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Implementing the National Primary Drinking Water Regulations for Radionuclides

40 CFR 141

TNRCC

White Paper

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Contents

Contributors

Dale Burnett, *Director, Waste Permits Division, Texas Natural Resource Conservation Commission (TNRCC)*

Eugene Forrer, *Chief Uranium/NORM Licensing Program, Texas Department of Health, Bureau of Radiation Control*

Alice Rogers, P.E., *Manager, UIC & Radioactive Waste Section, Waste Permits Division, TNRCC*

Sharon J. Smith J.D., *Senior Attorney, Industrial Hazardous Waste, Environmental Law Division, TNRCC*

George FitzGerald, *Team Leader, Radioactive Material Licensing, UIC & Radioactive Waste Section, Waste Permits Division, TNRCC*

Anthony E. Bennett, R.S., *Technical Specialist, Public Drinking Water Section, Water Permits & Resource Management Division, TNRCC*

Red Weddell, *Technical Specialist, Public Drinking Water Section, Water Permits & Resource Management Division, TNRCC*

Susan Jere White, J.D., Staff Attorney, Environmental Law Division, Office of Legal Services, *TNRCC*

Bryan S. Smith, *Engineering Assistant, UIC & Radioactive Wastes Section, Wastes Permits Division, TNRCC*

Dale Koler, *Team Leader, Compliance and Inspection, UIC & Radioactive Waste Section, Waste Permits Division, TNRCC*

Michael Honeycutt, *Toxicologist, Toxicology and Risk Assessment, TNRCC*

Charles Wheat, *Toxicologist, Toxicology and Risk Assessment, TNRCC*

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Radionuclides in Drinking Water

Allan Thomas, *Toxicologist, Toxicology and Risk Assessment, TNRCC*

Brad A. Broussard, *Health Physicist, Radioactive Material Team, UIC & Radioactive Waste Section, Waste Division, TNRCC*

Robert A. Beleckis, *Health Physicist, Radioactive Material Team, UIC & Radioactive Waste Section, Waste Permits Division, TNRCC*

Executive Summary

The U.S. Environmental Protection Agency adopted a revision to the National Drinking Water Standard for radionuclides on December 7, 2003. These federal regulations concern Naturally Occurring Radioactive Material (NORM) in drinking water.

Sources of NORM in Drinking Water

Many natural materials contain radioactive elements (radionuclides) including the earth's crust. In Texas, certain areas of the state have higher levels of naturally occurring radioactive material due to geologic activity which occurred when the land was first formed.

Radionuclides are leached into ground or surface water when water comes in contact with uranium- and thorium- bearing soils. Since water for domestic use comes from streams, lakes, reservoirs, and aquifers, it contains varying amounts of naturally occurring radioactivity. Although the level of individual radiation exposure from NORM is usually minimal, some water systems in

Texas have high enough levels to be of concern. To better understand the problem, the TCEQ has conducted stakeholder meetings and has researched the impact of the new federal rules for incorporation into our state drinking water regulations. TCEQ staff has also evaluated the impact of these drinking water rules on other agency programs which are linked to the management of residuals from any potential drinking water treatment processes.

Technical Considerations

In Texas, there are Approximately 135 water systems projected to be or are currently in violation of the EPA's radium, gross α, and/or uranium standard. Water systems have only a few technical options to bring their water into compliance. It is possible for many of these systems to develop alternate surface or groundwater sources, but for others the only option will be to treat the water and appropriately manage the treatment residuals.

Treatment methods are effective and are commercially available. These methods include ion exchange, reverse osmosis, and no- discharge adsorption technology. A key factor in determining the most viable treatment method is to consider what options are available to dispose/discharge of the treatment residual.

Options include: discharge of small concentrations of liquid residuals to an appropriate water body or sanitary sewer, land irrigation or Class V injection well. Higher concentrations of liquid residuals could also be injected in onsite Class I injection wells. Solid material would have to be exported out of state to licensed NORM waste facilities.

Schedule Requirements

Water systems already in violation are under compliance agreements which require them to find solutions to their radionuclide violations by December 2004. After the December 2003 effective date of the amendments to this rule, water systems with new violations of the radionuclide standards would be required to implement the revised radionuclide standard by December 2005. Within this time frame, rules must be written and adopted, compliance strategies developed, engineering designs formulated, and the approved plant designs constructed and placed into operation.

Legal Ramifications

TCEQ is currently under a rules adoption extension agreement with EPA. The TCEQ would need have to drinking water regulations developed and adopted by December 2004 to meet the deadline of the TCEQ extension agreement. After December 2004, the State could allow the federal government to enforce these regulations but this could lead to the loss of primacy delegation for the Public Water Supply Supervision (PWSS) program under the federal Safe Drinking Water Act. Withdrawal of primacy by the EPA would result in the loss of approximately $6 million in PWSS grant funds to the agency. Primacy loss also jeopardizes more than $50 million that the State receives from EPA under the Drinking Water State Revolving Fund administered by the Texas Water Development Board.

Few states have developed NORM disposal programs, due in part to the obstacles encountered by the Supremacy Clause and the Interstate Commerce Clause of the United States Constitution. These clauses would allow NORM waste generated by the federal government or in other states to be disposed of in a commercial facility in Texas. The Texas Railroad Commission, which has rules authorizing the disposal of oil and gas NORM in Texas, indicates that the volume of oil and gas NORM from outside Texas is low. However, because of this potential problem, the TCEQ has until now only looked at non-commercial disposal of the waste. A non-commercial disposal facility may be licensed to prohibit out-of-state NORM waste being disposed of in Texas.

Financial Burden

Determining the most viable treatment and disposal method must take into account reasonable costs that could be absorbed by the system's customers. A cost study performed by TCEQ contractors was conducted for 58 water systems in Texas. This study shows additional costs ranging from no cost per year per customer to greater than $100 per year per customer, depending on the option selected. The TCEQ will make every effort to assist affected communities in the selection of an option, so as to minimize costs. Also, part of these costs may be provided by the EPA's drinking water state revolving fund program administered by the Texas Water Development Board. Since 1996, the revolving fund program has made available better than $300 million to assist drinking water systems in Texas with projects that improve their infrastructure.

Conclusions

Federal regulations now require states to implement the radionuclide rule by December 2003. TCEQ has requested and been granted an extension to the adoption of the revised rule until December 7, 2004. In the interim, TCEQ will implement the new requirements as well as enforce existing radionuclide regulations. New violations will be referred to EPA for enforcement. TCEQ staff has held three stakeholder meetings with representatives of the major water utility associations and the affected water systems. In addition, TCEQ staff has reviewed existing regulations which affect the management of radionuclide containing treatment residuals. There are already existing mechanism to manage these residuals. However, there would need to be new regulations to deal with the commercial disposal of NORM drinking water wastes. The lack of such commercial disposal does not prohibit treatment of public water systems, commercial disposal in Texas may provide a cost efficiency compared with out of state disposal options.

Regulatory Background

Public water systems in Texas have been required to meet standards for radionuclides in drinking water since 1979 when the Texas Department of Health adopted the National Primary Drinking Water Regulations for Combined Radium-226 and Radium-228 of 5 picoCuries/liter (pCi/l), Gross Alpha of 15 pCi/l excluding radium and uranium, and Gross Beta of 4 millirem/yr (Refer to 40 CFR §§ 141.15, 141.16, and 30 TAC §§ 290.108).

Notice of Data Availability
In 1991, the EPA proposed revisions to the radionuclide regulations to add standards for Radon-222 and Uranium. A Notice of Data Availability (NODA) was issued in April 2000 which updated the 1991 proposal. The regulations were finalized in December 2000. All previous requirements remain the same but a new MCL was issued for uranium of 30 ug/l. In addition, new monitoring provisions were issued to ensure compliance. Radon-222, which is a gas, is being addressed in a separate rulemaking by EPA. All states that adopt the new standard will be required to develop their own rules and have their water systems implement the new regulations by December 2003. For new violations, states can also grant a two year extension for compliance to December 2005.

Consequences of No Action
Implementing the standard could be difficult but the costs for not taking action could also be severe. Besides allowing the potential public health problems to continue, other legal and financial costs could be incurred by the agency and the state. Failure to enforce these regulations could lead to the loss of primacy delegation for the Public Water Supply Supervision (PWSS) program under the federal Safe Drinking Water Act. Withdrawal of primacy by the EPA would result in the loss of approximately $6 million in PWSS grant funds and $7 in DWSRF setaside funds to the agency. Primacy loss also jeopardizes more than $50 million that the state receives from EPA under the Drinking Water State Revolving Fund administered by the Texas Water Development Board.

Compliance Agreements
The TNRCC public drinking water program typically addresses exceedances of the drinking water standards through compliance agreements issued by the Enforcement Division. These compliance agreements require the public water systems to evaluate all options for returning the system to compliance. These options include: developing new sources, purchasing water from another water system, or treating the water and disposing of the waste.

Compliance agreements have been developed for existing radionuclide violators. However, remedial action has been tied to the final adoption of the radionuclide rule by EPA and the TCEQ. The drinking water program has agreed to not pursue further formal enforcement until expiration of the compliance agreement, most of which expire in December 2004.

Health Risk

The public is exposed, in daily life, to a wide variety of radiological and chemical agents which are known to cause cancer. The EPA has established federal drinking water standards known as Maximum Concentration Limits (MCLs) for these agents in drinking water. The TNRCC's public drinking water program is charged with administering the EPA standards. An MCL goal of zero is favorable, but rarely practical or achievable. The EPA has also established what they consider an acceptable risk level to the population, usually between one cancer in ten-thousand (1/10,000) and one cancer in one-million (1/1,000,000).

Radiation Studies

Cancer risks for most chemicals are based on animal studies. In addition to animal studies, scientists have examined the effects to human subjects of radiation exposures by studying the Japanese atomic bomb survivors, uranium miners, medical patients receiving large therapeutic doses, and radium dial painters. A significant source of uncertainty in both chemical and radiation risk assessment is the interpolation and/or extrapolation from data gathered in the high dose region to low doses. Also, it has been shown that sensitive subpopulations, such as the fetus, children and individuals with certain genetic traits, may be hypersensitive to exposure to radiation and chemicals. Radiation risk assessment is complicated by the ever-present contribution from natural background radiation which constitutes the

most significant source of exposure to the human population. Natural background occurs from cosmic and terrestrial radiation and ranges from doses of less than
50 millirem/yr to greater than 400 millirem/yr. This variation is due to temporal (i.e. seasonal) and spatial (i.e. geology) differences in the environment.

Radiation Dose Limits

In Title 40, Code of Federal Regulations, Part 141, the EPA sets forth a limit on the annual dose equivalent to the whole body or any organ of 4 millirem from man-made beta/gamma-emitting radionuclides in drinking water. This limit represents only a fraction of the annual dose limit to members of the public from sources other than natural background radiation. To place a perspective on these dose levels, one of the Texas public drinking water systems of concern was calculated as having a potential dose to the public consumer of 125 millirem per year from radium. This is approximately 30 times the EPA allowable dose limit for the public from drinking water (125 versus 4 millirem per year). This increased dose would cause the total potential dose to the public consumer of this water system (excluding natural background radiation and medical contributions) to be more than twice the maximum allowable federal dose limit.

Radiation Risks

Radiation risk analysis is a very subjective area of radiation protection. The radiation standards recommended by the International Commission on Radiological Protection (ICRP) are some of the most widely recognized and accepted. Although, not a regulating or governing body, the ICRP has established risk estimates for radiation protection. The ICRP Report 60 provides risk estimates for fatal cancer to the whole
population from low dose-rate radiation to be 5×10^{-4} per rem received. The EPA's assessments for cancer risks were published in the radionuclide NODA and are depicted in Table 1. These radionuclide concentration levels represent some of the highest calculated cancer risks of any EPA-regulated drinking water contaminants. Presently, about 25 public water systems in Texas have concentrations that exceed the MCLs adopted by the EPA.

TDH Cancer Study

In response to concerns regarding a possible excess of cancer, the Cancer Registry Division of the Texas Department of Health (TDH) conducted an investigation into the occurrence of cancer in Concho, McCulloch, San Saba, and Tom Green counties. The public drinking water systems of these counties have some of the highest measured levels of radionuclides in Texas. Specifically, TDH evaluated 1995-1997 cancer incidence data and 1990-1998 mortality data for cancers of the nose/nasal cavity/middle ear, bone, and acute myelogenous leukemia. Incidence data are the best indicators of the occurrence of cancer in an area. Based on the relatively small sample size of this investigation, the results do not allow for any firm conclusions regarding the incidence of excess cancer in these Texas counties.

Table 1: EPA Maximum Concentration Levels and Associated Cancer Risks

Contaminant	Proposed Maximum Concentration Level (MCL)	Risk of Developing Cancer at these MCL levels
Radium-226	5 picoCuries/liter	1/13,700 (7.3×10^{-5})
Radium-228	5 picoCuries/liter	1/5,000 (2.0×10^{-4})
Uranium	30 picoCuries/liter	1/15,000 (6.7×10^{-5})

Water Planning

Over 200,000 Texans drink water from public water systems which are contaminated with relatively high levels of radium and other naturally occurring radioactive material. TNRCC projections show that as many as 140 systems in Texas may violate the combined radium, gross alpha or uranium standards for drinking water. Some of these systems contain levels of radioactive contaminants with a calculated cancer risk of 1/400 (1/10,000 being the allowable federal and state cancer risk for most contaminants), posing a potentially serious health concern.

Radon Evaluation
The Texas Department of Health (TDH) is currently investigating cancer rates in these areas (page 7). In addition, the impact from Radon-222, a gaseous daughter product of radium, is also present. Radon is being addressed in a separate multimedia mitigation evaluation to limit health effects related to its inhalation in indoor air.

Hickory Aquifer
The TCEQ has divided the state into regions for purposes of water use planning. The Region F Water Planning Area (Figure 1) includes the Hickory Aquifer which contains concentrations of radium, uranium, and other alpha particle emitters at levels that exceed the new EPA standards for radionuclides. The Region F planning group has studied the impact of these radionuclides on the availability of water in this area. Without a feasible means to treat the drinking water and manage the residuals, the Hickory Aquifer would become unusable as a public drinking water source. Many towns using the Hickory Aquifer are remote and alternate sources of drinking water would be very expensive and unavailable for many years.

Appendix A, on page 24, and Appendix B, page 27, provide a statewide list of current and potentially affected water systems. These lists include the location of the facilities by county along with their regional state representative and senator(s).

Figure 1: Texas Water Systems Currently In Violation

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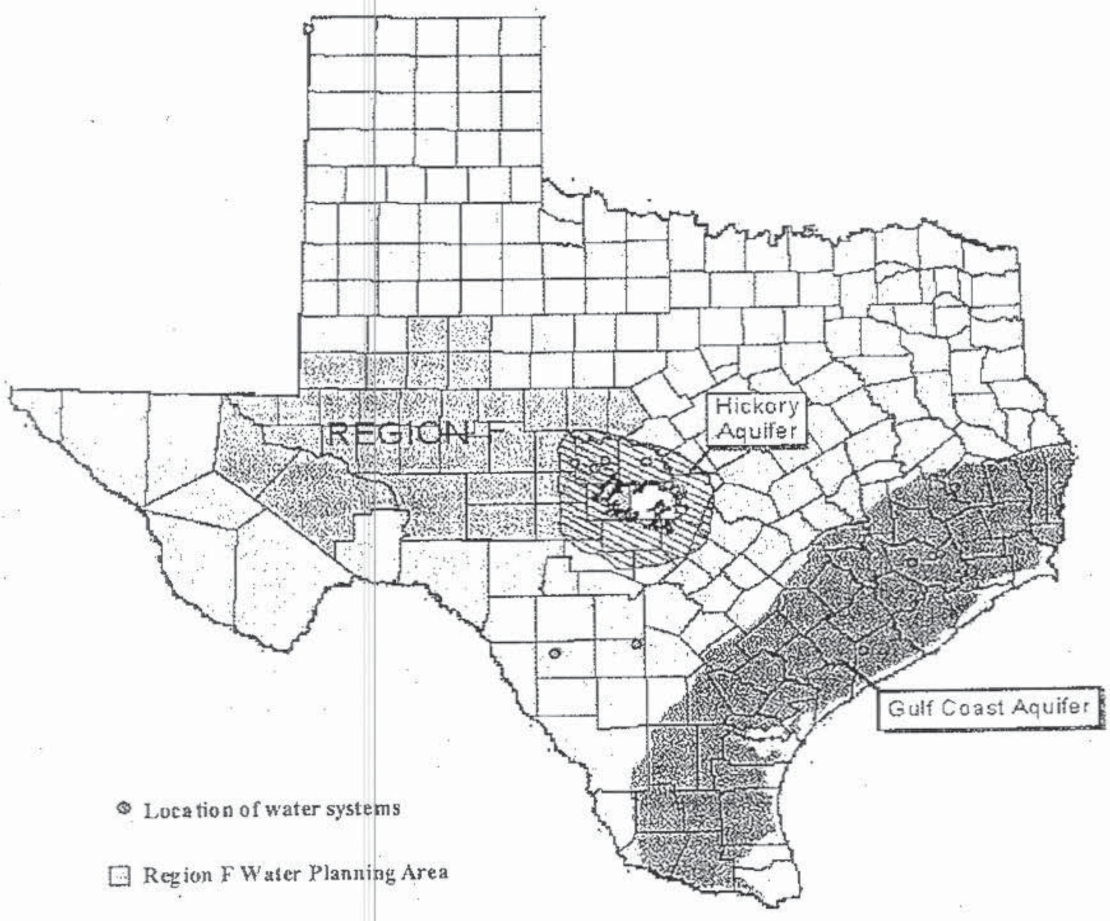


Implementing the EPA Standard

Water systems with radionuclide exceedances have only a few options to bring their water quality into compliance. One option is to develop alternate groundwater or surface water supplies that meet the EPA Standard. Another is to connect to neighboring, compliant drinking water systems for either exclusive use or blending. A third viable option is water treatment which can be less expensive than either development of other sources or connecting to other water systems.

Treatment Methods

Two radionuclide removal technologies have been evaluated by staff Cation Exchange water softening and Reverse Osmosis.

Cation Exchange

Cation exchange resins, such as those used in home water softeners to remove the components of hardness (calcium and magnesium), can also be used to remove radium and uranium. Table 2 demonstrates the calculated volume and concentration of radionuclides in the waste stream if cation exchange were used to treat a representative sample of the radium affected plants. These calculations are based on typical efficiencies and volumes of water used to regenerate the resin beds and show the volume of regenerant produced for disposal. These calculations show that even small systems may produce large volumes of waste.

Reverse Osmosis

Reverse osmosis (RO) is an effective treatment for all radionuclides in drinking water except for radon which is a gas. Table 2 shows the calculated waste volume and concentration of radionuclides in an RO waste stream. In general, by using "off the shelf" technologies for reverse osmosis, about 25% of the influent water is rejected to form a brine stream. Therefore, the brine stream generally contains a concentration of contaminants about four times greater than the influent water concentration. As shown in the table, reverse osmosis produces much more liquid radioactive waste than does ion exchange but at a lower concentration of radionuclides.

Point-of-Entry/Point-of-Use

Treatment at a centralized location may not be feasible in some areas, due to small population size, because centralized treatment may be cost prohibitive. In these instances, home water treatment may be an options. This home based treatment can consist of either whole-house or single faucet treatment. Whole house, or point-of-entry (POE) treatment is necessary when exposure to the contaminant by modes other than consumption is a concern. Single faucet or point-of-use (POU) treatment is preferred when treated water is needed only for drinking and cooking purposes. POU treatment usually involves single-tap treatment. POE and POU systems generally offer ease of installation, with lower capital costs and simplified operation and maintenance. They may also reduce engineering, legal and other fees typically associated with centralized treatment options. Specific requirements for the use of POU devices exist within the federal regulations. Regulatory allowance of the use of POU devices are made for each contaminant on an individual basis based on the potential exposure reduction of such a device. In either case, EPA regulations require that the devices be owned, maintained and tested by the public water system. The Current policy of EPA is to allow states to approve POU/POE technology only if the water system gains 100% perticipation by the customers. This requirement as well the maintenance and testing burden, may make POU/POE less desirable than potentially less capital intensive centralized treatment systems. Use of POE and POU does not reduce the need for a well-maintained water distribution system.

Table 2: List of City Treatment Facilities and Quantities of Liquid Radium Waste

Type of Treatment:			Ion Exchange		Reverse Osmosis	
Facility Name	County	Number of Connections	Waste Volume (gal/day)	Radionuclide Concentration (pCi/L)	Waste Volume (gal/day)	Radionuclide Concentration (pCi/L)
CITY OF JERSEY VILLAGE	Harris	1810	19,134	340	128,333	227
MILLERSVIEW-DOOLE WSC	Concho	1377	11,945	3,669	168,122	192
ZAVALA COUNTY	Zavala	522	12,429	217	55,941	137

TEXLINE MUNICIPAL WATER SYSTEM	Dallam	250	696	354	6590	175
OAK HOLLOW SUBDIVISION	Matagorda	22	682	105	1253	96

Residuals Management Options

Options available under existing TCEQ rules

Studies of various disposal options have been performed for NORM waste within the oil and gas industry. These studies are directly applicable to various drinking water systems since the radionuclides of concern are the same. The various options include: discharge to a Publicly Owned Treatment Works (POTW), land application, discharge to a water body, disposal in an underground injection well or shipment out of state. Disposal of NORM waste using these methods, at the concentrations provided in the following paragraphs, would meet all state and federal regulations.

Discharge to a POTW

In accordance with current state and federal regulations, release to a Publicly Owned Treatment Works (POTW) through a sanitary sewer system is allowed for radium up to 600 pCi/L average monthly concentration of Radium 226 and Radium 228 each in the waste stream. Natural uranium may be released at an average monthly concentration of 3,000 pCi/L. These limits have been set to preclude any problems disposing of the sludge and effluents from the wastewater treatment plants.

Land Application

Land application involves disposal by spreading or spraying liquid or sludge on the surface of open lands in an area where NORM was not originally present above background levels. This method is land intensive and has limited applicability in densely populated areas or areas with limited land availability. Only two land application methods were evaluated, landspreading of POTW sludge and effluents (which had received waste from an ion exchange treatment plant), and irrigation of RO reject water. Direct land application of ion exchange regenerate was not included in this study. Only ion exchange regenerate that has been discharged to a sewage collection facility can be land applied. This is because the ion exchange effluent with its high salt content, can not be directly applied to land or the land would become unfit for vegetation. Other treatment techniques such as lime softening or coagulation/filtration produce a sludge that could be land applied but these methods have been ruled out by the EPA as not being cost effective treatment methods.

Non Commercial Underground Injection Class V

Liquid injection into usable quality groundwater could under the Class V injection rules is possible if the effluent meets the limits prescribed for discharges to the environment. This would allow for onsite management in areas where a sewage collection system does not exist, where there is no recieving water body available and there is not sufficient land available for land application. Because ion exchange technology would add a large concentration of salt, and an efficiently operated ion exchange system would concentrate radium to levels above the effluent concentration limits allowed under TCEQ rules, this residuals management method is not practical for ion exchage radium

Non Commercial Underground Injection Class I

Sludge, liquids, and some filter media could be injected into formations which are isolated geologically and mechanically from U.S. Drinking Waters (USDW). This would involve transport, storage, and then injection of the waste. There are many geologic requirements for an underground injection well outlined in TNRCC rules at 30 TAC 331.121. The injection zone must have sufficient permeability, porosity, thickness, and areal extent to prevent migration into USDW. There are few drinking water systems located in geologically favorable areas for underground injection well disposal. In addition, drilling and operating an injection well is very expensive. Only large communities would be able to absorb the additional cost.

Options Not available under existing TCEQ rules

Commercial Class 1 Underground injection

While non commercial Class I injection could be authorized under existing TCEQ regulations. There are no regulations in place that allow for the licensing or permitting of a Class I injection well for NORM disposal. As new technologies become available which are capable of concentrating NORM at levels much higher than what can be managed within effluent concentration limits, commercial Class I disposal within Texas may provide a significant cost reduction in treatment costs compared with out of state disposal and non commercial Class I options.

Onsite or Commercial Buried Waste Facility

Technical studies, using the federal maximum radiation exposure limit of 25 millirem per year, indicate that sludge and equipment wastes having low NORM concentrations could be buried below 15 feet (4.6 m) and still allow for unrestricted use of the site once the facility is abandoned. Commercial NORM waste disposal facilities could be allowed to bury much higher concentrations of waste material. TCEQ does not have in place any regulations which would allow for the licensing or permitting of such an operation.

Low Level Radioactive Waste Disposal Site

Another possible alternative would be collocation of NORM at a low-level radioactive waste disposal facility. This is not allowed under the present legislation governing low level radioactive waste disposal. While technically possible, a change to the legislation would have to be made in order to facilitate the disposal of NORM at such a site.

NORM Waste Treatment and Disposal in Other U.S. States

The States of Illinois and Wisconsin have developed disposal criteria for water treatment plant wastes containing radium. The Conference of Radiation Control Program Directors is developing suggested standards for the disposal of NORM wastes.

Figure 2 shows the results of a survey of 33 states and summarizes their NORM waste disposal status. Seventeen of the surveyed states (52%) reported radium drinking water exceedances above the EPA's MCL of 5 pCi/L.

Six of these seventeen states currently have NORM drinking water rules in place. The other eleven are faced with the same concerns for complying with the newly adopted standards. Some may develop methods to treat and dispose of their drinking water NORM waste in-state and others may wish to transport and dispose out of state. Legal incentives for these states to develop their own facilities are addressed in this paper under the following section entitled "Supremacy Clause & Interstate Commerce Act."

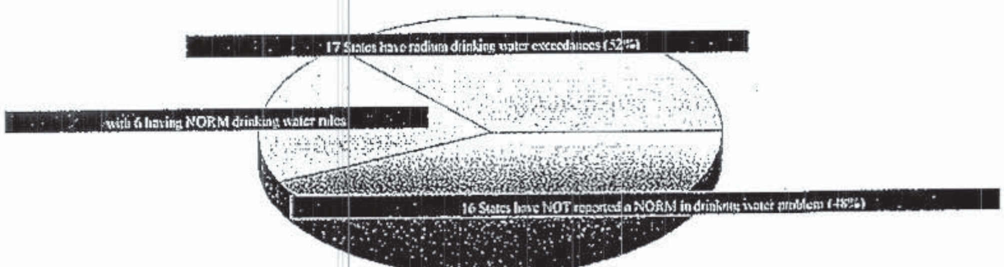


Figure 2: States with NORM Drinking Water Regulations

Supremacy Clause & Interstate Commerce Act

The State of Texas has experienced an ever-increasing need to address problems associated with the disposal of Naturally Occurring Radioactive Material (NORM). Few states have developed commercial NORM disposal programs, due in part to the obstacles encountered by the Supremacy Clause and the Interstate Commerce Clause of the United States Constitution.

Supremacy Clause

The Interstate Commerce Clause and the Supremacy Clause of the Constitution make it difficult to create a rule which restricts NORM waste generated by the federal government or by other states from entering Texas to be disposed of at a commercial disposal site. The Supremacy Clause declares that the laws of the United States shall be the supreme law of the land. Anything in the constitution or laws of any state to the contrary is preempted and without effect if it conflicts with federal law. In sum, a Texas law or regulation which purposefully prevents the federal government from enjoying the same benefits available to Texas entities would be invalid.

Interstate Commerce Clause

In addition to the Supremacy Clause, any rule governing NORM disposal would also need to take into consideration the Interstate Commerce Clause, which has the effect of restricting a state's power to enact laws that interfere with interstate commerce. Therefore, any law that excludes one state, while benefitting another, would be declared unconstitutional. Texas may be legally bound to dispose of NORM wastes from both federal and state entities if a commercial NORM waste facility is constructed in the state. This does not effect non-commercial disposal of NORM waste. A non-commercial disposal facility may be licensed to prohibit out-of-state NORM waste being disposed of in Texas.

Costs

A desk top treatment and disposal cost study was conducted by TCEQ staff for five facilities in Texas. These facilities represent a variety of treated flowrates and contamination concentrations. These figures do not include costs to process and store waste. Costs to treat each of the systems waters are shown in Table 3 on page 17.

Licensing Costs

The NORM associated with a water treatment plant would be generally licensed and would therefore not be subject to any licensing fees or even requirements to have the radiation safety program approved. The general license only requires that a program be evaluated and, if necessary, implemented to ensure doses to the public and/or workers do not exceed legal limits. At a minimum, each facility should retain a consultant to evaluate the facility and submit recommendations as to whether a radiation protection program is needed. The consultant would cost about $2500-$4000 depending on the size of the facility.

Radiation Equipment Costs

If a program is required then equipment will need to be purchased. Initial costs for equipment should not exceed $2000-$3000 depending on the size of the facility. Once the program has been setup any ongoing costs would be minimal (i.e. dosimetry, wipe tests, etc.). Unless the facility chooses to hire an outside consultant to run the program, the only other costs would be hours taken away from other duties while an employee attends to the program and for specialized training. A procedure should be included in the approval process for this type of facility for applicants to indicate what they have done to evaluate whether there is a need for a radiation protection program. Aspects that would need to be addressed would be external exposure, airborne problems, and discharge to the environment. This evaluation would be greatly influenced by the treatment method chosen, any on-site processing of waste, and the residuals management method used.

Economic Feasibility of Compliance

The Texas Water Development Board (TWDB) administers the Texas Drinking Water State Revolving Fund (DWSRF) and other state drinking water funds. The Rural Utility Service (RUS) administers other sources of federal funding for public water system improvements to achieve or maintain compliance. In reviewing applications for loans and grants, both of these agencies evaluate a public water system's financial infrastructure and the economic feasibility of loan repayment.

The RUS is not inclined to lend money to a public water system that required customers to pay more than $45.00 per month for the first 8,000 to 10,000 gallons. This quantity of gallons per month has been chosen by them

Radionuclides in Drinking Water

based on historical winter water usage records and reflects necessary in-house water consumption for a family.

The TWDB does not have a single maximum rate for all applicants. Instead they look at what economic income group a public water system's customers fall into to decide what is an economically feasible monthly rate. If the customer base of the water systems is economically disadvantaged, the TWDB evaluates the public water system to see if it qualifies for grant monies or loan forgiveness instead of or in addition to low interest loans. However, some of the public water systems have an economically diverse group of customers that may complicate this process.

Radionuclides in Drinking Water

Table 3: Costs to Treat and Dispose of NORM in Drinking Water for Five Systems in Texas

	System Name:	Oak Hollow Subdivision	Millersview-Doole WSC	City of Jersey Village	City of Texline MWS	Zavala Co. WCID No. 1
	Average Flow Rate (mgpd):	0.012	0.530	1.001	0.032	0.317
	Current monthly 8,000 gal water bill:	$31.35	$51.20	$18.10	$18.25	$13.65
	Combined Radium Concentration:	8 pCi/L	65 pCi/L	7 pCi/L	14 pCi/L	6 pCi/L
	Population:	66	4131	5430	420	1566
Alternate Source or Treatment Type	Disposal Method	($/mo water bill increase)	($/mo water bill increase)	($/mo water bill increase)	($/mo water bill increase)	($/mo water bill increase)
Drill a New Well	N/A	$8.87 (28%)	$2.69 (5%)	$48.02 (265%)	$1.92 (11%)	$9.05 (66%)
Pipe in Water	N/A	$84.75[4,5]	$5.96 (12%)	<$5.00 (28%)	$53.69 (294%)	$10.71 (78%)
Ion Exchange	Direct Discharge - 1000' Pipe	$56.56 (180%)	$4.16 (8%)	$7.25 (40%)	$7.44 (41%)	$11.35 (83%)
	Discharge POTW - 1000' Pipe	$58.11 (185%)	$5.15 (10%)	$9.12 (50%)	$7.44 (41%)	$13.04 (96%)
	Evaporation Ponds and Non-Hazardous Landfill	>$1000.00	>$1000.00	>$1000.00	$23.02 (126%)	>$1000.00
	POTW Sludge Landspreading	$86.67	$11.17 (22%)	$23.74 (131%)	$11.39 (63%)	$27.70 (202%)
	Landfill Burial of Ion Exchange Sludge	>$100.00	$12.66 (25%)	$17.65 (98%)	$29.66 (163%)	$32.66 (239%)
	Burial of Ion Exchange Sludge in a Commercial Waste Facility	>$300.00	>$1000.00	>$1000.00	$33.69 (185%)	>$1000.00
	Commercial LLRW Facility disposal of Ion Exchange Sludge	>$400.00	>$1000.00	>$1000.00	$35.93 (196%)	>$1000.00
	Non-Commercial Injection Well	>$1000.00	$25.06 (49%)	$23.12 (127%)	>$100.00	$66.51 (487%)
Reverse Osmosis	Direct Discharge - 1000' Pipe[2]	$12.46 (40%)	$11.05 (22%)[4]	$6.12 (34%)	$5.78 (32%)	$9.92 (73%)
	Discharge POTW-1000' Pipe[3]	$27.68 (88%)	$15.73 (31%)	$11.33 (62%)	$9.23 (51%)	$21.84 (160%)
POU Reverse Osmosis[1]	Disposed as exempt waste	$24.61 (79%)	$24.48 (48%)	$24.47 (135%)	$24.53 (134%)	$24.51 (180%)
POU Cation Exchange[1]	Disposed of in household waste	$24.51 (78%)	$24.40 (48%)	$24.39 (135%)	$24.44 (134%)	$24.42 (179%)
POE Cation Exchange[1]	Disposed of as exempt liquid waste	>$300.00	>$200.00	>$200.00	>$200.00	>$200.00

Notes [1] POU and POE are Point of Use and Point of Entry systems. Reverse osmosis or ion exchange waste water would go to sewer, septic tank, or drain field.
[2] Direct discharge - 1000' Pipe means discharge of liquid waste to a surface water body for dilution.
[3] Discharge POTW- 1000' Pipe means discharge of liquid waste to a Publicly Operated Treatment Works
[4] Methods considered to be infeasible due to high costs are shown with a blue background. Methods considered infeasible due to other water quality issues in yellow.
[5] A cost feasibility cut off point was chosen at a maximum total cost of $80 per month per customer. This amount is based upon the Rural Development Board's recommended amount for repayment of a loan along with the availability of grant monies and/or low interest loans to achieve an economically feasible rate schedule.

Outline of Proposed Changes to the TNRCC Rules

Drinking water plants, which need to treat their drinking water to meet the new standards, will have to find an economically feasible method to manage their treatment resuiduals. Currently, there are no TNRCC rules which specifically address disposal of naturally occurring radioactive material (NORM) waste. There are several limits listed in the TNRCC rules for discharge of radium, uranium, and other NORM material to sanitary sewers. There are also limits for land application and other discharges to the environment. However, other new disposal rules and/or amendments to existing rules will be required before some types of residual management methods could be allowed.

Drinking Water Rules

The new EPA MCL for naturally occurring uranium and the requirement for separate monitoring of radium-228 will have to be incorporated into TNRCC's 30 TAC Chapter 290, *Public Drinking Water*. To accomplish this, the TNRCC would submit a request for revisions to our rules to have them adopted by December 2002. The actual effective date of the new state requirements will be Dec. 8, 2003.

The requirements for gross alpha, beta particle, photon radioactivity, and combined radium-226 and -228 are unchanged in the new EPA rulemaking and are considered to be already in effect. The TNRCC will negotiate as soon as possible with the EPA for schedules to place the affected water systems into compliance. Chapter 290 already requires TNRCC to be notified and to approve all new construction for water treatment facilities. The TNRCC will share this notification information with the Texas Department of Health (TDH). The TDH will be involved with much of the regulation of these plants since they have jurisdiction over the treatment of radioactive material.

Health Department Rules

Drinking water treatment plants will be under the jurisdiction of the TDH for storage of their radioactive wastewater. Under TDH's new 25 TAC §289.259, *Licensing of Naturally Occurring Radioactive Material*, the drinking water treatment plants will have a "general license to possess" the radioactive waste. General licenses require a radiation safety program for workers and, if needed, record keeping of all radioactive waste transferred for disposal. No changes will be necessary to the existing TDH rules.

Discharge to Sewer

One of the simplest and most cost effective methods for disposal of radioactive waste brine is to discharge to a sanitary sewer leading to a Publicly Owned Treatment

Works (POTW). The radioactivity limits for sewer discharge of radioactive wastewater are already established in the current TNRCC rules and will not require a license or permit. However, sanitary sewer disposal is not available for all treatment plants and some plants with sewer hookup could not directly discharge due to radionuclide concentrations above the limits.

There are no know problems currently existing with radiation levels exceeding safety standards at POTWs or with radiation levels

exceeding safety standards in the sludge created at these POTWs, although EPA and the NRC are currently studying these levels. Some areas of Texas which have elevated concentrations of NORM in their drinking water are disposing of their waste water in a sewage system.

Concentrating the wastewater into a brine before discharge into the sewage system could increase the total amount of radioactivity introduced to the POTW. This could cause problems with disposal of the POTW effluent sludge and water. Concentration in the sludge would be due to the loss of dilution water especially in the summer months from watering lawns and other uses. Water systems which discharge their waste to a POTW will likely need to have a sampling program established at the treatment works and at the POTW. If necessary, the brine solution could be stored at the drinking water treatment facility and metered at an acceptable rate into the sewage system. Rules may be required to allow for permitting of treatment facilities to limit the quantity and concentration of radionuclides that they may safely discharge to the POTW.

If discharge to a sewage system is determined to be the preferred disposal method for a water system then 30 TAC Chapters 309 (*Domestic Wastewater Effluent Limitation and Plant Siting*) and 312 (*Sludge Use, Disposal, and Transportation*) would need to be modified. Acceptable radioactivity limits would have to be developed and added to these rules.

Radioactivity limits and methods for land application of treated sludge would also be
needed in 30 TAC Chapters 312 and 336.

Discharge to Receiving Streams
Another method for disposal of wastewater is to discharge controlled quantities into an appropriate receiving stream (one where the contaminates will not concentrate). To use this disposal method, a general permit for discharge into surface water would have to be developed under 30 TAC Chapter 205, General Permits for Wastewater Discharges. The limit for radioactivity in the discharged water in 30 TAC §336.359 would have to be cited in the newly developed general permit. A radioactive material license would not be required for this discharge.

Sludge Disposal
If it turns out to be economically feasible to create a sludge from a radioactive brine at the drinking water plant, that radioactive sludge would be regulated under 30 TAC Chapter 312, Subchapter F, Disposal of Water Treatment Sludge. Those rules relate to permits for disposal in landfills and require an annual report and possibly an annual fee. A radioactivity limit for radioactive sludge disposal going into a

landfill would then need to be developed and incorporated into 30 TAC Chapter 336.

Disposal in MSW and IHW Landfills
30 TAC Chapter 336, §§336.225(c) and 336.365 already authorize disposal of certain radionuclides in a Municipal Type I Landfill or a Hazardous Waste Landfill. However, radium radionuclides and uranium are not listed in these landfill provisions. Currently, these TNRCC landfill rules address only radionuclides with a short half-life (300 days or less). To dispose of drinking water treatment NORM wastes in a Chapter 330 or Chapter 335 landfill, 30 TAC Chapter 336 would need to be changed to address the longer half-life radium and uranium radionuclides.

Underground Injection
If disposal of the radioactive brine down a Class I underground injection well is economically feasible and necessary, a permit would be required under current 30 TAC Chapter 331, Subchapter D. Also, 30 TAC Chapter 336 would need to be amended to authorize licensing of radioactive waste (NORM) disposal in an underground injection well. TNRCC rules currently exempt inactive radioactive waste sites with radium wastes containing less than 2,000 pCi/gm from having to decommission. This is only if the waste remains on-site at an inactive facility. If necessary, this rule could be amended to make this a disposal exemption which would allow on-site injection of radium waste water by an active water treatment system.

Private Non-Commercial Landfills
Construction of a private non-commercial hazardous waste landfill is not recommended due to the difficulty in meeting various licensing requirements (such as a public review and approval of a facility). The costs to build a small facility appears to be feasible for larger communities. It may also be possible for several smaller water systems to combine their resources to build a small regional landfill. However, due to potential licensing problems, the TNRCC Staff will not pursue the use of private non-commercial landfills as an viable option for disposal of NORM wastes.

Reinjection into Aquifer
It is also technically feasible to reinject the radioactive wastewater from drinking water treatment back into the aquifer from which it came without a significant increase in the concentration of radionuclides. Injection of wastewater into a Class V well is currently permitted by rule under 30 TAC Chapter 331 <u>if the injectate meets drinking water MCLs</u> (40 Code of Federal Regulations §144.12 and §141.15). TNRCC 30 TAC Chapter 336 (and possibly Chapter 331) would have to be amended to authorize a licensee to inject NORM wastewater into an aquifer through a Class V well. Because the NORM wastewater would have a higher radionuclide concentration than the MCL, an exception or rule change will be needed to inject it. The likelihood for obtaining an exception or change to the federal rule is not known at this time.

Table 4: Summary of Rule Changes

POTENTIAL STATE AND FEDERAL RULE CHANGES

- Discharge to Sanitary Sewer
- Point or Entry & Point of Use Systems
- Water Treatment Sludge Disposal
- Municipal & Hazardous Landfill Disp. of POTW Sludge
- POTW Sludge Land Application
- POTW Sludge Landfill Disposal
- Discharge to Surface Water
- Private Injection Wells
- Land Application of RO Waste Water
- Reinjection of RO Waste Water into an Aquifer

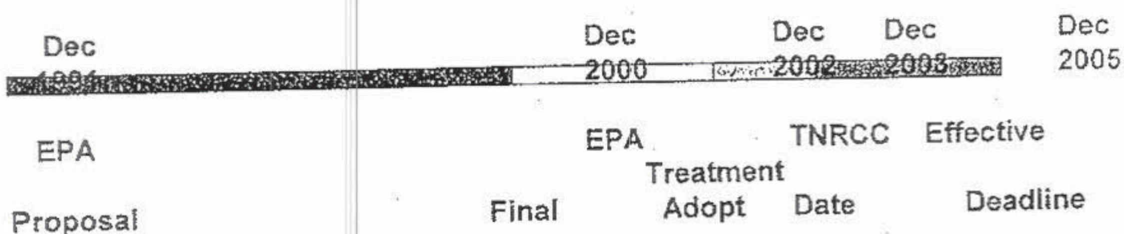
RULES **NOT** TO BE ADDED OR CHANGED

- New Commercial Landfill
- New Commercial Injection Well Facility
- Land Application of Ion Exchange Brine
- Private Non-Commercial Landfills
- Municipal & Hazardous Landfill Disp. of Liquid Wastes

Regulation Time Line

The EPA Drinking Water Standard: Radionuclides was first issued in December 1991. Because of apparent changes which were being proposed to the rules, many states held off on adopting the standard. Now, a revision to the radionuclide standard has been adopted by EPA which not only upholds the original radionuclide MCLs but introduces a new MCL for Uranium. Figure 3 provides a time line for implementation of the new radionuclide standard.

Figure 3: Time Line of Key Events for Regulation Implementation



Conclusions

Public drinking water systems are now faced with final regulations for radionuclides and must address health concerns for many citizens of Texas. Options for achieving compliance are limited to either finding an alternate source or to treat the water to lower the radionuclide concentration to acceptable levels. Alternate water supplies are not available at a reasonable cost in some parts of the state. Even where available, developing alternate sources or purchasing water from other systems may be more expensive than applying available treatment technologies. Treatment, however, is not an option if there are no rules to allow for disposal of the treated waste.

The staff of Public Drinking Water, Underground Injection Control and Radioactive Waste, Toxicology & Risk Assessment, and Legal have reviewed this issue. They have determined that there is a human health concern associated with radionuclides in some drinking water systems in Texas. The preferred option for some violators will be implementation of treatment technologies. However, this would result in producing NORM waste which must be disposed of in a proper manner.

There is a need to develop rules for the safe, economical disposal of NORM waste to protect human health and the environment. A rules revision is needed to address standards for licensing and permitting requirements for facilities which dispose of non-oil & gas NORM.

Appendix A

Currently Identified NORM Affected Facilities

by County, State Representative and Senator(s)

Radionuclides in Drinking Water

County	System Name	Representative	Senator(s)
Burnet	Council Creek Village	HARVEY HILDERBRAN	TROY FRASER
	South Silver Creek I. II. III	HARVET HILDERBRAN	TROY FRASER
Concho	**Millersview-Doole WSC**	BOB TURNER	TROY FRASER
Dallam	**Texline Municipal Water System**	WARREN CHISUM	TEEL BIVINS
El Paso	Gaslight Square Mobile Home Park	JOSEPH "JOE" PICKETT	ELIOT SHAPLEIGH
Erath	Pigeon Road Estates	SID MILLER	DAVID SIBLEY
Frio	Bigfoot Water Supply Corporation	TRACY KING	JUDITH ZAFFIRINI
Gillespie	Northwest Hills Water Supply	HARVEY HILDERBRAN	JEFF WENTWORTH
Grayson	Ridgecrest	RON CLARK	TOM HAYWOOD
Harris	HCO MUD No. 130	GARY ELKINS	JON LINDSAY
	Jersey Village - City of	GARY ELKINS	JON LINDSAY
	Rolling Creek Utility District	WILLIAM CALLEGARI	JON LINDSAY
	Trail of the Lakes MUD	SENFRONIA THOMPSON	JON LINDSAY
	West Houston Mobile Home Comm.	GARY ELKINS	JON LINDSAY
Jeff Davis	Ft. Davis Water Supply Corporation	PETE GALLEGO	FRANK L. MADLA
Kleburg	Utility Development & Research	IRMA RANGEL	CARLOS F. TRUAN
Llano	Bridgepoint Water System	HARVEY HILDERBRAN	TROY FRASER
	Tow Village Property Owners Assn.	SUZANNA GRATIA HUPP	TROY FRASER
Lubbock	Pecan Grove Mobile Home Park	CARL ISETT	ROBERT L. DUNCAN
	Shallowater - City of	DELWIN JONES	ROBERT L. DUNCAN
	Valley Estates	CARL ISETT	ROBERT L. DUNCAN
	Ft. Jackson Mobile Estates	DELWIN JONES	ROBERT L. DUNCAN
Matagorda	**Oak Hollow Subdivision**	D.R. "TOM" UHER	KENNETH L. ARMBRISTER
McCulloch	Live Oak Hills Subdivision	SUZANNA GRATIA HUPP	TROY FRASER
	Melvin - City of	SUZANNA GRATIA HUPP	TROY FRASER
	Brady - City of	SUZANNA GRATIA HUPP	TROY FRASER
	Richland Special Utility District - Brady	SUZANNA GRATIA HUPP	TROY FRASER
	Rochelle Water Supply Corporation	SUZANNA GRATIA HUPP	TROY FRASER
Medina	Benton City Water Supply Corp.	TRACY KING	FRANK L. MADLA
Nueces	Golden Acres Water Company	JAIME CAPELO	CARLOS F. TRUAN
Polk	Tempe Water Supply Corporation	DAN ELLIS	TODD STAPLES
San Saba	North San Saba Water Supply Corp.	SUZANNA GRATIA HUPP	TROY FRASER
	San Saba - City of	SUZANNA GRATIA HUPP	TROY FRASER
Tyler	Chester Water Supply Corp.	DAN ELLIS	TOD STAPLES
Zavala	**Zavala County WCID No. 1.**	TRACY KING	JUDITH ZAFFIRINI

Note: Water systems shown in bold were used in the cost study.

Appendix B

Facilities Potentially Affected by NORM

by County, State Representative, and Senator

	System Name	Representative(s)	Senator(s)
Bexar	Atascosa Rural Water Supply Corp.	JOHN LONGORIA	FRANK L. MADLA
	Nico Tyme Water Cooperative	CARLOS URESTI	FRANK L. MADLA
Bosque	Iredell - City of	ARLENE WOHLGEMUTH	DAVID SIBLEY
Brazoria	Brazoria Freshwater Supply District	D.R. "TOM" UHER	J.E. "BUSTER" BROWN
	Wolf Glen Water System	DENNIS BONNEN	J.E. "BUSTER" BROWN
Burnet	Bananza Beach Water Association	HARVEY HILDERBRAN	TROY FRASER
Comal	Comal Hills Water Supply Corp.	HARVEY HILDERBRAN	JEFF WENTWORTH
Concho	Eden - City of	BOB TURNER	TROY FRASER
Crockett	West Texas Utilities Rio Pecos Power Station	PETE GALLEGO	FRANK L. MADLA
Fort Bend	Thunderbird Utility District 1	CHARLIE HOWARD	RODNEY ELLIS
	Fort Bend County MUD 26	DORA OLIVO	J.E. "BUSTER" BROWN
Gillespie	Liveoaks Mobile Home Park	HARVEY HILDERBRAN	JEFF WENTWORTH
Grayson	Rocky Point A	RON CLARK	TOM HAYWOOD
	Rocky Point B	RON CLARK	TOM HAYWOOD
Grimes	Grassy Creek Mobile Home Park	THOMAS WILLIAMS	STEVE OGDEN
	Richards Water System	THOMAS WILLIAMS	STEVE OGDEN
Hardin	Kountze - City of	ZEB ZBRANEK	DAVID BERNSEN
	Bullocks Mobile Home Park	ZEB ZBRANEK	DAVID BERNSEN

Harris	Bertrand Water System	KEVIN BAILEY	JOHN WHITMIRE
	Nitsch & Son Utility Company	KEN YARBROUGH	JOHN WHITMIRE
	Hall Park Subdivision	KEVIN BAILEY	MARIO GALLEGOS
	Harris County MUD 25	GARY ELKINS	JON LINDSAY
	Harris County Utility District 6	GARY ELKINS	JON LINDSAY
	Harris County MUD 102	GARY ELKINS	JON LINDSAY
	Jackrabbit Road Public Utility District	GARY ELKINS	JON LINDSAY
	Emerald Forest Utility District	PEGGY HAMRIC	JON LINDSAY
	Harris Count MUD 136	GARY ELKINS	JON LINDSAY
	Windfern Forest Utility District	GARY ELKINS	JON LINDSAY
	Harris County MUD 105 Settlers Village	WILLIAM CALLEGARI	JON LINDSAY
	Langham Creek Utility District	WILLIAM CALLEGARI	JON LINDSAY
	Harris County MUD 157	WILLIAM CALLEGARI	JON LINDSAY
	Quailwood Water System	HAROLD DUTTON	JON LINDSAY
	Northwest Harris County MUD 16	WILLIAM CALLEGARI	JON LINDSAY
	Harris County MUD 162	GARY ELKINS	JON LINDSAY
	Barker Cypress MUD	GARY ELKINS	JON LINDSAY
	Fry Road MUD	WILLIAM CALLEGARI	JON LINDSAY
	Horsepen Bayou MUD	GARY ELKINS	JON LINDSAY
	West Harris County MUD 9	PEGGY HAMRIC	JOHN WHITMIRE
	Harris County MUD 189	HAROLD DUTTON	JON LINDSAY
	Harris County MUD 71	WILLIAM CALLEGARI	JON LINDSAY
	Harris County MUD 183	GARY ELKINS	JON LINDSAY
	Rolling Oaks	THOMAS WILLIAMS	DAVID BERNSEN
	Harris County MUD 185	GARY ELKINS	JON LINDSAY
	West Harris County MUD 10	PEGGY HAMRIC	JOHN WHITMIRE
	Harris County MUD 167	WILLIAM CALLEGARI	JON LINDSAY
Irion	Mertzon - City of	ROBERT JUNELL	ROBERT L. DUNCAN
Kendall	Kendall County WCID 1	HARVEY HILDERBRAN	JEFF WENTWORTH
Kerr	Horseshoe Oaks Subdivision Water System	HARVEY HILDERBRAN	JEFF WENTWORTH
	Elmwood Mobile Home Park	HARVEY HILDERBRAN	JEFF WENTWORTH
Lavaca	Moulton - City of	GEANIE MORRISON	KENNETH ARMBRISTER
McCulloch	Lohn Water Supply Corporation	SUZANNA GRATIA HUPP	TROY FRASER
	Brady Lake Water System	SUZANNA GRATIA HUPP	TROY FRASER
	Lakeland Services	SUZANNA GRATIA HUPP	TROY FRASER

Mason	Mason - City of	BOB TURNER	JEFF WENTWORTH
Montgomery	Keenan Water Supply Corporation	THOMAS WILLIAMS	TODD STAPLES
	Oak Ridge North - City of	RUBEN HOPE	DAVID BERNSEN
	Woodridge Estates Water System	RUBEN HOPE	DAVID BERNSEN
	Crystal Forest Subdivision	RUBEN HOPE	DAVID BERNSEN
	Lake Bonanza Water Supply Corporation	RUBAN HOPE	TODD STAPLES
	White Oak Hills	DAN ELLIS	STEVE OGDEN
	Settlers Crossing	RUBEN HOPE	DAVID BERNSEN
Moore	Moortex Water Supply Corporation	DAVID SWINFORD	TEEL BIVINS
Parker	Shangri La Subdivision	PHIL KING	CHRIS HARRIS
	Crazy Horse Water Company	PHIL KING	DAVID SIBLEY
	Abraxas Utilities	PHIL KING	CHRIS HARRIS
	Diamond Oaks Subdivision	PHIL KING	CHRIS HARRIS
Pecos	Pecos County WCID 1	PETE GALLEGO	FRANK L. MADLA
Polk	Indian Springs Lake Estate LL	DAN ELLIS	DAVID BERNSEN
	Crystal Lake Estates Water System	DAN ELLIS	DAVID BERNSEN
	Pinwah Pines Water System	DAN ELLIS	DAVID BERNSEN
	Texas Landing Utility Company	DAN ELLIS	DAVID BERNSEN
San Jacinto	Cape Royale Utility District	DAN ELLIS	DAVID BERNSEN
	Holiday Shores 4 LL	DAN ELLIS	DAVID BERNSEN
Tarrant	White Settlement - City of	CHARLIE GEREN	DAVID SIBLEY
	Chart House Condominium	CHARLIE GEREN	JANE NELSON
	Ranch Oaks Subdivision	CHARLIE GEREN	JANE NELSON
Val Verde	San Pedro Canyon Water Co.	PETE GALLEGO	FRANK L. MADLA
Victoria	Arenosa Creek Estates	DAN ELLIS	STEVE OGDEN
Walker	Anns Water System 1	DAN ELLIS	STEVE OGDEN
	Emeraldwood D&S Water	DAN ELLIS	STEVE OGDEN
	Walker County Rural WSC System C	DAN ELLIS	STEVE OGDEN
	Lake Jackson Estates III	DAN ELLIS	STEVE OGDEN
Washington	Country Place Northwest	LOIS KOLKHORST	STEVE OGDEN
Wichita	Electra - City of	RICK HARDCASTLE	TOM HAYWOOD
Williamson	Liberty Hill Water Supply Corporation	MIKE KRUSEE	STEVE OGDEN
Wise	Rhome - City of	PHIL KING	DAVID SIBLEY
Zavala	Loma Alta Water System	TRACY KING	JUDITH ZAFFIRINI

Conclusions

Public drinking water systems are now faced with final regulations for radionuclides and must address health concerns for many citizens of Texas. Options for achieving compliance are limited to either finding an alternate source or to treat the water to lower the radionuclide concentration to acceptable levels. Alternate water supplies are not available at a reasonable cost in some parts of the state. Even where available, developing alternate sources or purchasing water from other systems may be more expensive than applying available treatment technologies. Treatment, however, is not an option if there are no rules to allow for disposal of the treated waste.

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