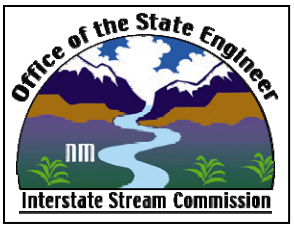

WELL PLUGGING HANDBOOK

June 2020

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New Mexico State Engineer

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Introduction

The New Mexico State Engineer is authorized by 72-2-8 NMSA to adopt rules establishing requirements for the plugging of wells*. The State Engineer adopted an updated version of such rules effective June 30, 2017. We received comments during the public hearing process requesting ways to expedite approval to plug a well. Therefore a goal of this handbook is in part to provide an expedited alternative. Public input on improvements to the handbook is appreciated and helpful when selecting additions to future versions. Public input may be emailed to nm.driller@state.nm.us.

The purpose of this handbook is also to provide a step-by-step guide to the plugging of a well in a manner that complies with 19.27.4 NMAC. The handbook describes the plugging process and provides a table of approved sealants and placement methods. Anticipated additions to future versions of the handbook include a FAQ section, definitions, and additional figures with detailed plugging methods for specific well and site characteristics.

The rules regarding well driller licensing; construction, repair and plugging of wells may be accessed via the Office of the State Engineer ("OSE") website at http://www.ose.state.nm.us/STST/wdRules.php. The rule is published in the New Mexico Administrative Code ("NMAC") as 19.27.4 NMAC. Rule requires the State Engineer give approval prior to plugging a well either by issuing a condition to plug on an OSE permit to drill a replacement well or by approval of a submitted plugging plan of operations ("plugging plan"). The entity filing the plan to plug the well must be the owner of record on file with the OSE.

*See definitions

The Well Plugging Process

Approval from the New Mexico State Engineer to plug a **non-artesian** well may be obtained only two ways, A) with a condition to plug on a replacement well permit or B) an approved well plugging plan (see Appendix A for the potential permit conditions you should be looking for on the permit). All **artesian** wells to be plugged require a plugging plan which must be signed by a well driller (see "Steps for filing a plugging plan of operations:" below).

A. Pre-Approved Condition to Plug on a Replacement Well Permit (Condition 6D): This is the most expedited process for receiving an approval to plug a well. The OSE may have already given approval to plug the replaced well, by placing this condition of approval on the permit to plug the well using the most stringent method which is located in the rule. When you are hired to replace a non-artesian well, ask to see the permit from the OSE before giving any quotations, as there may already be a permit condition to plug the replaced well that is pre-approved using the most stringent method. Condition 6D may not granted if the OSE has construction concerns or if the well is located in areas of known contamination or areas of highly mineralized water. Those wells will require the submittal of a plugging plan. If the driller wishes to use alternative methods or materials, they must submit a plugging plan requesting a variance. The plugging plan must be approved by the OSE prior to plugging the well. The plugging record will have the same due date as the well log for a replacement well or an Application for Permit to Change Location of a Well.

This pre-approved plugging condition does not affect the requirement to submit a plugging plan nor does it change the existing conditions for artesian wells, those wells at risk, replaced wells with a condition requiring submittal of a plugging plan or wells that may penetrate more than one aquifer that require a plugging plan, but it is an option for those smaller diameter wells or shallow wells that need to be plugged.

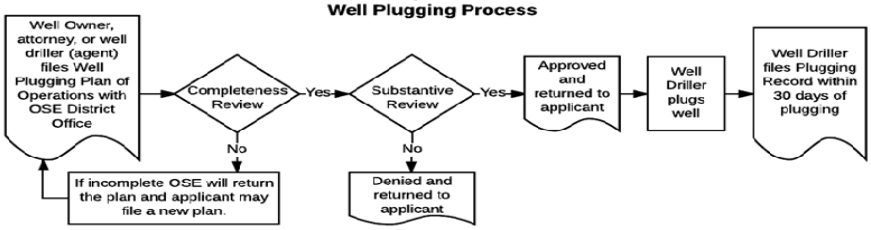
B. Approved Plugging Plan: You may need to plug a well that is not being replaced, or you have a permit that is lacking a pre-approved plugging condition 6D, and instead the permit has a Condition 6C requiring the submittal of a plugging plan of operations to be approved. The process to obtain approval to plug a well begins with the filing of a plugging plan (see Figure 1). Table 1 provides OSE guidelines that may be helpful when completing the form. When permitting a temporary use or short term well (most wells on form WR-07), consider submitting your plugging plan with the well permit application. Then when you are ready to begin the plugging you will already have an approved plugging plan saving you time. Within 30 days of well plugging submit Well Plugging Record WD-11. When plugging shallow wells with no construction or environmental concerns, and if the well record on a well to be plugged shows a proper 20 foot annular seal, a plugging plan can propose the use of clean fill material to a nominal 30 feet bgs, then placing an OSE approved sealant to surface. Lacking that information, we would require an excavation of at least 2-feet which shall then be filled in its entirety with sealant to surface.

For all wells, the well sealant shall be placed from the bottom of the well upwards to ground surface using a tremie; keeping the tremie pipe submerged in the sealant during the entire process. Any deviation from this process requires an approved variance from the OSE.

C. Collapsed or Blocked Casing: Every effort shall be made to free stuck pipe, pump equipment or any other blockage inside the well that is to be plugged. Wells that have been determined to have blockage and or collapsed casing throughout any section of the well, will require an approved Plugging Plan of Operations prior to plugging. Any well that has been determined to have "stuck" appurtenances such as, organic materials, submersible pump equipment and/or cable, downhole tooling, casing liner materials or any other material shall require an approved Plugging Plan of Operations and shall never be plugged using a Permit Condition 6D. Based on the characteristics and construction of the well, a a more stringent approach may be required to gain full access to this type of well, prior to plugging.

D. Contaminated Wells: A known contaminated well or well encountering contaminated water or soil shall not be plugged without an approved Plugging Plan of Operations and shall never be plugged using a Permit Condition 6D. Approved sealants for contaminated wells will be determined by the type of contamination on a case by case basis. Refer to §19.27.4.30.C(2) NMAC for more information regarding contaminated wells.

Figure 1
Well Plugging Process



Steps for filing a plugging plan of operations:

1. After the well plugging plan of operations is filed, the OSE will perform a completeness review of the plan. The completeness review determines whether all required information has been submitted. If the plan is incomplete, the OSE will contact the applicant or the driller to attempt to resolve the deficiencies. If the OSE does not receive the needed information, the plan may be returned un-approved or deny the plan.

2. If the plan is complete, the OSE will perform a substantive review to determine whether the proposed plugging methods and sealants are appropriate for the well and site characteristics. During this review process the OSE may contact the well owner or the well driller to request additional information or discuss modifications to the proposed plugging plan, if necessary.

3. Once the plugging plan is approved and the driller receives a copy, the well plugging may commence.

4. Within 30 days after a well is plugged, the well driller is required to file a complete plugging record Form WD-11 with the OSE and the permit holder. The plugging record describes the actual methods and sealants used to plug the well. If the well owner or well driller has any questions it is recommended that they contact the OSE. OSE staff will answer any questions.

The current version of the form must be used. If the well owner is not the land owner, then prior access approval from the owner of the land may be required. Plugging plan forms may be obtained from the OSE District Offices located in Albuquerque, Roswell, Deming, Las Cruces, Aztec, Santa Fe and Cimarron or on the OSE website at http://www.ose.state.nm.us/Statewide/wdForms.php.

Bluewater, Estancia, Gallup, Middle Rio Grande, Northern Tularosa, and Sandia Basins
District 1: 5550 San Antonio Dr. NE , Albuquerque, NM 87109 Phone # 505-383-4000

Capitan, Carlsbad, Casey Lingo, Curry County, Fort Sumner, Hagerman Canal, Hondo, Jal, Lea County, Peñasco, Roswell-Artesian, and Portales Basins
District 2: 1900 West Second St., Roswell, NM 88201 Phone # 575-622-6521

Animas, Cloverdale, Gila-San Francisco, Hachita, Lordsburg Valley, Mimbres, Mount Riley, Nutt-Hockett, Playas, San Simon, Virden Valley, and Yaqui Basins
District 3: 321 W. Spruce St., Deming, NM 88030, P.O. Box 844, Deming, NM 88031 Phone # 575-546-2851

Lower Rio Grande, Southern Tularosa, Hueco, Las Animas Creek, Salt, and Hot Springs Basins
District 4: 1680 Hickory Loop, Suite J, Las Cruces, NM 88005. Phone # 575-524-6161

San Juan Basin
District 5: 100 Gossett Drive, Suite A, Aztec, NM 87410 Phone # 505-383-4571

Northern Rio Grande and Upper Pecos Basins
District 6: P.O. Box 25102, Santa Fe, NM 87504-5102 Phone # 505-827-6120

Canadian River, Clayton, and Tucumcari Basins
District 7: P.O. Box 481, 301 East 9th Street, Cimarron, NM 87714 Phone # 575-376-2918

Highly Mineralized Water:
Mixing your sealants using highly mineralized groundwater will inhibit the sealant's hydration process. Mixing water needs to be cool, clean fresh water, free of oil soluble chemicals, organic material, alkalis, sulphates and other contaminates. Select sealants that are appropriate when plugging a well that has a standing column of mineralized groundwater. Cement based sealants can be altered with additives to reduce hydration time, strengthen the sealant, compensate for shrinkage, and have higher resistance to sulphate rich environments. Consult your supplier to assist with the sealant selection when plugging wells in areas of highly mineralized water.

Mixing and Placing Sealants:
When mixing a grout, it is important to follow the manufacturer's specifications using clean water, so as not to interfere with the reaction needed to make a slurry. If excess hardness is present in mixing water, the polymers or bentonite may clump and adhere to paddles during mixing phase. If the mixing water has a high pH or high level of total dissolved solids, it may cause cement based sealants to hydrate slowly and/or fail to set. Additives such as soda ash may be used to equilibrate pH prior to mixing sealants. Follow manufactures recommendations when using these types of additives. Improper water to cement ratios may also cause excessive shrinkage of the sealant.

Bentonite sealant products are available in various forms such as powder, granules, pellets and chips. Powder or granules should not be poured or dropped dry through a column of standing water. Pellets and chips hydrate more slowly so may be poured or dropped through a column of standing water; pellets may be poured or dropped dry through a column of standing water. Placing chips of pellets in a viscous fluid such as a polymer/bentonite based drilling fluid dramatically retards the fall time and increases the possibility for bridging.

The use of up to 6% pure bentonite powder ("90 barrel yield") as an additive in cement is allowed under NMOSE/AWWA guidelines. Neither granular bentonite nor extended yield bentonite shall be mixed with cement.

When supplementing a cement slurry with bentonite powder as requested, water demand for the mix increases at a rate of 0.65 gallons of water for each 1% increment of bentonite bdwc (by dry weight cement) above fundamental water demand of 5.2 gallons water per 94-lb. sack of cement. A 5% bentonite/cement slurry may therefore contain up to 8.5 gallons of water <u>total</u> per 94-lb. sack of cement / approximate 5-lb. bentonite increment, provided appropriate mixing order is maintained. The bentonite shall be properly hydrated separately with its required increment of water, prior to being added into the cement mixture. If water is otherwise added to the combination of dry ingredients or the

OFFICE OF THE STATE ENGINEER SEALANT GUIDELINES FOR WELL CONSTRUCTION AND PLUGGING

(FOR USE IN NON-CONTAMINATED CONDITIONS)

				APPLICATION										
				Non-Artesian (Unconfined) Well			Artesian (Confined) Well					Special Conditions		
	SEALANT	HYDRATION REQUIREMENT	PLACEMENT METHOD	Plugging	Annular Seal	Surface Casing	Plugging (Non-flowing)	Plugging (Flowing)	Annular Seal (Non-flowing)	Annular Seal (Flowing)	Surface Casing	Dry Borehole (Upper 10 feet sealant; drill cuttings or clean native fill below)	Ground Source Heat Pump
MATERIALS & METHODS	Bentonite Chips*	Fresh water to be added above water column at rate of 5 gallons per 50-lb. sack/bucket	Pour < 20' and dry	√	√	√	√				*Variance Only*	√	
			Tremie	√	√	√	√		√			√	
	Bentonite Pellets*	Fresh water to be added above water column at rate of 5 gallons per 50-lb. sack/bucket	Pour < 20' and dry	√	√	√	√				*Variance Only*	√	
			Tremie	√	√	√	√		√			√	
	Time Release Bentonite Pellets*	Fresh water to be added above water column at rate of 5 gallons per 50-lb. sack/bucket	Pour < 20' and wet	√	√	√	√				*Variance Only*	√	
			Tremie	√	√	√	√		√			√	
	High-Solids Bentonite Grout	Manufacturers' mixing ratios to attain minimum 20% active solids by weight	Tremie	√	√	√	√		√		*Variance Only*	√	
	Neat Cement Slurry** (type I or II portland cement)	No more than 6.0 gallons water per 94-lb. sack portland cement	Tremie	√	√	√	√	√	√	√	√	√	√
			Pressure Grout		√	√			√	√	√		
	Cement-Bentonite Slurry** (type I or II portland cement plus bentonite powder)	Maximum 5.2 gallons water per 94-lb. sack portland cement **PLUS** 0.65 gallon per 1% increase in bentonite up to maximum 6% bentonite by dry weight ratio. Bentonite must be hydrated separately and then mixed.	Tremie	√	√	√	√		√	√	√	√	√
			Pressure Grout		√	√			√	√	√		
	Sand-Cement Grout** (maximum 1 part sand to 1 part portland cement by dry weight ratio)	No more than 6.0 gallons water to 94-lb. sack portland cement. Ok to moisten sand before mixing.	Tremie	√	√	√	√		√	√	√	√	√
			Pressure Grout		√	√			√	√	√		
	Thermally-Enhanced Grout	Manufacturers' mixing ratios to attain minimum 20% active solids by weight. Addition of fine sand not in excess of 400-lb per 50-lb sack of bentonite. Permeability must remain less than 10^{-7} cm/sec.	Tremie	√	√	√						√	√
	Stratified			*Request Variance*									
	Additives			*Describe and Request on Plan*									

I hereby approve the above sealant guidelines for well construction and plugging this 9th *day of* June *2020.*

John T. Romero, P.E., WRAP/WR Director

*Groundwater concentrations of chloride and hardness are limited.

**Groundwater concentrations of sulfates are limited.

References

1. Arizona Department of Water Resources, 2008, Well Abandonment Handbook, 32 pp.
2. Ontario Canada Environmental Monitoring and Reporting Branch, Revised April 2015 Water Supply Wells: Requirements and Best Practices, Chapter 7
3. New Mexico Well Driller Licencing; Construcion, Repair and Plugging of Wells, NMAC 19.27.4
4. AWWA Standards ANSI/AWWA A100-06

Definitions

Artesian well: A well that penetrates a saturated hydrogeologic unit and allows underground water to rise or move appreciably into another hydrogeologic unit, or allows underground water to rise to freely flow at the ground surface. For regulatory purposes, the determination of whether a well or borehole is artesian shall be made by the state engineer, taking into consideration the potential for loss of water at the ground surface or into another hydrogeologic unit.

Well: A borehole, cased, uncased or screened, or other hydraulic structure that is drilled, driven, or dug, vertically, horizontally, or at an angle, that penetrates, is intended to penetrate, or otherwise affects the water stored in a saturated hydrogeologic unit. The intended use may be: water supply; monitoring water levels or water quality; exploratory purposes; water remediation; injection of water, both into saturated and unsaturated zones; dewatering purposes; ground source heat pump purposes, or for other purposes.

Well driller: A person subject to the licensing requirements of 72-12-12 through 72-12-17 NMSA 1978 and 19.27.4 NMAC.

Well drilling, well drilling activities: The activities associated with the drilling of a well, including, but not limited to, the construction, drilling, completion, repair, deepening, cleaning, and plugging of a well.

Appendix A – Possible Conditions on Replacement Well Permits

(Pre-approved plugging condition) Permit Condition 6D:

Well [OSE POD Number] shall be plugged completely using the following method per Rules and Regulations Governing Well Driller Licensing, Construction, Repair and Plugging of Wells; 19.27.4.30.C unless an alternative plugging method is proposed by the well owner and approved by the State Engineer.

All pumping appurtenance shall be removed from the well prior to plugging.

To plug a well, the entire well shall be filled from the bottom upwards to ground surface using a tremie pipe. The bottom of the tremie shall remain submerged in the sealant throughout the entire sealing process; other placement methods may be acceptable and approved by the state engineer. The well shall be plugged with an office of the state engineer approved sealant for use in the plugging of non-artesian wells.

The well driller shall cut the casing off at least four (4) feet below ground surface and fill the open hole with at least two vertical feet of approved sealant. The driller must fill or cover any open annulus with sealant. Once the sealant has cured, the well driller or well owner may cover the seal with soil.

A plugging record for said well shall be filed with the Office of the State Engineer in a District Office within 30 days of completion of the plugging, but no later than [date the well log is due].

(Plugging Plan of Operations required) Permit Condition 6C:

Upon completion of the new well, the replaced well shall be plugged. The well driller shall file a plugging plan for the replaced well with and it shall be approved by the Office of the State Engineer prior to plugging. The well driller shall file the Plugging Record with the appropriate district office and the applicant within 30 days of completion of plugging of the well but no later than [date the well log is due].

(For Wells that do not encounter water) Permit Condition 6E:

Wells that do not encounter a water bearing stratum shall be immediately plugged by filling the well with drill cuttings or clean native fill to within ten (10) feet of land surface and by plugging the remaining ten (10) feet of the well to land surface with a plug of a sealing material approved by the State Engineer.