

Reprinted from "Natural Resources Facts: Household Hazardous Wastes," Fact Sheet No. 88-3, Department of Natural Science, University of Rhode Island, August 1988.

* U.S. GOVERNMENT PRINTING OFFICE: 1990 269-645

APPENDIX E

Public Meetings
Questionnaire Survey and Results - Meetings

THE STATE OF WYOMING

MIKE SULLIVAN
GOVERNOR

1890-1990 WYOMING CENTENNIAL A LASTING LEGACY

Department of Environmental Quality

Herschler Building • 122 West 25th Street • Cheyenne, Wyoming 82002

Administration	Air Quality Division	Land Quality Division	Solid Waste Management Program	Water Quality Division
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Wellhead Protection Program

The enclosed information briefly describes an innovative approach to protection from contamination of those Wyoming Public Water Systems which rely upon groundwater as a source for drinking water supplies. Collectively, the elements addressed in developing and implementing such an approach are referred to as a "Wellhead Protection" program.

In 1991, EPA established groundwater protection principles which recognize that the primary role for groundwater protection should be vested with the State. Wellhead Protection is considered a vital component of each State's Comprehensive Groundwater Protection program. Federal law requires that every WHP program contain specific elements, however, EPA allows each State substantial flexibility in developing WHP programs to meet their individual needs. This approach to establishing a Wellhead Protection program enables Wyoming to tailor a program that suits its needs for providing adequate protection to public drinking water supplies. As an additional incentive for implementation of Wellhead Protection programs, EPA is considering waiver of certain public water system monitoring requirements for communities and municipalities whose public drinking water wells are adequately protected. Failure to develop WHP programs may diminish or eliminate Wyoming's WHP development flexibility if, in the future, EPA elects to enforce the statutory requirement that all States implement WHP.

The Department of Environmental Quality, Water Quality Division is mailing this information to those individuals, interest groups, organizations, and government agencies/officials whose interests, and participation will be fundamental to the successful development and implementation of Wellhead Protection programs in Wyoming's cities and towns.

Beginning June 25, 1991 representatives from the Water Quality Division, University of Wyoming, and U.S. EPA will be conducting a series of public meetings throughout Wyoming to present and discuss the elements of Wellhead Protection and alternative approaches to Wellhead Protection program development and implementation. Most importantly, these meetings will serve as a public forum to solicit public input as to the need for a Wellhead Protection program in Wyoming, and the form it should take. Wyoming residents are encouraged to attend and participate in any of the meetings as scheduled. Please refer to the enclosed schedule for information regarding meetings in your area.

For further information, please contact the Department of Environmental Quality, Water Quality Division at (307) 777-7781 (Groundwater Program).

Scheduled Meetings

CHEYENNE: June 25, 1991 (Tuesday), Highway Department Auditorium, 5300 Bishop Boulevard
(Including Laramie, Albin, Pine Bluffs, Burns)

WHEATLAND: June 26, 1991 (Wednesday), 4-H Building, 59 Antelope Gap Road
(Including Glendo, Guernsey, Chugwater, Hartville)

TORRINGTON: June 27, 1991 (Thursday), City Hall Council Chambers, 2042 East A
(Including Lusk, Yoder, Lingle, Fort Laramie, Lance Creek)

SUNDANCE: July 1, 1991 (Monday), Community Meeting Room, Court House, Highway 14
(Including Gillette, Newcastle, Moorcroft, Hulett, Pine Haven, Wright, Clearmont, Osage, Upton)

POWELL: July 9, 1991 (Tuesday), Northwest College, Engineering & Tech Building #70
(Including Cowely, Burlington, Byron)

WORLAND: July 10, 1991 (Wednesday), Community Hall, 125 North 8th Street
(Including Thermopolis, Manderson, Ten Sleep)

CASPER: July 11, 1991 (Thursday), Oil & Gas Commission, 777 West 1st Street
(Including Mills, Rolling Hills, Edgerton, Glenrock, Kaycee)

RIVERTON: July 16, 1991 (Tuesday), Central Wyoming College, 2660 Peck Avenue
(Including Dubois, Shoshoni, Hudson, Pavillion)

RAWLINS: July 17, 1991 (Wednesday), Jeffrey Center, 3rd & Spruce
(Including Medicine Bow, Bairoil, Split Rock Townsite, U.S. Energy Corporation, Jeffrey City, Wamsutter, Superior, Elk Mountain)

JACKSON: July 18, 1991 (Thursday), Ranch Inn, 45 East Pearl
(Including Bedford, Big Piney, Freedom, Marbleton, Teton Village, Afton, Thayne)

* All meetings will begin at 7 p.m.

/mad

WELLHEAD PROTECTION

A Groundwater Pollution Control Program

What is Wellhead Protection (WHP)?

Wellhead protection may be broadly defined as any action or combination of actions designed to protect the quality of groundwater used for drinking water. Pro-active measures which may be taken to protect drinking water supply wells and groundwater from becoming contaminated include those taken through simple housekeeping practices, farming practices, permitting systems, ordinances, and planning, in addition to other accepted and innovative approaches taken by private, public and government sectors.

A Wellhead Protection Area (WHPA) is, by program definition, the surface and underground area surrounding a public water well or well field through which contaminants could likely pass and eventually reach the groundwater supply. Factors that determine the boundaries of a WHPA include: the potential sources of groundwater contamination, the distance from the well and resultant time it would take for contaminants to reach the well, pumping rates, and the hydrogeologic characteristics of the area. Wellhead Protection Areas can range anywhere from a few hundred feet to thousands of feet from the well or well field.

Are Wyoming's Public Water Systems (PWS) which use groundwater vulnerable to contamination from pollution sources?

Yes. Wyoming has 242 Public Water Systems where groundwater is used as a source for drinking water. Many draw their water from shallow aquifer(s) that are often susceptible to contamination from activities in the area surrounding the wells or well field. Other systems draw their drinking water from deeper, confined aquifers which are typically less susceptible to contamination.

Nevertheless, these deeper aquifers may also be susceptible to contamination from surface sources through natural (e.g. fractures, faults), as well as man-made (e.g. boreholes) groundwater migration pathways.

Enclosed is a list of Wyoming Public Water Systems that illustrates a relative comparison of vulnerability to pollution. This table was developed by the University of Wyoming on behalf of the Department of Environmental Quality's Water Quality Division, and prioritizes Public Water Systems whose drinking water supplies from groundwater sources may be most vulnerable to contamination as determined from: 1) the geographic distribution of the aquifer; 2) the proximity of human populations and industrial development to areas where the aquifer is present at relatively shallow depths; 3) typical water quality and groundwater development in areas where the aquifer is present at relatively shallow depths; and 4) known occurrences of resources whose development could cause contamination. On the table, a vulnerability ranking of 1 (last column) would be the highest, or most vulnerable to contamination, with relative vulnerability decreasing as the ranking number increases.

(OVER)

Why develop a Wellhead Protection program?

Once a drinking water source (aquifer) and its supply (well) is contaminated by pollution, drinking water from the source must either be treated, or an alternative source must be placed into service. In most instances of groundwater contamination, the party responsible for causing the pollution does not have the financial means to remediate and restore the groundwater, or provide for treatment or replacement of the drinking water source. The Public Water System, or its users, are frequently left with this financial burden. The costs associated with the protection of drinking water sources from contamination is nearly always less expensive than the cost of cleanup, treatment or replacement of the source.

The dollar cost for cleanup, treatment or source replacement is only the tip of the iceberg. Increased environmental liabilities, high insurance costs and the potential health and environmental problems associated with groundwater contamination may ultimately diminish the ability of towns and cities to attract future development. Business relocations to other cities or States could possibly lead to long-term loss to an area in terms of economic growth and development and tax base.

Aside from the obvious health, economic and environmental quality considerations for protecting groundwater sources used to supply drinking water, a Federal statute mandates that each State develop and implement a WHP program. The 1986 amendments to the Federal Safe Drinking Water Act (SDWA) established the Wellhead Protection program to protect groundwaters used as sources of drinking water. Under Section 1428 of the SDWA, all States are required to prepare a WHP program and submit it to EPA for approval before 1990. To date, over half (39) of the States have submitted WHP programs to EPA. Failure to develop and implement WHP programs and Comprehensive State Groundwater Protection programs may adversely affect Wyoming's ability to continue receiving Federal funding for water projects, as well as for water quality protection.

In 1991, EPA established groundwater protection principles which recognize that the primary role for groundwater protection should be vested with the State. Wellhead Protection is considered a vital component of each State's Comprehensive Groundwater Protection program. Federal law requires that every WHP program contain specific elements, however, EPA allows each State substantial flexibility in developing WHP programs to meet their individual needs. This approach to establishing a Wellhead Protection program enables Wyoming to tailor a program that suits its needs for providing adequate protection to public drinking water supplies. As an additional incentive for implementation of Wellhead Protection programs, EPA is considering waiver of certain public water system monitoring requirements for communities and municipalities whose public drinking water wells are adequately protected. Failure to develop WHP programs may diminish or eliminate Wyoming's WHP development flexibility if, in the future, EPA elects to enforce the statutory requirement that all States implement WHP.

For further information, please contact the Department of Environmental Quality, Water Quality Division at (307) 777-7781 (Groundwater Program).

Revised Copy

Municipal System	System #	County	Pop. Served	Pop. Sub.	# Wells Drawn Into [ref. note]	> Wells Ranking
Bairoil, Town of	13	Sweetwater	250		3 [1]	1
Banford Water & Sewer	14	Lincoln	300		1 [1]	1
Big Piney, Town of	15	Sublette	520	69	5 [1]	1
Burlington, Town Water System	20	Big Horn	100		2 [1]	1
Burns Board of Public Utility	21	Laramie	268		4 [1]	1
Byron, Town of	22	Big Horn	433		1 [1]	1
Casper Board of Public Utility	24	Natrona	51016	2049	25 [1]	1
Cheyenne Board of Public Utilities	32	Laramie	50000	1354	12 [3], 11 [1]	1
Chugwater Mun. Water System	44	Platte	243		3 [1]	1
Clearmont Water Supply	45	Sheridan	127		3 [1]	1
Dubois Water System, Town of	58	Fremont	1067		3 [1]	1
Elk Mtn, Town of	61	Carbon	225		3 [1]	1
Fort Laramie Mun. Water System	72	Goshen	350		3 [1]	1
Freedom Pipeline Inc.	74	Lincoln	100		1 [1]	1
Glendo, Town of	113	Platte	367		1 [1]	1
Glenrock Mun. Water System	114	Converse	2000		4 [1]	1
Hartville Water System	120	Platte	149		2 [1], 2 [4]	1
Hudson Mun. Water System	121	Fremont	514		13 [1]	1
Hulett, Town of	122	Crook	406		3 [1]	1
Jackson, Town of	126	Teton	7000	2348	3 [1], 1 [4]	1
U.S. Energy Corp. (Jeffrey City)	87	Fremont	36		3 [1]	1
Laramie, City of	146	Albany	25000	566	5 [1], 1 [6]	1
Lingle, Town of	152	Goshen	475		2 [1]	1
Lyman, Town of	155	Uinta	2203		1 [1]	1
Manderson, Town of	156	Big Horn	110		2 [1]	1
Manderson, Town of	158	Sublette	600		4 [1]	1
Medicine Bow, Town of	160	Carbon	300		4 [1]	1
Mills, Town of	162	Natrona	2139	240	6 [1]	1
Moorcroft, Town of	165	Crook	1100		6 [1]	1
Opal Water System	175	Lincoln	175		3 [1]	1
Pavillion, Town of	177	Fremont	287		6 [1]	1
Pine Bluffs, Town of	178	Laramie	1077		6 [1]	1
Powell, City of	181	Park	5000	300	6 [1]	1
Riverton, City of	186	Fremont	10000	1577	15 [1], 2 [6]	1
Shoshoni, Town of	219	Fremont	615		4 [1]	1
Split Rock Townsite (US Energy)	187	Fremont			1 [1]	1
Thermopolis, Town of	229	Hot Springs	3500		3 [1]	1
Torrington Mun. Water System	230	Goshen	6000		12 [1]	1
Town Village Wtr & Sew Dist.	235	Teton	200		2 [2]	2
Albin, Town of	8	Laramie	128		4 [3]	3
Evanston, City of	63	Uinta	12177	1166	3 [6], 3 [3]	3
Guernsey, Town of	119	Platte	1512		3 [3]	3
Lance Creek Util. Inc.	143	Niobrara	96		3 [3]	3
Lusk Water System	154	Niobrara	1650		5 [3]	3
Yoder Water Sys, Town of	242	Goshen	110		6 [3]	3
Sundance, City of	223	Crook	1100		3 [4], 1 [7]	4
Rolling Hills, Town of	115	Converse	443		3 [3], 2 [4]	5
Wheatland Mun. Water System	235	Platte	3795		8 [5]	5
Gillette, City of	75	Campbell	20949	7503	5 [6], 9 [4], 8 [5]	6
Ten Sleep, Town of	224	Washakie	350		2 [4]	6
Wright Water & Sewer Dist.	240	Campbell	1800		4 [4]	6
Cowley Municipal Water System	52	Big Horn	455		1 [8]	8
Edgerton, Town of	68	Natrona	450		4 [8]	8
Kaycee, Town of	148	Johnson			2 [8]	8
Newcastle, City of	172	Weston	3800	899	3 [8], 1 [12]	8
Pine Haven, Town of	179	Crook	180		1 [8]	8
Rawlins Water Supply, City of	183	Carbon	11547	175	1 [8], 3 [12]	8
Superior, Town of	222	Sweetwater	330		2 [8]	8
Wetland Board of Pub. Utilities	239	Washakie	6000		2 [8]	8
Wamsutter, Town of	234	Sweetwater	250		3 [10]	10
Black Hills Power & Light (Osage)	176	Weston	350		4 [12]	12
Upton, Town of	233	Weston	1183		5 [12]	12
Afton Board of Public Utilities	1	Lincoln	1481	315	NA	20
Osmond Pipeline Co.	3	Lincoln	250		NI	20
Fairview Pipeline	5	Lincoln	200		NA	20
Alpine, Town of	10	Lincoln	275	27	NI	20
Cokeville, Town of	51	Lincoln	550		NA	20
Douglas, Town of	53	Converse	6000	100	NA	20
Alta Community Pipeline	56	Teton	130		NI	20
Bear Pipeline Co.	62	Lincoln	200		NI	20
Evansville, Town of	98	Natrona	2500		NI	20
Pronghorn Mun. Water System	79	Big Horn	138		NA	20
Grover Dean. Water Works Co.	118	Lincoln	200		NI	20
Hyattville Water Co.	124	Big Horn	50		NI	20
Kirby Water System, Town of	-	Hot Springs	84		NA	20
La Barge, Town of	141	Lincoln	742		NI	20
La Grange	142	Goshen	252		NI	20
Lucas Utility	151	Johnson	100		NI	20
Manville, Town of	157	Niobrara	104		NI	20
Incline Reserve Inc. (McFadden)	159	Carbon	48		NI	20
Mountain View, Town of	169	Uinta	1360	100	NA	20
North Riverton Wtr & Sewer Dist.	188	Fremont	120		NI	20
Wind Creek Landowners Assn. (Rose	212	Campbell	27		NI	20
Smoot Farmers Pipeline (Smoot)	220	Lincoln	50	30	NI	20
Thayne, Town of	227	Lincoln	535		NA	20
South Torrington Water Dist.	231	Goshen	600		NA	20
				NA = Not Applicable		
				NI = No information		

WELLHEAD PROTECTION PUBLIC MEETINGS

Speakers:

Jake Strohman, Water Quality Division, Department of Environmental Quality, Groundwater Program Manager

Kevin Frederick, Water Quality Division, Department of Environmental Quality, Supervisor, Groundwater Pollution Control Program

Beth Pratt, Water Quality Division, Department of Environmental Quality, Non-Point Source Program Manager

Randy Brown, EPA, Environmental Planner, Denver, CO

Dr. Vic Hasfurther, Wyoming Water Research Center, Associate Director

PRESS RELEASE

PUBLIC NOTICE

...INVITATION TO ATTEND and PARTICIPATE...

The Department of Environmental Quality's Water Quality Division will be conducting a series of Public Meetings to present and discuss the elements of Wellhead Protection, a pro-active approach to protecting public drinking water supplies from contamination. These meetings will serve as a forum to solicit public input as to the need for a Wellhead Protection program in Wyoming, and the form it should take. All interested Wyoming residents are invited to attend any of the meetings scheduled below. Residents from those communities, and surrounding areas, listed below are especially encouraged to attend.

Scheduled Meetings

CHEYENNE: June 25, 1991 (Tuesday), Highway Department Auditorium, 5300 Bishop Boulevard
(Including Laramie, Albin, Pine Bluffs, Burns)

WHEATLAND: June 26, 1991 (Wednesday), 4-H Building, 59 Antelope Gap Road
(Including Glendo, Guernsey, Chugwater, Hartville)

TORRINGTON: June 27, 1991 (Thursday), City Hall Council Chambers, 2042 East A
(Including Lusk, Yoder, Lingle, Fort Laramie, Lance Creek)

SUNDANCE: July 1, 1991 (Monday), Community Meeting Room, Court House, Highway 14
(Including Gillette, Newcastle, Moorcroft, Hulett, Pine Haven, Wright, Clearmont, Osage, Upton)

POWELL: July 9, 1991 (Tuesday), Northwest College, Engineering & Tech Building #70
(Including Cowely, Burlington, Byron)

WORLAND: July 10, 1991 (Wednesday), Community Hall, 125 North 8th Street
(Including Thermopolis, Manderson, Ten Sleep)

CASPER: July 11, 1991 (Thursday), Oil & Gas Commission, 777 West 1st Street
(Including Mills, Rolling Hills, Edgerton, Glenrock, Kaycee)

(Continued)

RIVERTON: July 16, 1991 (Tuesday), Central Wyoming College, 2660 Peck Avenue
(Including Dubois, Shoshoni, Hudson, Pavillion)

RAWLINS: July 17, 1991 (Wednesday), Jeffrey Center, 3rd & Spruce
(Including Medicine Bow, Bairoil, Split Rock Townsite, U.S. Energy Corporation, Jeffrey City, Wamsutter, Superior, Elk Mountain)

JACKSON: July 18, 1991 (Thursday), Ranch Inn, 45 East Pearl
(Including Bedford, Big Piney, Freedom, Marbleton, Teton Village, Afton, Thayne)

* All meetings will begin at 7 p.m.

For further information, please contact the Department of Environmental Quality's Water Quality Division at 777-7781 (Groundwater Program)

/mad

Water Issues

Groundwater
June 1991
B-957

Cooperative Extension Service
UNIVERSITY OF WYOMING
College of Agriculture

Wyoming Water Research Center
University of Wyoming

Wellhead Protection

Over 75 percent of the population in Wyoming relies on groundwater for part or all of their drinking water supply. This water is supplied from more than 90,000 water wells. The quality of water from these wells is extremely important to the quality of life and livelihood of Wyoming residents. Once groundwater is contaminated, it is very difficult and expensive to clean up or treat the water supply. It is in the public interest, therefore, to take measures to help prevent contamination of our vital groundwater supplies.

Wellhead protection (WHP)

Protection from contamination is a key to maintaining good quality groundwater. One way to protect groundwater supplies from contamination is to protect the area surrounding a well. Through the wellhead protection (WHP) program, state and local governments and communities can designate WHP areas around drinking water wells to safeguard underground supplies for the future. The purpose of the wellhead protection program is to help prevent contamination of public water supplies.

Sources and costs of contamination

Groundwater can be contaminated from many sources on the land surface or underground. Potential sources of contamination include croplands and lawns treated with fertilizers and pesticides, landfills, septic tank drainfields, underground storage tanks, abandoned wells, animal feedlots, industrial/mining impoundments, and accidental spills. The amount of time and money required to clean up contaminated groundwater, when possible, is staggering. For example, a leak in a gasoline storage tank in one community required the nearby municipal wellfield to be closed, disrupting the community's only source of drinking water. Alternative drinking water supplies had to be developed, conservation programs instituted, and a clean-up process started. Many years of work and a total cost of over $3 million dollars is a high price to pay for a leak in a gasoline storage tank. Wellhead protection programs can pay off through future health, environmental, and economic benefits.

Wellhead protection measures

A variety of measures can be used to protect groundwater supplies in a WHP area. Educating the public about wellhead protection is the first line of defense. WHP activities can also involve land use management authorities through special local ordinances and permits, and regulation of specified activities in the WHP area. The idea is to minimize land use restrictions while maximizing

groundwater protection. Restrictions on the issuance of building and construction permits within a WHP is another means. Other deterrents to contamination should include implementation of best management practices (BMPs). BMPs are voluntary guidelines and techniques that can help prevent contamination. Often BMPs are just common sense, such as storing pesticides away from wellheads, proper disposal of chemicals or sealing abandoned wells to prevent contamination. Development of monitoring and contingency plans can also help avert contamination. Finally, actual land acquisition may be an alternative WHP measure.

How large is a WHP area?

WHP areas can range anywhere from a few hundred feet to a distance of several thousand feet from wells. A wellhead protection area is, by program definition, the surface and underground area surrounding a public water well or well field through which contaminants could likely pass and eventually reach the groundwater supply. Factors that determine the boundaries of a WHP area include the potential sources of groundwater contamination, the distance and time it would take for contaminants to reach the well, pumping rates, and the hydrogeologic characteristics of the aquifer being used.

WHP areas in Wyoming

A critical nitrate problem exists in and surrounding Torrington, Wyoming. Measures using BMP's and establishing WHP around community and private wells are being investigated in an attempt to improve the problem.

Starting a WHP program

Local towns and communities can set up their own wellhead protection programs. WHP program elements must include: the roles and duties of state agencies, local governments, and public water suppliers, with respect to the development and implementation of WHP programs; identification of WHP program boundaries; potential sources of contaminants; management approaches (technical and financial assistance, control measures, and education and training projects); and contingency plans for public water supply. Program development and technical assistance is available from the Wyoming Department of Environmental Quality, Water Quality Division, (Herschler Building, Cheyenne, Wyoming 82002 - Groundwater Program (307) 777-7781) and U.S. Environmental Protection Agency publications listed below. Limited federal grants are available to help develop wellhead protection programs.

Additional sources of information and references:

Developing a State Wellhead Protection Program: A User's Guide to Assist State Agencies Under the Safe Drinking Water Act, U.S.Environmental Protection Agency 440/6-88-003, July 1988. *Wellhead Protection: A Decision-Makers' Guide*, U.S. EPA, Office of Ground Water Protection, May 1987. *Wellhead Protection Programs: Tools for Local Governments*, U.S.EPA 440/6-89-002, April 1989. *If Your Public Water Supply Depends on Ground Water, Consider Establishing a Wellhead Protection Area*, The Texas Water Commission, Ground Water Conservation Section, Austin, Texas, July 1990.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Jim DeBree, Director, Cooperative Extension Service, University of Wyoming, Laramie, WY 82071. Persons seeking admission, employment, or access to programs of the University of Wyoming shall be considered without regard to race, color, national origin, sex, age, political belief, handicap, or veteran status. This publication was funded in part by a grant from the U.S. Environmental Protection Agency through the Wyoming Department of Environmental Quality.

7-91/7.5c/.22

EPA

DEPARTMENT OF ENVIRONMENTAL QUALITY WYOMING

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 from 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 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)

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

(OVER)

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 used 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 it's natural quality

____ the **State** should pay for restoration of the aquifer's water to its natural quality.

____ other: (please list) _____

(OVER)

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 Wellhead Protection Areas?

____ the water user

____ the local city/county government

____ the State

____ other: (please list) _____

18. Who should perform the contaminate source inventory in the community?

____ the **public water system operator**

____ the **local city/county government**

____ the **State**

____ other: (please list) _____

19. Who should pay for the contaminate source inventory?

____ 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 from the Department of Environmental Quality's Water Quality Division at a future date.

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	Edgeetow	1
Powell	5	Gillette	1
Rawlins	5	Glendo	1
Glenrock	4	Jeffrey City	1
Jackson	4	Laramie	1
Evanston	3	Lusk	1
Riverton	3	Medicine Bow	1
Wheatland	3	New Castle	1
Worland	3	Opal	1
Cody	2	Sundance	1
Shosoni	2	Thermopolis	1
Torrington	2	Wright	1
Cheyenne	1	Yoder	1
Chugwater	1		

3. Type of water supply from which you currently derive your the 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

4. You feel that your community drinking water supply is in danger of contamination from:

	Number	Percent
existing groundwater contamination		
	(Y) 38	40.4
	(N) 56	59.6
total	94	100.0
future groundwater contamination		
	(Y) 61	68.5
	(N) 28	31.5
total	89	100.0

5. Sources of groundwater contamination which you believe have the potential to contaminate community drinking water sources and/or supplies:

	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	0.0
total	106	100.0

7. Community **needs** to protect its public drinking water supply wells and/or aquifers from potentially hazardous or toxic contamination:

	Number	Percent
(Y)	97	97.0
(N)	3	3.0
total	100	100.0

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:

my community	3	3.8
all communities	69	86.4
only communities with contaminated public drinking 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 Program:

	Number	Percent
(Y)	103	98.1
(N)	2	1.9
total	105	100.0

If yes, the form(s) of assistance received:

technical assistance	92	89.3
financial assistance	75	72.8
education/information aids	95	92.2
other	5	4.9
total	267	259.2

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 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 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

15. Reasonable management approaches to implement for protection of drinking water aquifers and wells:

	Number	Percent
Regulatory		
permit programs	64	37.8
enforcement	43	25.5
zoning ordinances	62	36.7
total	169	100.0
zoning ordinances		
land use control	54	87.1
performance controls	36	58.1
operating controls	34	54.8
total	124	200.0
Non-Regulatory		
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

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 contaminate source inventory in the community:

	Number	Percent
the public water system 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 contaminate source inventory:

	Number	Percent
the public water system operator	22	15.2
the local city/county government	70	48.3
the State	44	30.3
other	9	6.2
total	145	100.0

ADDITIONAL COMMENTS

1. Should take the approach to protect all groundwater not just public water supply wells serving twenty or more connections. Individual wells are just as important as community ones. Bear River Aquifer is very porous. Pollution could migrate rapidly downstream. Should be aquifer protection!

2. State should help with a toxic waste disposal facility and collection of house hold wastes. Communities could prepare delineations with assistance of consultants. Most discussion has centered on community supplies. We need to also protect public water supplies which are not community such as Wilson School, Fish Creek Inn. If the state is involved to provide technical assistance it would seem that the WDDC would be more appropriate than DEQ. WWDC was established to develop water supplies and assist communities. DEQ is generally a regulatory agency.

3. Prevention is a great idea but people are too short sighted. A Wellhead Protection Program is needed statewide. If left to communities, most will wait for a problem to develop until they start a program.

4. Wellhead protection is very important and needed in many or most areas of Wyoming. I think the state needs to take over regulation of PWS in Wyoming. We are the only state that does not do this. This should be a priority, then the Wellhead Protection department can come into existence more naturally not as it is now with EPA controlling our state.

5. As circuit rider for Wyoming Association of Rural Water Systems, the opportunity is good to offer assistance through educational means to water systems throughout the state. Please feel free to extend to us the opportunity to be placed in a position to be of help to the state of Wyoming in Wellhead Protection.

   Address:

   201 South 4th #1
   P.O. Box 1750
   Glenrock, WY 82637

6. Save money, act now! Use the experience gained in other communities in other states. Pass a Wyoming Superlien Law for oil and hazardous waste liability determination and rapid enforcement of cleanup. Provide for state funding of significant aquifer mapping.

7. The questions are designed so that answers have to be local or state. There are no questions or answers that spell out specific individual situations. It is nice to have things perfect, but it is possible to have costs greater than public benefit.

8. Those communities who expect funds for clean-up must have the Wellhead Protection Program. The State Engineer's Office should be able to assist in delineation process. Disposal of even perfectly treated municipal waste by injection well back into a drinking water aquifer violates the basic notion of groundwater protection. The definition of "public water supply" should be expanded to include private well "fields," in Wilson, Wyoming and the like. To focus solely on the town of Jackson, Teton Village, and Teton Pines does not deal adequately with the present and <u>future</u> needs of the community.

9. As program manager of the Wyoming Rural Water Association, I would like to pledge our support and assistance in anyway we can. The National Rural Water Association has started a Groundwater Protection Program and if funding comes through, Wyoming should have the program in a couple of years. This should help with education and technical assistance. If we can be of any help please give us a call.

   Wyoming Association of Rural Water Systems
   P.O. Box 1750
   Glenrock, WY 82637

   Lloyd Brown--Program Manager
   Roger Strecker--Circuit Rider

10. The state seems to lack enforcement capability.

11. A. Let's try to do it on a voluntary basis, if it doesn't work, we'll need to mandate.

    B. I feel that between the Conservation District and my County Commissioners, we can find and conduct the delineation and inventory locally. I just don't think that many other communities in the state can either, either because of lack of funding, interest or expertise.

12. As with any such program, the idea is excellent. Actual implementation is the problem. So many snags can come up (i.e. attorneys! etc). If a cohesive state/local/volunteer team can get together who can really commit, then there is a very high potential for actual Wellhead Protection areas to be implemented. Private landowners who fall within a WHPA area should be a part of any team as recharge areas may fall under these landowners. This is not a "scare tactic," it's legitimate. The plan exhibits foresight yet, commitment from <u>local</u> people is what is really needed.

13. I believe Wyoming should implement a program statewide. Additional taxes should be used to fund this program so it can be implemented equally across the state. Small communities may not have the money or knowledge to participate. As EPA's goal stated, we should ensure all people receive high quality drinking water.

14. Have local people when possible take care of their problems.

15. A cement slab on top of the ground will not protect the well.

16. Try to be more specific about what John Q. Public can do to support the program (i.e. talking with city councilmen, mayor, etc). Don't continue to support how uncomfortable the room condition may be--downplay. Overall presentation was good--information presented well!! Last presentation too technical. Visual handouts may be useful showing area delineation--copies of overheads.

17. I believe people are becoming more and more environmentally aware, and they are increasingly willing to work at issues designed to improve the quality of the environment. The time is ripe to "seize the moment" and get something done on water quality.

18. Make a list of publications for officials that they can direct to public.

19. How do you decide what all wells should be protected from? Meeting was informative.

20. I will not answer yes to protect my water and have regulations thrown in my face with (over kill). BPU in Casper has done a good job protecting my water and into the future. (No doubt in my mind.)

21. The DEQ, EPA, state and local health departments should involve the public or people at risk in the out come of hazardous conditions. All too often we are left with no say in these matters that involve our daily lives.

22. Program should also apply to rural wells and their potential contamination. Some are close to towns and cities. All rural wells should be tested on an annual basis, plot results and see trends, such as fertilizer applications in shallow water sources.

23. Local city and county governments will need additional revenue raising authority (more home rule).

24. Our water system is located in an area 8 miles south of town in a remote canyon area. The area is not susceptible to contamination, however, care should be taken to maintain the existing environment. A WHP may be in order for future management of the area.

25. Education should be your highest priority. Because of limited funds for us all, education is by far the most cost effective.

26. The public makes a big fuss about any contamination found (they want a big money settlement), but the poor turn out at the meeting tonight shows they don't have enough interest to prevent it unless it has a direct benefit to them, i.e. money or public attention.

27. The most important element is reaching the public and education. The media also seems to emphasize quantity rather than quality. A quality philosophy must be developed over the state of Wyoming.

28. Worland is blessed with a deep artisan well whose wellhead is far from ag pollution and steep terrain minimizes surface or non-point pollutants.

29. Good presentation. Good focus on human relations as part of environmental problems. Glad to see it. Not sure we got focused on our own goals, but now we have an idea. Thanks.

30. Even though Worland isn't in any immediate danger, I believe that this is the time to begin a program.

31. The people want good water. The people need to be educated and understand that water resources can and will be polluted through misuse even in Wyoming. As for who pays for what, have we forgotten that the people no matter if they are a water user, a city dweller, a county dweller, or a state of Wyoming dweller, we pay taxes and that is what pays the bills. We just need to better associate that prevention is needed and necessary vs. dealing with the problems.

APPENDIX F

Computer Information, Well Information, Etc.
(Box and Tubes)

For information contact
Victor Hasfurther
in Civil Engineering