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September 15, 2016

**Via Electronic Mail**

Ms. Andrea Kock, Deputy Director  
Decommissioning and Uranium Recovery Licensing Directorate  
Division of Waste Management and Environmental Protection  
Office of Federal and State Materials and Environmental Management Programs  
U.S. Nuclear Regulatory Commission  
11545 Rockville Pike  
Rockville, MD 20852-2738

Dear Ms. Kock:

**Subject: Sweetwater Uranium Project – Docket Number: 40-8584  
Source Material License SUA-1350 - Sweetwater County, Wyoming -  
Characterization Plan- Extent Of Groundwater Contamination**

The U.S. Nuclear Regulatory Commission (NRC) is conducting a review of the Kennecott Uranium Company (Kennecott) Sweetwater Uranium Project request for a ten-year renewal of Source Material License SUA-1350 that was submitted on July 24, 2014. The NRC provided Requests for Additional Information (RAIs) in letters dated July 13, 2015 and February 12, 2016. On August 18, 2016, a public conference call involving Kennecott and the agency was held to discuss specific license conditions that will be modified as part of the license renewal process. A letter dated August 25, 2016 entitled *Draft Renewal Materials License, Sweetwater Uranium Project; Sweetwater County, Wyoming* was received following the conference call. This letter contained draft language for License Conditions 9.10, 11.3 and 11.4. In partial response to this letter, specifically to the item entitled License Condition 11.3, Kennecott provided a letter dated September 1, 2016 that committed to provide a characterization plan for the groundwater plume by Friday, September 16, 2016 for agency review.

Attached please find *Attachment 1- Characterization Plan Extent Of Groundwater Contamination* for review.

If you have any questions please do not hesitate to contact me.

Sincerely yours,



Oscar Paulson  
Facility Supervisor

Cc: James Webb – Project Manager – (2)  
Director – USNRC DNMS – Region IV (w/o enc.)  
Rich Atkinson

NM5520  
NM55

**ATTACHMENT 1**

**CHARACTERIZATION PLAN**

**EXTENT OF GROUNDWATER CONTAMINATION**

**OVERVIEW**

This attachment presents a plan for Kennecott Uranium Company (Kennecott) to characterize the extent of groundwater contamination at the Sweetwater Uranium Project. The contaminated groundwater is in the Battle Spring Aquifer and is the result of releases of mill process fluids, from the catchment basin and/or the existing tailings impoundment, which occurred during operations (1981 to 1983) prior to Kennecott's acquisition of the facility,

In a letter dated August 25, 2016, the NRC stated,

*“NRC staff is therefore requiring the licensee to fully characterize the current extent of groundwater contamination and provide a revised corrective action plan (CAP) to bring the groundwater into compliance with the groundwater standards.” ... “The revised CAP shall propose acceptable methods to achieve and demonstrate compliance for those parameters in exceedance of the corresponding groundwater protection standard and also include a time limit to reach compliance.”*

**BACKGROUND**

Facility operations by the previous site licensee (Minerals Exploration Company, a wholly owned subsidiary of Union Oil Company of California (UNOCAL)) resulted in fluids from mill operations entering the Battle Spring Aquifer through the unlined bottom of the catchment basin and from leaks in the tailings impoundment's single Hypalon® liner. These process fluid-influenced waters have resulted in a relatively small portion of the aquifer with water quality parameters measurably above background levels.

Kennecott operates the CAP to contain, control and monitor the extent of the groundwater contaminants as well as to remove contaminants from the aquifer. Every year Kennecott monitors and reports on the mass of salts removed from the aquifer above expected background levels. This analysis shows that considerable mass has been removed from the aquifer. The CAP includes pumpback wells to recapture mill-influenced fluids and maintain a cone of depression containing the plume, and monitoring wells which allow evaluation of the groundwater (including water levels and quality) and efficacy of the CAP.

The areal extent of the groundwater contamination has been influenced by local and regional groundwater flow paths, which have changed over time. Prior to site operations, the long-term regional groundwater gradient was toward the southwest. During mill operations the open pit mine was dewatered via a ring of wells creating a large cone of depression and a localized groundwater gradient. This artificial gradient influenced the groundwater flow direction to the northwest in the mill vicinity.

When the mill ceased operation and went into standby on April 15, 1983, pit dewatering ceased on April 25, 1983, and the localized groundwater gradient to the northwest began to dissipate. The open pit slowly filled, reaching steady state as an evaporative sink by 1998. The water elevation in the pit annually fluctuates between approximately 6539 to 6540 feet above mean sea level (NGVD 29). The flooded open pit remains an evaporative sink with the elevation of the water being approximately 1.5 to 2.0 feet below the elevation of the water in the surrounding Battle Spring Aquifer.

Additionally, operation of the pumpback wells under the CAP, which has been ongoing since 1986, has formed a capture cone that creates short-term localized effects on groundwater flow paths. This capture cone creates a localized flow path in the vicinity of the tailings impoundment and mill toward the pumpback wells shown in Figure 1.

Mill process fluids were first introduced into the Battle Spring Aquifer in 1981 from the catchment basin and in 1983 to 1984 from the tailings impoundment. Flow paths in the mill and tailings impoundment vicinity have changed over time, from the natural southwest flow direction, to a northwesterly influence during pit dewatering and for some time thereafter, and then toward pumpback wells over the last 30 years. Monitoring wells are numerous near the tailings impoundment and immediately east of the mill building around the now remediated catchment basin. However, monitoring wells west of the mill are fewer in number. Plots of constituent concentrations in the groundwater (combined radium-226/228, natural uranium, and sulfate, for example) based on existing wells including TMWs-108 and 109 indicate that elevated levels of these constituents persist to the west of the mill building.

The Sweetwater Pit is located in a natural uranium deposit, and thus naturally high levels of natural uranium, radium-226, selenium and other associated constituents to the west of the mill are to be expected. Pit closure and reclamation (including bioremediation of the 1.2 billion gallons of water in the pit lake) has resulted in a lake with a stable water surface elevation resulting in a local groundwater sink. As a result, groundwater flow paths near the pit point toward the pit lake. It is essential that any characterization plan consider the various local and regional influences on groundwater flow and quality in the mill and tailings impoundment vicinity. This is especially true west of the mill because of the presence of naturally high background concentrations of radionuclides.

Telesto completed a groundwater characterization report in 2009 which interpreted the groundwater hydrology and geochemistry in the vicinity of the groundwater plume. Telesto has also assisted Kennecott in the preparation of annual groundwater contour and constituent concentration mapping, and has prepared responses to two NRC Requests for Additional Information regarding the groundwater contamination and plume characteristics. These documents will be referenced in the characterization plan.

## **CHARACTERIZATION PLAN**

This document provides an approach to locate and complete monitoring wells and/or borings west of the mill facility, and north and east of the tailings impoundment. Groundwater and formation samples will be used to fully characterize the extent of groundwater contamination, and help determine influences of naturally occurring mineralization.

## ***Plan for Installation of Monitoring Wells***

### *Task 1 Data Review*

A preliminary review of existing groundwater quality data has been conducted to identify where the margins of existing groundwater contamination are not well defined. Three general areas have been identified (Figure 1):

- north of well TMW-89
- east of well TMW-36 between TMW-36 and TMW-5
- northwest, west and south of TMW 73

A more detailed review of groundwater quality data will be conducted to better locate drilling sites before drilling begins. This more detailed review will include additional groundwater sampling data gathered from project files or from recent sampling efforts by Kennecott including:

- sample data from dewatering wells operated between September 1979 and April 25, 1983
- other well samples from recently located data not previously included in the site groundwater database
- additional groundwater elevation data including data collected from the dewatering wells and the pit lake in fall 2015

Prior to conducting drilling operations, existing core will be examined for signs of natural uranium presence and movement in the Battle Spring Formation. This core was collected in 1996 by Shepherd Miller, Inc. as part of a site geotechnical evaluation for construction of a new tailings impoundment, and remains stored on site. This core can be analyzed for parameters that would not be affected by long exposure to air.

### *Task 2 Drilling and Sampling*

Hollow stem auger drilling will be the primary drilling method utilized to complete boreholes to determine the extent of groundwater contamination. If for any reason hollow stem auger drilling cannot be used, drilling methods that allow for satisfactory sample collection and borehole completion will be employed. Boreholes may vary in diameter and will be either completed as groundwater monitoring wells or used as test borings and abandoned in accordance with Wyoming State Engineer's Office Regulations and Instructions Part III Water Well Minimum Constructions Standards revised June 2011.

The water table is expected to be encountered at approximately 100 feet below ground surface in the proximity of the study area. The surface elevation and proximity to the CAP cone of depression will influence the depth to the water table. For the sake of consistency, boreholes that are to be completed as monitoring wells will be constructed in the same manner as recently

completed monitoring wells. Fifty feet of well screen will be installed across the water table with approximately five feet of screen above and 45 feet below the water table. Other completion configurations may be used as warranted by site specific conditions.

A split-spoon/SPT sampler will be used to collect at least two formation samples above the water table and two formation samples below the water table for each borehole. A fifth formation sample may be collected at the water table. The samples will be inspected and the lithology will be logged and described on site. Formation samples will be sent to a laboratory and tested for natural uranium, thorium-230, radium-226, metals, total organic carbon (TOC) and general chemical parameters resulting from whole rock and the Synthetic Precipitation Leaching Procedure (SPLP) tests. Field measurements will be performed on collected formation samples and will include paste pH and redox (oxidation) state using a standard platinum probe.

These data will be used to characterize the natural leaching/mobilization process of uranium and other constituents of concern resulting from percolating rainfall or snowmelt, fluctuating water table, and groundwater movement. These data will also be used to estimate the influence of localized and naturally occurring mineralization on groundwater quality, which likely result in elevated naturally occurring uranium concentrations in groundwater at the very top of the Battle Spring Aquifer.

Groundwater samples will be collected during the drilling process. The samples will be collected at approximately ten foot intervals below the water table from the inside of the hollow stem auger. Samples will be collected using a bailer or a small downhole submersible electric pump. Field analysis will be conducted for pH, redox potential, conductivity, total dissolved solids (TDS), total iron, ferrous iron ( $\text{Fe}^{+2}$ ), and sulfate. Larger quantities of selected groundwater samples will be collected, filtered, preserved and sent chilled to an analytical laboratory for additional analysis. Collection and handling of these samples will be performed in accordance with site Standard Operating Procedures (SOPs) EP-13 and EP-13B.

The purpose of this approach of real-time assessment of field data is to fine-tune the selection of well placement to generate the best data at reasonable cost. The formation and groundwater samples collected and field-analyzed during drilling will be used to determine if the well location and/or proposed 50 foot screened interval is appropriate for each well completion and if adjustments are required. The formation and groundwater samples will also be used in an initial estimation of the extent of the contaminant plumes. If the data obtained are useful, the boring will be completed as a monitoring well; however, if the data indicate the boring to be redundant, the borehole will be abandoned in accordance with the Wyoming State Engineer's Office Regulations and Instructions Part III Water Well Minimum Construction Standards revised June 2011. This field data collection and initial estimation of contamination extent will be used to determine where to locate additional drilling.

A minimum of six wells are planned; more may be drilled and completed as a result of the field data assessment. Two wells will initially be drilled to better define the extent of contamination north and east of the tailings impoundment associated with wells TMW 89 and TMW 36 respectively, to be supplemented with additional wells as necessary. TMW-89 has exceeded the Groundwater Protection Standard (GPS) for uranium and is unbounded to the North. TMW-36 exceeds the Groundwater Protection Standard (GPS) for uranium and while bounded to the East by TMW-5, the distance between the wells is over 1,000 feet creating uncertainty in that area. Two wells will initially be drilled west and south of TMW 73, to be supplemented with additional wells as necessary. Figure 1 depicts those areas targeted for initial drilling. An additional one to three borings may be drilled and abandoned while identifying the optimal locations to install monitoring wells.

Permits from the Office of the Wyoming State Engineer will not be required because these will be monitor wells that are four inches in diameter or under (see Attachment 1-A). Those completed within the area of Permit to Mine #481 will be included within that permit and their reclamation covered under the associated surety. Other wells will be completed within the NRC bonded area. Reclamation of these sites will be covered by the surety for Source Material License SUA-1350. It is expected that at least two of these wells will be on unpatented mill sites held by Kennecott Uranium Company but outside of lands held in fee. The Bureau of Land Management (BLM) has recently prepared a letter dated April 11, 2016 pursuant to 43 CFR 3809.400 concluding that Kennecott's recent submission of the Supplemental Environmental Report for the facility is accepted as complete. BLM notes that an archaeological survey is required prior to disturbing any un-surveyed areas.

The wells will be completed according to the Wyoming State Engineer's Office Regulations and Instructions, Part III, Water Well Minimum Construction Standards, revised June 2011. A well completion diagram is included in Attachment 1-B. Four-inch schedule 40 PVC pipe and casing will be used to construct the wells. No glued joints will be used as a measure to prevent hydrocarbon contamination. The annulus around the slotted pipe will be gravel- or sand-packed. The filter pack will continue at least six feet above the top of the well screen. At least five feet of bentonite chips will be placed above the gravel or sand pack. The annulus will be filled with neat cement according to the current Wyoming Department of Environmental Quality standards: Guideline 8, Hydrology, Coal and Non-Coal and Chapter 26, Well Construction Standards.

### *Task 3 Monitoring Well Data Collection*

The newly installed monitoring wells will be developed by bailing and/or jetting and airlifting. The wells will be allowed to sit for at least one week to allow sediments in the wells to settle prior to sampling.

Groundwater samples from the newly installed wells will be collected and analyzed monthly for a period of three months. At least three casing volumes will be pumped from the well prior to sample collection and the samples will be filtered, preserved and refrigerated on site, and sent chilled to an analytical laboratory for analysis. Collection and handling of these samples will be performed in accordance with Kennecott's Standard Operating Procedures (SOPs) EP-13 and EP-13B.

#### *Task 4 Data Analysis*

The data returned from the field and laboratory tests will be reviewed and evaluated. These data will be added to the site conceptual model, which will then be updated to fully characterize the groundwater flow field and extents of ground water contamination originating from mill operations. The conceptual model will include an updated description on the influence of naturally occurring mineralization (uranium in particular) on local groundwater quality.

The groundwater surface elevations of new wells will be evaluated in comparison to existing nearby wells and trends in the potentiometric surface. A potentiometric map using new and existing data will be prepared.

The formation chemistry results will be evaluated and assessed for the relative influence from mill fluids or from background geochemical conditions, in particular for natural uranium. The formation chemistry will be compared to the groundwater quality at each well.

#### *Task 5 Reporting*

New contaminant extent maps for constituents of concern will be prepared following data analysis, and a data analysis report will be submitted to the NRC for review. The data analysis report will also include analysis of local background groundwater quality. If the data evaluation determines it to be necessary, we will develop a revision to the background groundwater quality parameters developed and submitted in the Addendum to the Revised Environmental Report Background Ground Water Quality and Detection Standards (Shepherd Miller, Inc., January 23, 1996).

### ***Sampling Parameters and QA/QC***

The license, CAP, and sampling and analysis protocols established by Kennecott provide an already-proven definition of parameters to be sampled. The existing sampling and analysis QA/QC plan will be followed while monitoring the samples. Kennecott Environmental Procedures EP-13 and EP-13B will be followed during the sampling and analysis portion of this project. EP-13 describes the sampling and sample procedures and EP-13B describes the sampling and sample preparation procedures and water level measurement procedures.

### ***CAP Compliance and Time Limit***

Following review by NRC staff, the CAP may be modified based on the conclusions of the data analysis report and NRC comments. Per NRC comment, any CAP modification will be based on an approach and estimated schedule to achieve compliance with groundwater standards.

## Attachment 1-A

Policy Memo from the Wyoming State Engineer's Office, Permitting Requirements for Groundwater Monitoring Wells, March 12, 2013




## State Engineer's Office

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(307) 777-7354 FAX (307) 777-5451  
seoleg@seo.wyo.gov

MATTHEW H. MEAD  
GOVERNOR

PATRICK TYRRELL  
STATE ENGINEER

### POLICY MEMO: PERMITTING REQUIREMENTS FOR GROUNDWATER MONITORING WELLS

TO: State Engineer's Office  
FROM: Patrick T. Tyrrell, State Engineer   
DATE: March 12, 2013  
SUBJECT: Permitting requirements for groundwater monitoring wells

The State Engineer issued a Policy Memo, dated January 4, 2005, captioned "Policy Memo: Permitting Requirements for Groundwater Monitoring Wells".

Several questions have arisen recently as to whether the policy enunciated in that memo is still applicable to Wyoming's groundwater appropriators.

To the extent it may still be applicable, that policy memo is rescinded effective immediately, and is replaced with the following statement of policy:

#### Policy:

To streamline the permitting process and effectively utilize existing resources, the State Engineer's Office – Ground Water Division will no longer require monitoring wells to be permitted through the Division. This policy is effective immediately.

#### Justification:

A water right is a right to use the water of the state, when such use has been acquired by the beneficial application of water under the laws of the state relating thereto, and in conformity with the rules and regulations dependent thereon. W.S. § 41-3-101 states, in part, that beneficial use shall be the basis, the measure and limit of the right to use water at all times. In general, monitoring wells are used to measure water levels and/or collect water samples for analytical purposes. Monitor wells are not used for production of water for beneficial use.

Surface Water  
(307) 777-6475

Ground Water  
(307) 777-6163

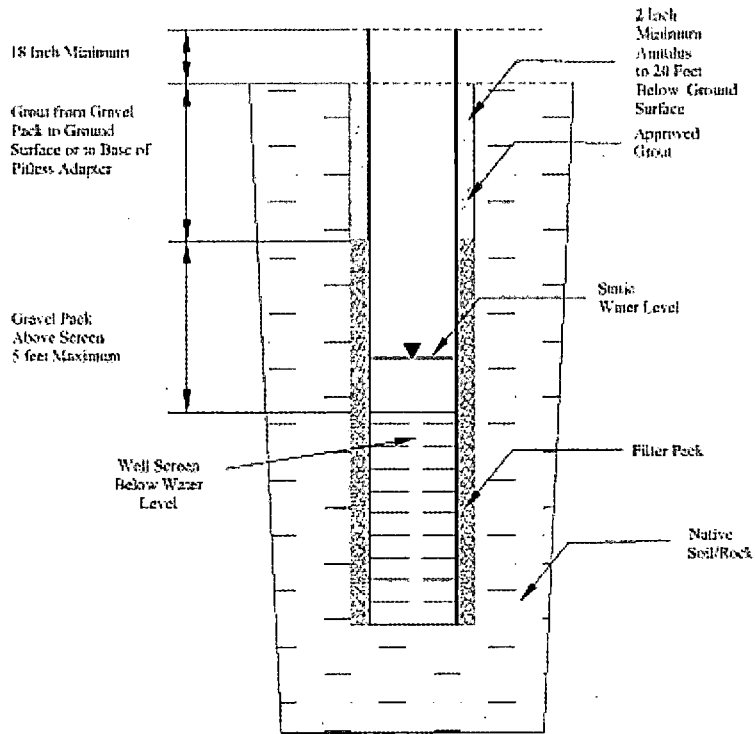
Board of Control  
(307) 777-6178



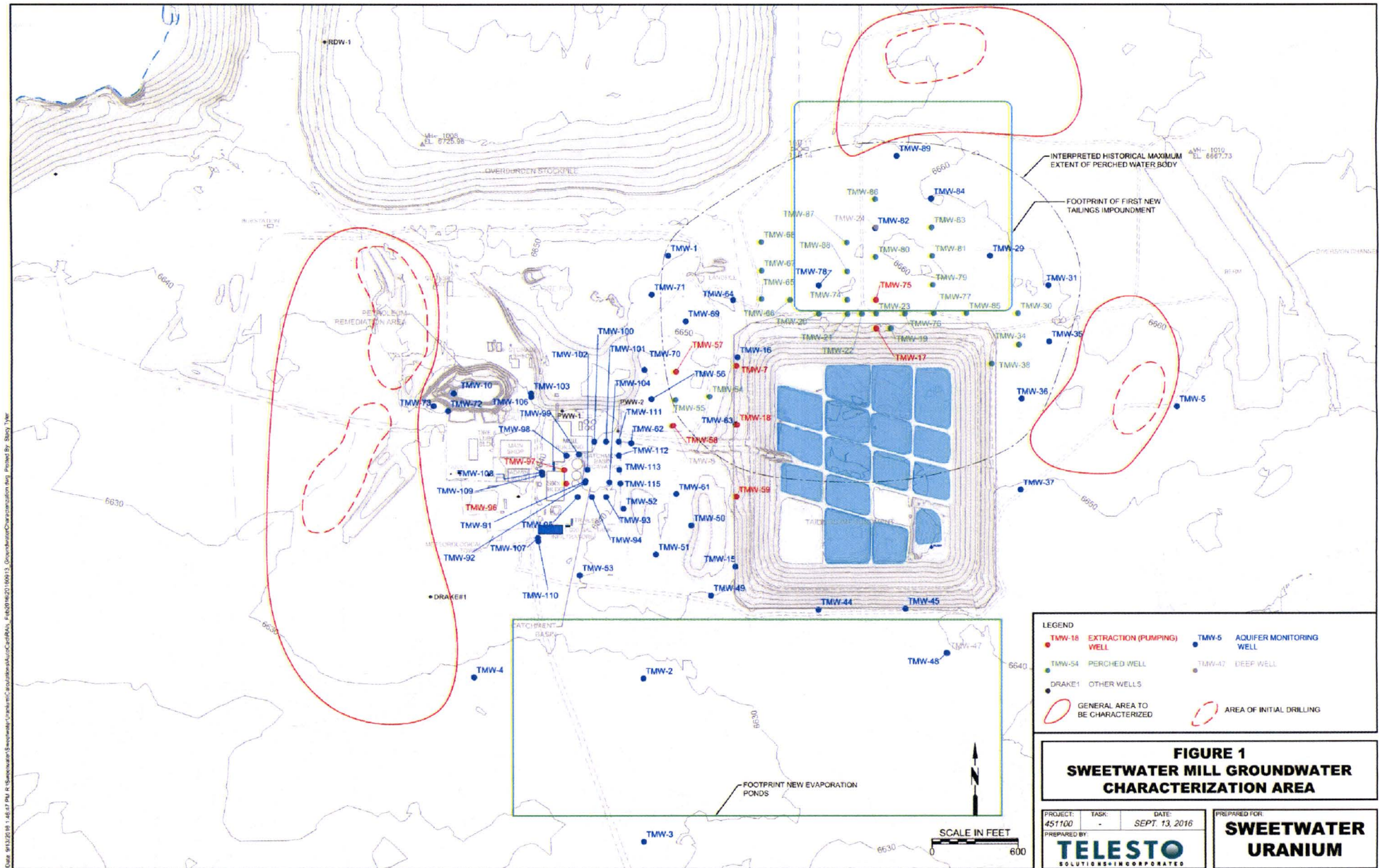
## Attachment 1-B

Well Completion Diagram Appendix C-3 from the Wyoming State Engineer's Office, Regulations and Instructions Part III Water Well Minimum Construction Standards June 2011

**Appendix C-3**  
**TYPE III WELLS**



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