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M.1 Introduction

This Attachment M has been prepared in support of an application by Curis Resources (Arizona) Inc. (Curis Arizona) to the United States Environmental Protection Agency (USEPA) to transfer, with amendments, Underground Injection Control Class III (Area) Permit No. AZ396000001 (UIC Permit) from Florence Copper Inc. (Florence Copper) to Curis Arizona.

This attachment provides details of the Class III injection well design including schematic drawings showing construction details of injection and recovery wells. In the following discussion the Class III injection wells are referred to as injection and/or recovery wells. This attachment does not include a description of downhole equipment that will be used during in-situ copper recovery (ISCR) operations. Downhole equipment may include submersible pumps, injection pipes, orifice plate assemblies, packer assemblies, fluid level instruments, and well cleaning tools.

M.2 Multi-Use Wells

During the operation of the ISCR area, an individual Class III well will serve multiple uses throughout its life cycle. A well may serve as an injection well, a recovery well, a perimeter well, or an observation well. Perimeter wells will be installed along the edges of resource blocks or operational units to provide hydraulic control. Observation wells will be paired with designated perimeter wells for measuring hydraulic gradients; some observation wells may be equipped to collect samples at one or more depth intervals. Regardless of use, each of the wells will meet the specifications provided in the UIC Permit for Class III injection wells. As a result, all ISCR wells will be designed and constructed in accordance with standard designs as described in the following subsections. Although the ISCR wells are designed to accommodate multiple uses, they will generally be referred to as injection and recovery wells unless the context requires otherwise.

M.3 Well Design

Well design details are shown on Drawings M-1 through M-4. The drawings are similar to drawings included in Attachment 9A of Curis Arizona’s January 31, 2011 application to the Arizona Department of Environmental Quality to amend Aquifer Protection Permit No. 101704 (APP). Drawing M-1 shows details of a typical injection/recovery well. Drawing M-2 shows detail of the well head for a typical injection/recovery well. Drawings M-3 and M-4 show details of the annular conductivity device (ACD) that will be installed on all injection and recovery wells.

M.3.1 Well Casing

The surface casing will be low carbon steel manufactured in accordance with American Society for Testing and Materials (ASTM) Specification 153-89A (1989) Grade A (or better) steel. This casing will be of a diameter sufficient to allow a minimum 2½-inch annular space between the casing wall and borehole wall to ensure that an adequate seal can be installed.

The surface casing diameter will vary based on the diameter of the planned well casing to be installed. Because of the chemical environment in which the casing will be installed, fiberglass reinforced plastic (FRP), polyvinyl chloride (PVC), or other corrosive-resistant threaded casing will be used to complete the injection/recovery wells. These casing materials will be of sufficient grade so that they will not fail in tension and will not collapse or burst, and will be chemically resistant to the planned sulfuric acid injectate solutions. Because of the varying depth of the injection zone across the ISCR area, different grades, weights, and sizes of casing will be used to meet the requirements above.

Well screen made of PVC or other suitable material may be used in the lower portion of each injection/recovery well as necessary to keep the hole open and to provide the operational flexibility to isolate segments of the full length of the injection zone.
M.3.2  **Casing Centralizers**

Casing centralizer will be installed on the well casing every 40 feet along the entire well casing, including screens where applicable. The centralizers will be made of stainless steel and will be suitable for contact with injectate solutions.

M.3.3  **Screened Interval**

The screened interval will vary in length at each well and may include one or more screened segments within the full length of the injection zone. Formation characteristics may require that wells be completed without well screen and filter pack within the injection zone. If this proves to be necessary, all other aspects of the proposed design will remain in effect. No screened interval will be installed higher than 40 feet below the Lower Basin Fill Unit (LBFU)/oxide bedrock contact.

M.3.4  **Annular Seal**

The annular seal will be installed from 40 feet below the LBFU/oxide bedrock contact to the surface. The annular seal material will be cement and will be installed either by the tremie method or by the displacement method.

M.3.5  **Annular Conductivity Device**

The ACD will be installed on the well casing in a location that will be as close as possible to the top of the Middle Fine-Grained Unit (MFGU), and no more than 20 feet above the MFGU. It will consist of a pair of metal bands spaced 3 feet apart, and connected to electrical wires which extend to the surface. The ACD will be constructed of materials suitable for contact with the annular seal materials and the forecast injectate solutions. Details of the ACD are presented in Drawings M-3 and M-4.
**UPPER BASIN FILL UNIT (UBFU)**

- **MIDDLE FINE-GRAINED UNIT (MFGU)**
- **LOWER BASIN FILL UNIT (LBFU)**
- **40' BEDROCK EXCLUSION ZONE**

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**OXIDE BEDROCK UNIT**

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**CONDUCTIVITY PROBE WIRES, STRAPPED TO CASING WITH STAINLESS STEEL STRAPS EVERY 20 FEET**

**CONCRETE PAD**

**STEEL SURFACE CASING, CEMENTED 18-1/2-INCH MIN. BOREHOLE**

**CASING DIAMETER WILL BE SIZED TO PROVIDE A MINIMUM 2-1/2-INCH ANNULUS**

**CONDUCTIVITY PROBE TO BE LOCATED AS CLOSE AS POSSIBLE; AND NOT MORE THAN 20 FEET ABOVE MFGU - DETAIL SHOWN ON DRAWINGS M-3 AND M-4**

**12-1/4-INCH MIN. BOREHOLE**

**TYPE V PORTLAND CEMENT (NEAT MIX)**

**FIBERGLASS REINFORCED CASING OR OTHER APPROVED ACID RESISTANT MATERIAL**

**FIBERGLASS REINFORCED TO PVC PIPE ADAPTER**

**PVC SCREEN OR OTHER APPROVED ACID RESISTANT MATERIAL**

**PVC BLANK CASING OR OTHER APPROVED ACID RESISTANT MATERIAL**

**SILICA SAND FILTER PACK**

**BENTONITE SEAL, TYPICAL**

**STAINLESS STEEL CASING CENTRALIZERS EVERY 40 FEET**

**PVC CAP**

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NOT TO SCALE

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**Drawing M-1**

**TYPICAL INJECTION/RECOVERY WELL CONSTRUCTION DIAGRAM**

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**Brown AND Caldwell**

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SWVP-014948
1" CHECK VALVE

TRANSDUCER CABLE

COMPRESSION FITTING

3/4" INSTRUMENT TUBE

FLOWMETER

ISOLATION VALVE

BLEED / SAMPLE VALVE

ANNULAR CONDUCTIVITY DEVICE LEADS

GROUND SURFACE

SURFACE CASING

TYPE V CEMENT

PUMP / INJECTOR PIPE

WELL CASING

TYPE V CEMENT

NOT TO SCALE

Drawing M-2
WELL HEAD DETAIL FOR INJECTION/RECOVERY WELL

HDI CURIS

Brown AND Caldwell

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SWVP-014949
WIRE LEADS

WELL CASING BANDS, STAINLESS STEEL BANDING JOINED WITH A MECHANICAL CLIP AROUND THE CASING PIPE AS SHOWN, TWO BANDS WILL BE INSTALLED PARALLEL TO EACH OTHER WITH A 3 FOOT SPACING

DETAIL 2

CASING WALL

DRAWING M-3
ANNULAR CONDUCTIVITY DEVICE DETAIL 1
NOT TO SCALE

NOTE: THE ANNULAR CONDUCTIVITY DEVICE WILL BE CEMENTED WITHIN THE ANNULUS OF THE BOREHOLE

CABLE INSULATION

SINGLE STRAND 12 GAUGE COPPER WIRE, PVC COATED, CRIMPED AND JOINT COATED WITH ACID RESISTANT EPOXY

STAINLESS STEEL BANDED HOSE CLAMP

CASING WALL

DRAWING M-4
ANNULAR CONDUCTIVITY DEVICE DETAIL 2
NOT TO SCALE

HDICURIS

Drawings M-3 & M-4
ANNULAR CONDUCTIVITY DEVICE DETAILS