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Standard Practice for Monitoring Well Protection[1]

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INTRODUCTION

This practice for monitoring well protection is provided to promote durable and reliable protection of installed monitoring wells against natural and man caused damage. The practices contained promote the development and planning of monitoring well protection during the design and installation stage.

1. Scope

1.1 This practice identifies design and construction considerations to be applied to monitoring wells for protection from natural and man caused damage or impacts.

1.2 The installation and development of a well is a costly and detailed activity with the goal of providing representative samples and data throughout the design life of the well. Damages to the well at the surface frequently result in loss of the well or changes in the data. This standard provides for access control so that tampering with the installation should be evident. The design and installation of appropriate surface protection will mitigate the likelihood of damage or loss.

1.3 This practice may be applied to other surface or subsurface monitoring device locations, such as piezometers, permeameters, temperature or moisture monitors, or seismic devices to provide protection.

1.4 *This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 150 Specification for Portland Cement[2]

C 294 Descriptive Nomenclature of Constituents of Natural Mineral Aggregates[3]

D 5092 Design and Installation of Ground Water Monitoring Wells in Aquifers[4]

3. Terminology

3.1 *Definitions:*

3.1.1 *barrier*—any device that physically prevents access or damage to an area.

3.1.2 *barrier markers*—plastic, or metal posts, often in bright colors, placed around a monitoring well to aid in identifying or locating the well.

3.1.3 *barrier posts*—steel pipe, typically from 4 to 12 inches in diameter and normally filled with concrete or grout that are placed around a well location to protect the well from physical damage, such as from vehicles.

3.1.4 *borehole*—a circular open or uncased subsurface hole created by drilling.

3.1.5 *casing*—pipe, finished in sections with either threaded connections or bevelled edges to be field welded, which is installed temporarily or permanently to counteract caving, to advance the borehole, or to isolate the zone being monitored, or a combination thereof.

3.1.6 *casing, protective*—a section of larger diameter pipe that is emplaced over the upper end of a smaller diameter monitoring well riser or casing to provide structural protection to the well and restrict unauthorized access into the well.

3.1.7 *riser*—the pipe extending from the well screen to or above the ground surface.

3.1.8 *sealed cap*—a sealable riser cap, normally gasketed or sealed, that is designed to prevent water or other substances from entering into, or out of the well riser.

3.1.9 *vented cap*—a cap with a small hole that is installed on top of the riser.

4. Significance and Use

4.1 An adequately designed and installed surface protection

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[1] This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.21 on Ground Water and Vadose Zone Investigations.

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[2] *Annual Book of ASTM Standards,* Vol 04.01.

[3] *Annual Book of ASTM Standards,* Vol 04.02.

[4] *Annual Book of ASTM Standards,* Vol 04.08.

system will mitigate the consequences of naturally or man caused damages which could otherwise occur and result in either changes to the data, or complete loss of the monitoring well.

4.2 The extent of application of this practice may depend upon the importance of the monitoring data, cost of monitoring well replacement, expected or design life of the monitoring well, the presence or absence of potential risks, and setting or location of the well.

4.3 Monitoring well surface protection should be a part of the well design process, and installation of the protective system should be completed at the time of monitoring well installation and development.

4.4 Information determined at the time of installation of the protective system will form a baseline for future monitoring well inspection and maintenance. Additionally, elements of the protection system will satisfy some regulatory requirements such as for protection of near surface ground water and well identification.

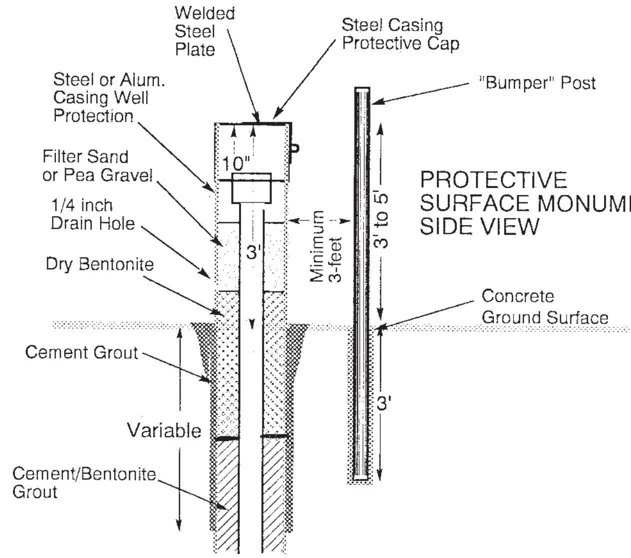

FIG. 1 Example of Protective Design

5. Design Considerations

5.1 The design of a monitoring well protective system is like other design processes, where the input considerations are determined and the design output seeks to remedy or mitigate the negative possibilities, while taking advantage of the site characteristics.

5.2 The factors identified in this practice should be considered during the design of the monitoring well protective system. The final design should be included in the monitoring well design and installation documentation and be completed and verified during the final completion and development of the well.

5.3 In determining the level or degree of protection required, the costs and consequences, such as loss of data or replacement of the well, must be weighed against the probability of occurrence and the desired life of the well. For monitoring wells which will be used to obtain data over a short time period, the protection system may be minimal. For wells which are expected to be used for an indefinite period, are in a vulnerable location, and for which the costs of lost data could be high, the protective system should be extensive. Factors to consider and methods of mitigating them are presented in the following sections.

5.3.1 *Impact Damages*—Physical damages resulting from construction equipment, livestock, or vehicles striking the monitoring well casing frequently occur. Protective devices and approaches include:

5.3.1.1 Extra heavy protective casings with a reinforced concrete apron extending several feet around the casing may be an acceptable design in those areas where frost heave is not a problem. The principle behind this is to design the protective casing so that it will be able to withstand the impact of vehicles without damage to the riser within.

5.3.1.2 Barrier Posts placed in an array such that any anticipated vehicle can not pass between them to strike the protective casing. Barrier posts are typically filled with concrete and set in post holes several feet deep which are backfilled with concrete. Barrier posts typically extend from 3 to 5 feet above the ground surface. Barrier posts are frequently used in and around industrial or high vehicle traffic areas. Costs for installation can be substantial however they provide a high degree of protection for exposed wells. Cost of removal at decommissioning can also be substantial.

NOTE 1—Cattle frequently rub against above ground completions leading to damage of unprotected casings. Concrete filled posts or driven T-posts, wrapped with barbed wire, are frequently used.

5.3.1.3 Barrier Markers are relatively lightweight metal or often plastic posts which provide minimal impact resistance but which by their color, location, and height, warn individuals of the well presence. The use of barrier markers is effective in areas that are well protected from impact type damage by other features, such as surrounding structures or fences. They are relatively inexpensive to install.

5.3.1.4 *Signs*—An inexpensive means of identifying the presence of a monitoring well. Signs provide protection only by warning of the well presence. Signs may be required in some circumstances and appropriate in others. Wells known to contain hazardous, radioactive, or explosive compounds should be marked to warn sampling personnel of potential dangers. When a potential exists for water usage, signage indicating that the water is non-potable and is utilized strictly as a monitoring well, and not for any other purpose, may be appropriate. Disadvantages of signs are that they may be ignored, are often difficult to maintain, and may invite vandalism to the well.

5.3.1.5 Recessed or Subsurface casings may be used to mitigate impact damage by allowing the vehicles to pass over.

Frequently used techniques include recessing the casing below ground level, using commercially available covers. These may take the form of valve pits or manholes, as examples. Advantages include both protecting the well while minimizing the interference to surface traffic, such as in parking lots or urban areas and screening the well from view. Using this technique, wells may be located in the most desired locations from a ground-water monitoring perspective. Disadvantages include the need to assure surface drainage does not enter the well riser, either by maintaining positive drainage or by using a sealed riser cap (or both). When the risk is from the influx of surface water, drains below the level of the riser should be installed. In extreme cases, such as in location with high ground-water levels or potential drainage from surrounding areas, automatic sump pumps may be required. Consideration should be given to the sampling personnel who will require adequate space to perform sampling, particularly in manhole situations. Additionally, personnel protection requirements from working in a confined space should be considered.

5.3.1.6 Fencing, such as commercial chainlink type fences may provide adequate protection in areas with light risk from vehicles, but where people or animals may interfere or affect the well. Advantages are relative minimal costs, ease of removal or opening. Disadvantages include maintenance, adequacy of protection from hard vehicle impacts, and visual and traffic interference.

5.3.2 *Vandalism*—Damage from vandals can take two forms, those which seek to damage or destroy the well itself, and those which intend to damage the data that the well may provide. Theft of sampling pumps, loss of access to the riser, plugging of the well with foreign debris, or injection of foreign materials or chemicals are potential results of vandalism.

5.3.2.1 Physical damage to the well can be minimized with many of the same techniques as used to protect the well from impact damages. Generally two techniques can be used to protect a well from physical damage, one, by hiding or camouflaging the well, the other by constructing the surface protection of the well with multiple physical barriers. Hiding or camouflaging the well utilizes the philosophy that what can't be found can't be damaged. Camouflage techniques include enclosing the well in manholes or sumps, planting shrubs or vegetation to shield the well from view, enclosing the well in another structure, such as inside a raised planter or a small shed. Color characteristics of the above ground can be used to disguise the well or to assist in making it blend into the surroundings. Costs for camouflage can vary widely, but are generally minimal when included with other protections. Disadvantages are that if found, the well is still susceptible to damage by vandals, that damage may be undetected, and that sampling personnel not familiar with the well may have difficulty locating it.

5.3.2.2 Protection from vandalism is generally achieved by constructing multiple physical barriers. The first barrier should always include a rugged protective casing with a locking cap or lid. The lock quality can vary from relatively inexpensive and easily broken types to more costly high security type locks. Locks used on wells are subject to weather, dirt and deterioration. Frequently locks must be cut if not regularly maintained and the design and selection of the cap and lock should include this consideration. Construction of the hasps, locking lugs, or other mechanisms should be rugged, made of metal and welded to prevent access to the casing by prying, hammering or other typical vandalism. The casing should be heavy enough to resist penetration by bullets in areas where shooting may occur. A concrete apron or grout collar around the casing will provide mass to defeat attempts to pull the casing upwards, or sideways. Additional physical barriers should be added in consideration of the location and likelihood of vandalism. These include locked chainlink fences, use of barbed or concertina wire, concrete walls, or enclosure inside of buildings or other fenced or enclosed areas. When placed in below ground level structures, such as sumps or manholes, the access covers can be equipped with a lock. Access to keys should be controlled to prevent unauthorized use and entry.

5.3.2.3 Protection of the well and the data, (for example, ground-water level elevations), that the well will provide can be generally achieved by the physical barriers previously described. Detection of access to a well should also be considered. While not protecting the well and the sample data directly, it will be valuable in evaluating the data derived from the well samples. Sampling personnel should be alert and inspect the well and the protective devices for signs of vandalism. Foil or paper seals can be applied to the riser and cap at the end of each sampling to allow visual verification that the riser cap has not been disturbed between samplings. Seals are inexpensive and provide assurance of the well integrity and should be considered for use on all wells.

5.3.3 *Landslides*—Movement of the surface layers of soil due to seismic activity or other changes can result in lateral movement with the riser being bent or ultimately sheared. The primary protection against this type of damage is location. Whenever possible, the well should be located outside of the slide area. When relocation is not possible and the moving soil layer is relatively thin, limited protection may be achieved by extending the protective casing several feet below the shear line. Additional protection may be gained by driving piling or posts through the surface layer and below the shear line to anchor the surface. Protection and maintenance of wells in slide areas can be expensive and may result in only delaying the loss of the well.

5.3.4 *Freeze Damage*—Freezing of the ground surrounding a well riser can result in heaving which can sever the riser resulting in the loss of the well. In areas where extended freezing temperatures are expected, the well protective casing should be constructed to minimize the possibility of damage. The protective casing should extend several feet below the frost line and the space between the well riser and the protective casing should be filled with a granular, free draining fine gravel down to the ground surface elevation and the bentonite below the gravel. Alternative designs in frost heave problem areas use a tapered concrete collar preferable to a 4-in. concrete pad. This will allow vertical movement of the protective casing and apron or collar without placing stress on the riser. The casing should have drain holes at several locations and heights to allow any water that may accumulate to drain freely. In areas where freezing occurs, the top of riser elevation and casing or concrete apron should be periodically checked to verify if movement has occurred. This will also allow for correction of ground water levels measured from the surface reference points.

5.3.5 *Floods*—Flood waters provide opportunities for physical damage to the well and to the integrity of the data that the well may provide. Wells located in low areas, floodplains, or areas where there is a potential for ponding of water should consider protection from physical damage and infiltration. Physical damage is generally mitigated by the protective devices described previously. Infiltration of water into the well from flooding can affect the data that will be derived from the well samples. It can also serve as a pathway for surface contaminants to reach the ground water. When flood or ponding surface waters are a possibility, the riser should be extended above an anticipated water level, such as the 100 year flood level. Additionally, a sealed cap capable of preventing leakage should be considered. If extending the riser is not possible or desirable, the riser cap should be sealable and capable of withstanding the anticipated head pressures that the site may experience.

NOTE 2—Where a sealed cap is used to prevent surface water from entering a well, it can also impede the vertical movement of water in the well casing, thus affecting the accuracy of the water level measurements.

5.3.6 *Elevation Changes*—Frequently wells are placed in locations where the surface elevations are expected to change, such as in landfills, borrow areas, or construction fill areas. Design of the well surface protection should take these changes into consideration. In areas where the surface elevation will be raised to a known level, the riser and casing should be extended to above the expected level. A second concrete collar and surface protection system can be put into place at that time. When the elevation change was not anticipated or known, the protection of the well and casing during the change should be carefully planned to protect the well riser from damage. Damage can occur due to equipment impacts, shearing of slopes, having the riser and casing buried, or falling over when surrounding soils are removed. Elevations before the change should be known. Elevations should be re-established at the completion and included in the well history records. Costs for protecting a well during elevation changes are minimal and less than the cost of replacing a well that was badly damaged or lost.

5.4 *Signage*—External signs provide a means of economical administrative control. Signs can protect the well from damage or accidental extraction by informing personnel of the well's purpose for providing ground-water data. Signs also have the negative aspect of informing vandals and others of the well's presence. The use of signs should consider the benefits and disadvantages of identifying the well. Signs may be required by regulation, to identify the owner, permit identifications, location identification, date of installation, and other information.

5.4.1 Internal signs or tagging may also be placed inside the protective casing, an attached locking cap, or other structures to provide information to the sampling personnel and to prevent inadvertent errors, such as sampling the wrong wells. Signs, or tags may also inform the samplers of relevant information or requirements, such as recording the total volume of water extracted, or other information such as the well elevation, chemical or other hazards, explosive potential, or required safety precautions. Signs or tags used for identification should be positively attached inside the individual well protective casing. When several well risers are clustered inside a single protective casing, the identification should be affixed to the riser, rather than the cap to prevent inadvertent misidentification.

5.5 *Decommissioning*—If the well is to be used only for a limited period, the ease or difficulty and costs of removing the surface protective devices should be considered along with the need to protect the well while in use. In cases where the surface or surrounding soils may become contaminated by materials extracted from the well, preventative protection should be considered, such as placing liners below the soil surface, and concrete cap, using raised berms, and protective coatings on the metal and concrete surfaces. These will prevent the spread of contamination, should it occur, and will minimize the amount of material that must be decontaminated or removed at the time of cleanup or decommissioning.

6. Records and Reports

6.1 *Well Design Considerations*—Surface protection, including signs, labeling, barriers, and other details should be included in the well design documentation. Other information, such as the initial survey elevations at the time of well completion and asbuilt configuration should also be included as baseline information that can be referred to during the life of the well and for use during the decommissioning. The design information should be updated as new information becomes available. Such information may include periodic elevation surveys, records or changes to the surface devices, changes in surrounding grade or land uses, and the like.

6.2 *Well Condition Checklists*—Checklists for use during the life of the well should be developed during the design stage to insure that the well protective devices are maintained throughout the life of the well. These checklists should be completed whenever the well is sampled or in a predefined inspection schedule. Needed repairs to the surface protective devices should be recorded and accomplished to maintain the well protection. Any damage, or suspected intrusions into the well should be recorded. This information may be useful during evaluation of the well sample data, particularly when unauthorized spiking or tampering is suspected.

6.3 *Repair/Maintenance History*—Any maintenance performed, including the costs, should be included in the well documentation.

7. Keywords

7.1 ground water; surface protection; well damage; well protection; well vandalism