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C.0 OUTFALL 200 MERCURY TREATMENT FACILITY CONTRACT OVERVIEW AND OBJECTIVES

C.0.1 BACKGROUND

The Department of Energy (DOE) Oak Ridge Reservation (ORR) was created in 1943 as part of the World War II Manhattan Project to support the development of the world’s first atomic weapon. The ORR is comprised of three sites: (1) Oak Ridge National Laboratory (ORNL), (2) Y-12 National Security Complex (Y-12), and (3) East Tennessee Technology Park (ETTP). Y-12 was originally created to separate U-235 from natural uranium; ORNL produced and separated plutonium; and ETTP produced highly enriched uranium. Since that time, the missions of these sites have changed, with each site having a different purpose: ORNL is DOE’s largest science, technology and energy national laboratory; Y-12 manufactures, stores, and disassembles nuclear weapon components; and ETTP is being environmentally restored for conversion into a private sector industrial park.

Historical missions at Y-12 resulted in the release of mercury into the environment. Residual mercury in the 60-year-old, deteriorating storm drain infrastructure, infiltrating groundwater and sediment-bound mercury are remobilized and transported through the storm drain network to Outfall 200 (OF200) into the Upper East Fork Poplar Creek (UEFPC). Currently, this is the largest environmental risk on the DOE ORR. The primary pathway of concern is surface water because the UEFPC flows directly from the Y-12 complex into the city of Oak Ridge. Over the past two decades, DOE has implemented a series of projects that have reduced the concentrations of mercury measured at the site boundary at Station 17, the Y-12 National Pollutant Discharge Elimination System (NPDES) permit compliance point. Despite the success of these actions, an unknown volume of mercury remains in the soils beneath and adjacent to the buildings, storm sewers, and process pipelines, which continues to be released to the storm sewer system. Current mercury discharges to public water at the site boundary (Station 17) exceed the Clean Water Act standard for mercury (51 parts per trillion [ppt]) and the mercury goal established in the CERCLA Phase I Interim ROD (200 ppt). Design and construction of a water treatment system at OF200 is expected to mitigate the current downstream migration of mercury, as well as potential future changes in mercury flux characteristics.

In 2011, the Department of Energy, Oak Ridge Office awarded a contract to URS|CH2M Hill Oak Ridge LLC (UCOR). The work includes the completion of the East Tennessee Technology Park and surveillance and maintenance operations at the Y-12 and ORNL. UCOR is currently responsible for
the design phase of the Outfall 200 (OF200) Mercury Treatment Facility Project, including support for DOE Order 413.3B Critical Decision (CD) approval through CD-2/3.

C.0.2 OBJECTIVES

Historical missions at the Y-12 National Security Complex (Y-12) resulted in the release of mercury to the environment. Residual mercury is being remobilized and transported through the storm drain network to OF200 into the Upper East Fork Poplar Creek (UEFPC). The objective of this procurement is two-fold: (1) provide a capability to treat mercury-contaminated water that discharges from the Y-12 storm sewer to UEFPC; and (2) provide future capability to assist with treatment of mercury-contaminated water that is expected to be generated during large-scale demolition and soil remediation projects.

C.0.3 TECHNICAL DOCUMENTS, EXHIBITS, AND OTHER ATTACHMENTS

To further define the requirements and quantities of work within Section C, the Government will provide additional data in the Request for Proposal (RFP) Section J, “Outfall 200 Mercury Treatment Facility Final Design Drawings” and in Section J, “Outfall 200 Mercury Treatment Facility Final Design Specifications” when the RFP is released. In the event of a discrepancy between information contained in the Statement of Work, the specification, or the drawings, the drawings have precedence.

C.1 SCOPE

The scope of this contract is for the construction of a water treatment facility for mercury remediation at the Y-12 National Security Complex (Y-12). The design phase of the facility is being completed by URS|CH2M Hill Oak Ridge, LLC (UCOR). The construction scope includes but is not limited to: foundation work; construction of treatment buildings, storage tanks and equipment, pedestrian and vehicle access; construction, installation, and testing of associated process equipment; and process chemistry requirements.

To capture mercury-contaminated water entering UEFPC from OF200 for treatment, the water diversion system shall be located just downstream of OF200. Due to site constraints, the OF200 Mercury Treatment Facility (MTF) has been planned to be comprised of two primary areas, the Headworks area and the MTF Treatment Plant area, joined by a transfer pipeline.

The OF200 diversion structure and Headworks shall be located adjacent to the outfall on the south side of UEFPC. This location will permit in-stream diversion along with collection and transfer components. Locating the diversion structure near the outfall optimizes the capture of flow from the West End Mercury Area (WEMA) without treating the large volumes of additional, relatively clean water that flows into UEFPC downstream. The Headworks are sized to divert flows up to 40,000 gallons per minute (gpm) for collection and treatment while allowing excess storm flow to bypass. Provisions are included for grit separation prior to transfer of the collected water via a pipeline to the MTF for treatment. For diverted stormwater in excess of the treatment capacity, grit separation is followed by pumping to a 2-
million-gallon stormwater storage tank. Stormwater collected in the storage tank will be fed into the MTF as treatment capacity allows. The grit removal system includes solids dewatering and loading into solid waste containers for disposal.

The Water Treatment Plant components are planned to be located at the site of the former Bldg. 9720-8 near the east end of Y-12. The MTF consists of outdoor tanks, treatment equipment, and a metal building that houses weather-sensitive and control area equipment. The outdoor equipment includes an equalization tank, clarifier/thickeners, sludge settling tanks, bulk chemical tanks, and process reaction tanks. The indoor equipment includes multi-media filtration (MMF), filter presses, polymer make-down systems, filter clearwell and backwash basins, backwash pumps and associated equipment, anda control room, motor control center (MCC), chemical feed systems, and process support room.

A transfer pipeline approximately 4000 feet (ft) long shall be located along the south side of UEFPC between the Headworks and MTF areas. The transfer pipeline is typically an at-grade, single-contained, high-density polyethylene (HDPE) pipe. The pipe will be routed to minimize interference with Y-12 site operations, and appropriate vehicle and pedestrian crossings (e.g., below-grade driveway and road crossings, footbridges, etc.) shall be constructed at locations requiring access.

**C.1.1 DESIGN BASIS**

The following sections describe key aspects of the project that formed the process design basis.

**C.1.1.1 Capabilities and Performance Goals (Key Performance Parameters)**

The following preliminary key performance parameters (KPPs) have been developed and included in CD-1 for OF200 MTF:

- Provide OF200 MTF with a capacity to capture and treat 3000 gpm of water from UEFPC
- Construct and deliver to operations an OF200 MTF capable of reducing downstream mercury contamination from OF200 discharges to UEFPC

DOE, EPA, and TDEC signed a dispute resolution agreement in May 2015 that includes the following additional performance requirements:

- OF200 MTF will have 40,000 gpm combined base flow and stormwater capture.
- OF200 MTF will have stormwater storage capacity of 2 million gal.

**C.1.2 FACILITY COMPONENTS**

The following subsections discuss the primary components for each of the areas discussed above. Figure 1 shows the relative location of each area within the Y-12 site.
C.1.2.1 OF200 Headworks

The contractor shall construct and install Headworks to include an in-stream diversion structure to divert flows up to 40,000 gpm for collection and treatment while allowing excess storm flow to bypass. The design specifies vortex grit chambers to remove the grit prior to transfer of the collected water via a pipeline to the MTF area for treatment. For diverted stormwater in excess of the treatment capacity, grit separation, followed by pumping to a stormwater storage tank. Stormwater collected in the storage tank will be fed into the MTF as treatment capacity allows. The grit removal system includes solids dewatering and loading into solid waste containers for disposal. Supporting infrastructure and utility connections are provided, along with site perimeter access control fencing. Truck access to the Headworks area will be provided for transportation of grit solid waste containers from the site. The contractor shall provide stormwater storage consisting of a single vertical coated steel tank with an operating capacity of 2 million gallons. The tank shall be vented to the atmosphere and equipped with mixers to minimize the potential for solids settling and accumulation or anaerobic conditions within the tank contents.

C.1.2.2 Pipeline Corridor

The contractor shall construct a transfer pipeline to connect the Headworks to the Water Treatment Plant. The pipeline shall run from the Headworks primarily along the south bank of UEFPC east toward the treatment plant. This pipeline will cross UEFPC prior to entering the treatment plant. The transfer pipeline is typically an at-grade, single-contained, high-density polyethylene (HDPE) pipe. It will be routed to minimize interferences with Y-12 site infrastructure and operations, and will include road crossings and pedestrian access crossings as appropriate.

C.1.2.3 Water Treatment Plant

The MTF consists of outdoor tanks and treatment equipment adjacent to a treatment building housing weather-sensitive and labor-intensive equipment. The outdoor equipment includes an equalization tank, two inclined plate clarifier/thickeners, three sludge settling tanks, two bulk chemical tanks, and six process reaction tanks. Heat trace and insulation for piping and tanks are required to prevent freezing during winter months. Weather-sensitive equipment and equipment requiring higher frequency for manned operation is indoors. Indoor equipment includes six gravity multi-media filtration MMFs, a clearwell, a backwash basin, two filter presses and associated equipment for sludge dewatering and loading into solid waste containers, feed chemicals and polymer make-down systems, backwash pumps and associated equipment, and operations support and control areas.

Space for solid waste handling, chemical and supply delivery, parking, and staging are provided outdoors. The MTF site includes supporting infrastructure and utility connections, along with site perimeter access control fencing.
Fig. 1. Location of the OF200 MTF.
C.1.3 PROCESS DESCRIPTION

This section summarizes the treatment process and information for supporting engineering disciplines. Infrastructure, including an enclosed process treatment building with control room, motor control center (MCC), chemical feed systems, and process support room, are included in the preliminary design to deliver an operational water treatment system to meet the needs of the OF200 MTF. Process descriptions for each process step are presented in the following sections.

For the chemical precipitation process, colloids and mercury associated with suspended solids become enmeshed with solids formed through coagulation and flocculation using ferric iron and organic polymers. Ferric chloride will be used as the coagulant along with a sulfide functional polymer to produce mercury-sulfide and ferric hydroxide solids. The mercury-sulfide solids adsorb onto the ferric hydroxide solids, which are more readily settled and filtered than mercury-sulfide solids alone. Dissolved mercury is generally precipitated to low concentrations by the sulfide groups on the sulfide functional polymer. After initial precipitation, the resulting precipitate is flocculated with an organic flocculant (polymer) using mixing for initial polymer dispersion followed by slower mixing to build floc. The iron coprecipitation process for mercury removal is pH dependent. Laboratory testing during pre-design studies determined that a pH of 6.4 provides the most mercury removal. Effluent from the iron coprecipitation process will then be sent through a clarification step prior to filtration.

The OF200 MTF consists of the following major process components:

- Intake structure (including bar screen) with overflow diversion to UEFPC
- Vortex grit chambers
- Grit classifier/washer
- Stormwater tank
- Equalization tank
- Dechlorination system with reaction tank
- Sulfide-functional polymer addition system, sulfuric acid addition system, and ferric hydroxide addition system with reaction tank
- Coagulant addition system with flocculation tank
- Inclined plate clarifier/thickeners
- Gravity MMFs, including backwash storage and backwashing equipment
- Sludge thickening and dewatering system

A block flow diagram for the OF200 MTF is shown in Fig. 2.
C.1.3.1 **Headworks (Intake Structure, Grit Removal, and Pump Stations)**

An intake structure with an overflow/diversion weir will divert water from UEFPC downstream of OF200 by gravity flow through a concrete channel fitted with a manual bar rack to prevent oversize material from entering the facility. The intake structure will divert up to approximately 40,500 gpm. Flows exceeding that amount will overflow the bypass weir and continue to flow downstream in the current UEFPC stream channel.

The control system includes three stages. Stage 1 is for flows less than 3000 gpm, with water flowing only to the base side. Stage 2 is for flows between 3000 and 40,500 gpm, with water flowing to both the base and storm sides. A storm side weir gate is used to control the flow rate to the base side, with a setpoint of 3000 gpm. If the storm side flow reaches 39,000 gpm, an override control system operates the gate to limit storm flow and a second slide gate on the base side begins to throttle to limit the base flow to no more than 3500 gpm. As flow increases above this total of 42,500 gpm, the water level rises quickly in the intake structure and begins to overflow the bypass weir. A level sensor detects this condition and the control system enters Stage 3, with the flow control setpoints reset to 3000 gpm and 37,500 gpm for the base and storm sides, respectively. Both weir gates operate to control these flow rates, with excess flow bypassing the facility downstream in UEFPC. If the stormwater storage tank reaches full capacity, the storm side flow is stopped and all flow in excess of 3000 gpm is bypassed downstream.

To prevent interference with treatment processes or undue mechanical wear and increased maintenance on equipment, vortex grit chambers will be used to remove larger solids and grit.
from the intake channels downstream of the bar rack and upstream of the pump stations. There will be two grit chambers, a smaller unit for base flow and a larger unit for storm flow.

The base flow grit chamber, due to standard available model sizes, is rated for 6.2 million gal per day (mgd) or 4320 gpm, but will normally be limited to a maximum flow of 3000 gpm, except during transition between control stages as noted above. After flowing through the grit chamber, the water will be pumped to the treatment plant by the base flow pump station. Grit that settles in the lower compartment of the grit chamber will be removed periodically and processed through a grit classifier/washer. The dewatered grit will be sent for disposal as solid waste and decant water will return to the intake channel.

When flow passes to the storm side (i.e., Stages 2 and 3 described above), this water will flow through the storm flow grit chamber, in which a maximum flow of 37,500 gpm is sustained with peaks as high as 39,000 gpm when transitioning from Stage 2 to Stage 3. After flowing through the storm flow grit chamber, the stormwater will be pumped to the stormwater storage tank by the storm flow pump station. Grit capture in the storm flow grit chamber will be similar to the base flow unit as described above.

**C.1.3.2 Stormwater Storage**

As described above, stormwater will be pumped from the storm flow pump station to the stormwater tank. This is a single, 2-million-gal-capacity welded steel tank. The tank will be equipped with level instrumentation and associated valving, piping, and controls to return stored water to the base flow pump station. The tank also will be vented to the atmosphere and equipped with a passive overflow. The tank will be mixed to minimize the potential for solids settling and buildup or anaerobic conditions.

**C.1.3.3 Equalization and Mercury Precipitation Process**

An equalization tank at the treatment plant site will be used prior to major treatment processes to stabilize flow through the mercury treatment process and will be followed by dechlorination, pH control, sulfide-functional polymer addition, and chemical precipitation.

A single 500,000-gal equalization tank will be provided at the front end of the treatment system. The equalization tank will be fed by the base flow pump station and will receive influent from the backwash waste basin. The equalization tank will be a coated, carbon steel tank that will provide a minimum hydraulic retention time (HRT) of approximately 150 minutes at the 3000 gpm design flow condition. High storage capacity will assist to stabilize flow when the backwash basin is being discharged. The equalization tank will be equipped with one-side entry mixer and equalization discharge pumps.

Equalization tank effluent will be pumped to dechlorination reaction tanks. The two 8500-gal fiber-reinforced plastic (FRP) tanks will each be equipped with a top-mounted mixer and will provide a minimum HRT of 5 minutes. A sodium metabisulfite feed system, including chemical tote bins and metering pumps, will be provided for dechlorination.

Dechlorination tank effluent will flow by gravity to two polymer and iron coprecipitation reaction tanks. In these tanks, the pH is adjusted by adding sulfuric acid, sulfide functional polymer (Nalmet 1691 or equivalent) is added to produce mercury sulfide solids, and ferric
chloride coagulant is added along with sludge recycled from the clarifier/thickener bottom. These two tanks will be 17,000-gal FRP tanks, each equipped with a top-mounted, low-shear mixer, will provide a minimum HRT of 9 minutes. A polymer make-down system, including chemical tote bins and metering pumps, will be included for polymer addition. Ferric chloride will be added from a chemical storage tank using metering pumps. Provisions for pH adjustment include a feed tank and metering pumps for sulfuric acid. Concentrated underflow sludge from the clarifier/thickeners will be pumped to the coprecipitation reaction tanks to promote the growth of denser precipitate solids, to improve settling and fines capture, and to drive the precipitation process closer to equilibrium.

The polymer and iron coprecipitation reaction tank effluent will flow by gravity to two flocculation tanks. A polymer will be added in the dip tube from the coprecipitation reaction tanks to enhance flocculation. The flocculation tanks will each be a 17,000-gal FRP tank equipped with a top-mounted mixer and will provide a minimum HRT of 9 minutes. A polymer make-down system, including chemical tote bins and metering pumps, will be included for polymer addition.

The flocculation tank effluent will flow by gravity to two inclined plate clarifier/thickeners. The clarifiers are sized for 2000 gpm each and follow the flocculation tanks for removal of solids generated during the coprecipitation process. The inclined plate clarifiers include a thickener chamber with a rake to thicken solids removed by the clarifier. The clarifiers will have a provision to recycle a fraction of the sludge back to the polymer and iron coprecipitation reaction tanks to provide seed crystals as described previously. Clarifier effluent will overflow to MMF units.

C.1.3.4 Filtration

The clarifier effluent will flow by gravity to an inlet channel for the gravity flow MMF system. The MMF downstream of the clarifiers will remove flocculated solids carryover to further reduce mercury prior to discharge of the effluent back into UEFPC. The MMF system will consist of six gravity filtration units, where the media is held in concrete basins and the wastewater flows through the bed in a top-down flow pattern. Each unit will be 13 ft wide by 20 ft long, with all units normally operating in parallel except when one unit is offline for backwashing. The preliminary design includes the addition of a flocculant aid using chemical tote bins and metering pumps upstream of MMF for enhanced removal of solids.

The MMF will include a 6-in. layer of coarse garnet to serve as the supporting base layer, topped with a 24-in. layer of sand that provides the fine filtration, topped by a deep 48-in. layer of anthracite coal, which provides coarse deep bed filtration. The coarse anthracite layers at the top of the bed allow particles to penetrate into the bed rather than form a plugging layer on top of the bed. This increases the run time of MMFs between backwash cycles compared to a monolithic bed of fine sand or fine garnet.

The MMF effluent will collect in a 78,000-gal clearwell located under the filter complex and extending east of the filters. From the clearwell, water will pass over a weir into a channel containing a Parshall flume for flow measurement. From there, the water will pass through an outfall pipe and be returned by gravity flow to UEFPC.
The MMF units require periodic backwashing at a higher loading rate sufficient to adequately lift and loosen the bed. Backwashing generally starts with air scour to loosen packed solids in the media bed. Following air scour, the backwash process includes a high-flow rate step, low-flow rate step, rinse step, and filter-to-waste step. The high-flow, low-flow, and rinse steps utilize filtered effluent from the clearwell. In the filter-to-waste step, the filter is operated in parallel with the other filters except the filter effluent is discharged to the backwash basin.

Pumps in the clearwell will provide backwash water. Since the backwash rate exceeds the MMF flow rate, the clearwell will be drawn down during backwashing, interrupting the effluent from the facility. Following backwashing, the water level will again rise and overflow the weir to the outfall.

A second basin located under the filter complex will collect backwash wastewater, including filter-to-waste flows from MMFs following backwashing, and the discharge from the sump pump system in the filter press room. The backwash waste basin has a capacity of 52,000 gal. The backwash waste basin contents will be pumped back to the equalization tank.

C.1.3.5 Solids Dewatering and Residuals

Part of the clarifier sludge will be wasted and pumped to sludge settling tanks. The three cone-bottomed sludge settling tanks, each with a 30,000-gal capacity, will provide a combined 72-hour HRT to increase solids concentration prior to dewatering. Because thickened solids from the sludge settling tanks will be pumped to the filter press system, which requires manned operation, the 72-hour HRT will provide greater operator flexibility (e.g., 3-day weekend). A polymer make-down system, including chemical tote bins and metering pumps, will be included for addition of a dewatering aid polymer to concentrate the sludge in the sludge settling tanks. The decant supernatant from the tanks will gravity overflow to the filter press filtrate sump.

Thickened solids from the sludge settling tanks will be pumped to a filter press for dewatering. Two recessed plate and frame filter press units, each with 60-cf capacity, will be provided to dewater the solids. The cake solids generated at the filter press will be containerized for disposal as solid waste. The filter press filtrate will be sent to a filtrate sump. The combined filtrate will be periodically pumped to the backwash waste basin described above.

C.1.4 UNIT OPERATIONS

This section discusses the preliminary design as related to the following O&M activities:

- Process monitoring requirements
- Chemical supply
- Equipment redundancy approach

C.1.4.1 Process Monitoring

In addition to any required regulatory or programmatic monitoring or reporting, monitoring of system components will be necessary to maintain proper operation and treatment performance. The anticipated monitoring based on the preliminary process design would
include a combination of influent and effluent sampling and analysis, in-process sampling and analysis, and online instrumentation.

- Routine sampling for influent and treated effluent water: Temperature, pH, oxidation reduction potential (ORP), conductivity, turbidity, total suspended solids, total and soluble (dissolved) mercury, and various parameters (e.g., other metals, oil and grease, common salts, whole effluent toxicity test, etc.) may be monitored to observe and respond to changes in influent conditions. Effluent data will be used to monitor the treatment system performance and discharge parameters.

- Routine in-process sampling: Temperature, pH, ORP, conductivity, and turbidity may be monitored to verify that the treatment system is operating within the optimal range and to confirm online monitoring data. Total and soluble (dissolved) mercury data may be collected periodically to monitor treatment system performance across major process steps.

- Online monitoring: Flow, temperature, pH, turbidity, and conductivity will be continuously monitored to help verify the treatment system is operating within the optimal range. Pressure and pressure drop across filters will be monitored as part of routine filter backwash, while chemical weights and tank levels will be monitored to track and maintain on-site treatment chemical supplies.

C.1.4.2 Chemical Supply

Table 1 summarizes the chemical consumables for the OF200 MTF, which includes chemicals for pH adjustment, dechlorination, chemical precipitation, coagulation, flocculation, and solids dewatering. Drawing J941001-F-0003 provides additional data from the mass balance tool developed using the chemical dose streams.

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Usage(^a)</th>
<th>Storage capacity at average operating conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfuric acid (93%)(^b)</td>
<td>1520 lb/day (277 ton/year)</td>
<td>30 days</td>
</tr>
<tr>
<td>Sodium metabisulfite (40%)</td>
<td>22 lb/day (4 ton/year)</td>
<td>66 days</td>
</tr>
<tr>
<td>Ferric chloride (35%)</td>
<td>406 lb/day (74 ton/year)</td>
<td>56 days</td>
</tr>
<tr>
<td>Sulfide functional polymer (Nalmet 1691 or equal)</td>
<td>203 lb/day (37 ton/year)</td>
<td>31 days</td>
</tr>
<tr>
<td>Flocculant (Nalclear 7763 or equal)</td>
<td>12.2 lb/day (2 ton/year)</td>
<td>236 days</td>
</tr>
<tr>
<td>Filter feed polymer</td>
<td>90 lb/day (16 ton/year)</td>
<td>61 days</td>
</tr>
<tr>
<td>Sludge settling polymer</td>
<td>6 lb/day (1.1 ton/year)</td>
<td>471 days</td>
</tr>
<tr>
<td>Backwash polymer</td>
<td>12 lb/day (2 ton/year)</td>
<td>300 days</td>
</tr>
</tbody>
</table>

\(^a\)Assumes usage at average operating condition of 1350 gpm.
\(^b\)Assumes an alkalinity of 130 mg/L as CaCO\(_3\) and raising or lowering the pH 1 unit from a base pH of 7.5.
C.1.4.3 Redundancy and Availability

Requirements for unit operation reliability, availability, and maintainability are addressed in the design criteria. In general, the MTF is designed to run on a continuous basis with a high overall system availability goal without providing complete redundancy of systems and components. A quantitative availability requirement was deemed inappropriate. The TDEC design criteria for sewage works were used as a guide in establishing redundancy. The stormwater collection equipment (e.g., pumps, storage tank, etc.) are not subject to the same installed spare capacity since the process treatment plant availability is not impacted by stormwater storage.

C.1.5 PROCESS PIPING AND MECHANICAL

Yard and process piping plans are presented with the civil and process mechanical drawings. Generally, piping is maintained above ground, where possible, through the use of pipe supports. However, some process and transfer piping at the Headworks will be buried to avoid conflicts with facility access. Above-ground process piping requires insulation of either fiberglass or calcium silicate and heat trace for smaller diameter pipes that are less than or equal to 8 in. In areas where below-ground piping is required, such as road or driveway crossings and work areas requiring frequent access for O&M activities, piping is placed in a secondary containment trench with traffic-rated grating. The piping schedule is presented in Specification 40.27.00, Process Piping—General.

C.1.6 CIVIL

This section summarizes the preliminary features of the civil components of the OF200 MTF. The preliminary design layout of the Headworks and treatment plant sites is shown in Drawings C941001-F-0009 and D941002-F-003.

C.1.6.1 Existing Conditions, Demolition, and Erosion Control

Improvements associated with the MTF Headworks facility will encompass approximately 1 acre near OF200, which is in the UEFPC floodplain. These improvements will require demolishing driveways and foundations of several abandoned buildings (9419-2, 9404-7, 9418-9, and 9404-8) and demolishing or relocating various utilities. These improvements will also require encroaching into UEFPC near OF200 for construction of the Headworks. Existing overhead steam condensate piping will be relocated to the north side of UEFPC. The depth of fill in the area will bring the site above the 100-year UEFPC floodplain. The possibility of soil contamination in the area is anticipated to be low based on limited historical data available for the area and will be verified through planned site characterization by OREM.

The pipeline will follow the UEFPC south bank from the Headworks to a new pipe bridge to be constructed east of the 3rd Street crossing. The new pipe bridge will cross over UEFPC at the southwest corner of the MTF site. An alternative alignment begins at the 3rd Street crossing where it will cross under the bridge. The pipeline will continue on the UEFPC north bank and then cross under 3rd Street into the plant. The HDPE pipeline will generally be placed on bedding at existing grade with accommodation for pipe snaking to allow for the thermal expansion and contraction of the HDPE pipe. The pipeline will have underground crossings at C Road and at the
intersection of 3rd Street and B Road. The route will be designed to avoid existing structures and utilities, with only some guy wire relocations anticipated along the route.

Improvements at the former 9720-8 site for the treatment building and outdoor process area encompass approximately 2.3 acres. These improvements will require some demolition of the existing concrete slab to accommodate facility foundations and demolition of some existing abandoned utilities. The MTF discharge pipeline will be routed to the north bank of UEFPC.

Erosion and sedimentation control during construction will be through silt fences, temporary sediment basins, and other measures. The final design of these measures will be in accordance with the *Tennessee Erosion and Sediment Control Handbook* (Fourth Edition, 2012). A Stormwater Pollution Prevention Plan will be prepared in accordance with the Tennessee General NPDES permit for discharges associated with construction activities.

### C.1.6.2 Roads, Access, and Parking

Access to both facilities will be from existing roads and will be able to accommodate semi-tractor trailers or single-unit trucks (i.e., *American Association of State Highway and Transportation Officials* [AASHTO] WB-62 and SU-40 design vehicle). All vertical and horizontal curves will be designed in accordance with AASHTO design guidelines. All roads, curbs, road bases, and subgrades will be consistent with Tennessee Department of Transportation (TDOT) design standards and will comply with Y-12 pavement design requirements.

Headworks access will be through a primary driveway off E Road. This driveway is designed to accommodate trucks capable of transporting a 22-ft-long roll-off dumpster. There is one loading area for the headworks and it is designed to handle roll-off trucks and tote chemical deliveries.

The MTF plant access will be through a primary driveway located off B Road to provide primary access to both the outdoor process area and treatment building. A secondary driveway on the southeast will provide emergency access from A Road and 3rd Street. The driveways are designed to accommodate semi-tractor trailers.

There will be three loading areas for MTF. Two will be at the outdoor process area: one for deliveries of chemicals (i.e., sulfuric acid and ferric chloride), and the other near the sludge settling tanks at the southwest corner of the treatment building, both paved with concrete to provide additional protection against minor drips and spills. The third outdoor process loading area will provide access to the filter press inside the treatment building and is designed to handle roll-off trucks.

There will be two designated parking areas within the treatment plant area, one area west of the outdoor process area and the other on the northeast side of the treatment building. Sufficient space is available for an Americans with Disabilities Act of 1990 (ADA) accessible parking spot.

### C.1.6.3 Earthwork and Retaining Walls

A retaining wall is proposed at the Headworks structures along UEFPC. The retaining wall will be a secant-pile wall installed along the southern edge of UEFPC as part of site preparations at the
Headworks. In addition to providing support for the ultimate fill at the site, the wall will provide separation from UEFPC during excavation for the structures at the Headworks.

C.1.6.4 Utilities

Utilities to be relocated or demolished include overhead steam condensate piping, demineralized water main, overhead and buried electric lines, and overhead communication lines. Service connections for potable water and communication lines will be provided from existing Y-12 utilities infrastructure.

The overhead steam condensate piping will be rerouted on a new support system similar to the existing system and will consist of a concrete base with steel columns supporting a frame that holds the steam condensate lines. The approximate spacing of the concrete base is 20 ft.

C.1.6.5 Stormwater Transfer Pipe

Stormwater management for MTF consists primarily of conveying on-site flow through the use of existing storm drain systems to UEFPC. All pipes and swales have been designed in accordance with the TDOT Design Division Drainage Manual, which specifies that stormwater piping be designed for the 10-year design storm using the rational method. The corresponding rainfall intensity for a 5-minute period of concentration is 6 in. per hour.

C.1.6.6 Fencing and Landscaping

An 8-ft-high chain-link fence topped with barbed wire is planned around both the Headworks and MTF sites. A manual swing gate is proposed for the Headworks driveway to control vehicle access, with a manual pedestrian gate to allow access to the pipeline corridor. An automated cantilever sliding gate is proposed at the primary treatment plant access, with a manual swing gate at the secondary access.

Disturbed areas that are not either paved or have gravel surfacing will be hydroseeded or sodded. No trees or shrubs are proposed.

C.1.6.7 Groundwater Control

The groundwater table is anticipated to be at or near existing ground surface (i.e., at elevations from 930 to 940 ft) at the Headworks, although groundwater can be expected to perch at MTF during heavy rain events. Flow rates and groundwater control will depend on the depth and nature of the materials overlying the bedrock. The highly irregular nature of the bedrock surface and the possibility of large materials in the channelized banks preclude the use of sheet piles or similar methods to provide an effective cutoff. The overburden is expected to consist of fine-grained materials that are not conducive to dewatering with well points. Groundwater may need to be collected in the excavations and pumped out. Note that if large materials such as shotrock were used in the channel construction, groundwater flow rates will be high in these areas. Construction will likely need to consider multiple dewatering methods depending on what materials are encountered.

For preliminary design, a secant pile wall along the creek is proposed both to serve as potential excavation support along the north side of the Headworks and to provide some groundwater
cutoff. The secant wall can then be used for the final structures planned along the creek channel.

Groundwater control could also be necessary for foundation excavations or trenches for MTF. Groundwater that accumulates in the bottom of any excavations should be diverted by trenching to a low sump and pumping out with a sump pump. Water pumped from excavation sumps should be discharged into temporary sedimentation basins, which should be installed to collect the water resulting from the dewatering operation. Attempts should be made to divert stormwater runoff away from open excavations by building temporary diversion berms or ditches.

C.1.6.8  Foundation Design

Based on anticipated foundation soil, the following two foundation types should be considered:

- Type 1 foundation—over excavate the foundation soil to competent soil below the bottom of the base slab, or to bedrock (whichever is shallower), and replace the over excavation with compacted structural fill. Support the proposed facilities with spread footings, slabs-on-grade, or mat foundation. Design the foundation using an allowable bearing pressure of 3000 psf. This type of foundation is recommended for lightly loaded reinforced concrete slab-on-grade or mat foundation.

- Type 2 foundation—over excavate the foundation soil to bedrock and replace the over excavation with compacted structural fill. Support the proposed facilities with mat foundation. Design the foundation using an allowable bearing pressure of 6000 psf. This type of foundation is recommended for the equalization tank.

The anticipated type of foundation for each facility is presented in the drawings. When the site-specific exploration is completed, it is possible that bedrock depths may be too deep for over excavation and replacement to be cost effective. Deep foundations consisting of drilled-in piers, driven H-piles, or similar may be warranted in specific locations such as beneath the equalization tank or the stormwater tank.

C.1.6.9  Spread Footings, Slabs-on-Grade, and Mat Foundation

Assuming that the facilities foundations will be prepared as recommended above and over excavation and replacement is cost effective based on the depth to bedrock, it is anticipated that the proposed facilities would be supported with shallow spread footings, slab-on-grade, or mat foundation provided the foundation soil is prepared as recommended above. For a Type 1 foundation, the spread footings and slab-on-grade should be designed using a maximum allowable net bearing pressure of 3000 psf. This allowable bearing pressure can be increased 30 percent for short-term loads such as wind loading. The spread footings should be at least 18 in. wide and embedded at least 18 in. below the finished grade to prevent frost heave. The frost penetration depth is less than 12 in.

For a Type 2 foundation, the mat foundation should be designed using an allowable net bearing pressure of 6000 psf and a modulus of subgrade reaction for a 1-sf plate of 150 tons per cf. This modulus of subgrade reaction should be adjusted to account for the difference in size between the plate and the actual foundation.
The total and differential settlements of the proposed facilities, supported by the foundation recommended above and assuming the foundation soils are over excavated and recompacted as recommended above, are estimated to be about 1 in. and 2/3 in., respectively, which are within tolerable limits for the proposed facilities.

C.1.6.10 Rock Anchors

To resist overturning, it may be necessary to install rock anchors for facilities such as the stormwater tank. For the design of rock anchors, it is recommended that the anchors be installed through overburden soil and embedded and grouted at least 10 ft into hard limestone. A 1-in. Dywidag™ grade 150 thread bar should be considered. The rock anchor should be designed for an allowable resistance of 20 tons.

C.1.6.11 Seismicity

The preliminary site classification was determined based on the soil profile and standard penetration test blow count of soil borings documented in Final Report of Subsurface Exploration, Revision 1, Special Materials Complex Purification Prototype Facility, Y-12 National Security Complex, Oak Ridge, TN (MACTEC 2003) for the most relevant nearby investigation. The MTF site soil should be classified as C based on the 2009 edition of the International Building Code.

C.1.7 ARCHITECTURAL

The architectural design goal is to achieve treatment plant and Headworks electrical buildings that efficiently protect process equipment and staff from the elements and facilitate operation of the mercury treatment process. It will provide space for storage of supplies, maintenance of equipment, safe handling and removal of waste, and facilities for sampling and characterizing untreated and treated water.

The treatment building will be a cross-braced steel frame with lateral support from the filter tanks, and the skin will be similar to a pre-engineered metal building with girts and purlin secondary framing and metal panels inside and out. This building will have an expected lifetime of at least 30 years; will provide a low-maintenance, weatherproof shelter; and will be well insulated to moderate summer and winter weather extremes. The electrical building will be a pre-engineered metal building, with rigid frames, girts and purlins, and roof and wall panels provided by a building manufacturer. Major components for both buildings will include the following:

- The metal roof will consist of heavy-gauge steel panels with factory-applied fluoropolymer finish. Vapor barriers and batt insulation will be installed below the roof at underlying ceilings to reduce the volume of the heating envelope. It will be a simple gable roof, shedding water to gutters and downspouts. There will be a 3-ft overhang at the eaves to provide some protection to the walls and to people at entrances. The electrical building will have minimal overhangs.

- The metal walls will consist of heavy-gauge steel panels with factory-applied fluoropolymer finish. Batt insulation with a vapor barrier will be installed inside the wall panels. Metal liner panels will protect the vapor barrier on the interior of perimeter walls.
• The trim will consist of steel panels with factory-applied fluoropolymer finish to match the roof and walls as provided by the roof and wall panel manufacturer (or the metal building manufacturer); trim will be fully sealed to prevent wind and water infiltration.

• Insulated glazing unit windows will be installed at the treatment building to provide optimum daylighting inside. The electrical building will not have windows.

• Personnel doors will be insulated steel with thermally broken steel frames, factory primed and finish coated in the field.

• Overhead doors will be insulated steel panels with a factory finish and motorized with an automatic stop and a reverse door edge sensor.

• The louvers will be aluminum with factory finish.

The process area (lower level), will have a minimum clearance of 20 ft to the structure. All coiling doors will be at least 14 ft high to facilitate installation and eventual replacement of process equipment. The entire building will have a continuous 6-in.-high concrete curb for spill containment. Interior ramps will be provided at all exterior personnel coiling door entries, with a 1:12 slope to facilitate the use of trucks, forklifts, and hand trucks. The interior wall panels will be white. Ceilings will be a light color to reflect light.

Accessory spaces only need to be 8-ft, 6-in high and have finished ceilings. Upper level process support rooms will have 10-ft clearances and finished ceilings hung from the structure above. The operating gallery will have moisture-resistant ceiling and wall assemblies. The process support room, control room, and restroom will have resilient floor tile finishes. Other spaces will have concrete floors with a clear sealer. Interior walls will be painted, abuse-resistant gypsum board. The process support block at the lower level will have a sloped metal roof to facilitate wash down cleaning and prevent the room ceilings from being used for storage, risking ceiling collapse.

Consistent with Executive Order 13693, “Planning for Federal Sustainability in the Next Decade,” OREM has determined that pursuit of Leadership in Energy and Environmental Design certification is not realistic for the OF200 MTF project. The project will continue to comply with the Guiding Principles for Federal Leadership in High Performance and Sustainable Building (HPSB), and will incorporate environmentally aware design features wherever practicable.

C.1.8  STRUCTURAL

This section presents the preliminary design features and structural requirements for the OF200 MTF. Since site-specific geotechnical data became available too late to incorporate into the preliminary design, the structural design features may change during final design in coordination with completion of the geotechnical design.

In general, loads will be based on the most stringent applicable codes and standards identified in the design criteria. Building foundations, tank foundations, backfilled water-holding basin walls, and retaining walls will be designed to resist seismic loads caused by lateral earth pressures. Water-holding basin walls, tanks, and tank foundations will be designed for the effects of seismic sloshing loads in accordance with American Concrete Institute 350.3 and American Society of Civil Engineers 7.
C.1.8.1 Treatment Building Description, Features, and Demands

- Structure/Building Type: 163-ft × 131-ft × 47-ft tall, braced-frame steel building with an intermediate level at approximately 24 ft above finished floor. Concrete filters, approximately 84-ft × 66-ft × 24-ft tall, at the northwest corner of the building.
- Use/Function: Process.
- Foundation System: Continuous footing and knee wall along perimeter of the exterior filter walls with piers and spread footings at building columns. Grade beams to tie footings of braced frames. Reinforced cast-in-place concrete slab on grade.
- Framing Material: Steel.
- Lateral Load-Resisting System: Braced frames.
- Site Design Requirements: Provide continuous 6-in.-tall containment curb at perimeter of building.
- Hazardous or Corrosive Materials: Noncorrosive environment.

C.1.8.2 Grit Pump Building Description, Features, and Demands

- Use/Function: Process pumps in basement, electrical equipment in building.
- Foundation System: Cast-in-place concrete mat foundation.
- Framing Material: Steel building frame with reinforced cast-in-place concrete slab.
- Lateral Load-Resisting System: Braced frames.
- Hazardous or Corrosive Materials: Noncorrosive environment.

C.1.8.3 Headworks Description, Features, and Demands

- Use/Function: Liquid-holding basin and channels for surface water diversion.
- Foundation System: Cast-in-place concrete mat foundation.
- Lateral Load-Resisting System: Not applicable.
- Special Conditions or Considerations: Dynamic loads from the pumps may generate objectionable vibration and will be taken into consideration during design.
- Liquid Holding Structure (maximum liquid level): Yes, refer to PFD for maximum operating levels.
• Hazardous or Corrosive Materials: Noncorrosive environment.

C.1.8.4 Welded Steel Tank Description, Features, and Demands

• Structure/Building Type: American Water Works Association D100 welded steel tank with steel floor.
• Number, Size, and Use or Function: One 48-ft-high × 44-ft-diameter equalization tank. One 75-ft-high × 70-ft-diameter stormwater tank.
• Foundation System: Reinforced cast-in-place concrete slab on piers for stormwater tank, at grade for equalization tank.
• Special Conditions or Considerations to be Addressed in Design: Tank size, weight, volume, etc. will be coordinated with tank or equipment manufacture. Tank and anchor bolt configuration will be designed by tank manufacturer and coordinated with the concrete foundation for required embedment, minimum clearances, and stability requirements. Tank will be secured to foundation with mechanical anchors to resist overturning.
• Liquid Holding Structure (maximum liquid level): Refer to PFD for maximum operating levels.
• Hazardous or corrosive materials: Noncorrosive environment.

C.1.8.5 Miscellaneous Tanks and Equipment Description, Features, and Demands

Miscellaneous supports/foundations are required for equipment, pumps, fiberglass-reinforced plastic tanks, MCCs, etc.

• Foundation system: reinforced cast-in-place slab on grade.
• Special conditions or considerations: concrete support slab will extend below frost depth, coordinate secondary containment requirements and elevations with the process design where needed, foundation uplift will be resisted by rock anchor.
• Hazardous or corrosive materials: tank containment areas for acid, ferric chloride, and caustics will be protected with coating systems as required.

C.1.8.6 HVAC Control Systems

The HVAC control systems generally will be stand-alone electric or microprocessor-based electronic type as required. Control systems will include local control panels (LCPs) for equipment, either provided with packaged equipment or free standing.

C.1.8.7 Specific Zone Criteria

Table 2 lists the criteria for the electrical rooms and treatment area zone.
### Table 2. Specific zone design

<table>
<thead>
<tr>
<th>Electrical rooms</th>
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</thead>
<tbody>
<tr>
<td>Heating</td>
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<tr>
<td>Ventilation</td>
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<tr>
<td>Exhaust</td>
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<tr>
<td>Air conditioning</td>
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<tr>
<td>Environment</td>
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<td>Comments</td>
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<table>
<thead>
<tr>
<th>Treatment area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating</td>
</tr>
<tr>
<td>Ventilation</td>
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<tr>
<td>Air conditioning</td>
</tr>
<tr>
<td>Environment</td>
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</tbody>
</table>

Table 3 lists the design criteria for the control room and other process support room zones.

### Table 3. Specific zone design criteria: control room and process support rooms

<table>
<thead>
<tr>
<th>Control Room and Process Support Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating</td>
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<tr>
<td>Ventilation</td>
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<tr>
<td>Exhaust</td>
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<tr>
<td>Air conditioning</td>
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<tr>
<td>Environment</td>
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<tr>
<td>Comments</td>
</tr>
</tbody>
</table>

ASHRAE = American Society of Heating, Refrigerating, and Air Conditioning Engineers

Heat for all areas of the treatment building will be achieved by the use of air-to-air heat pumps to minimize energy costs. Electric heating coils will be provided as a backup to the heat pump.

Packaged, wall-mounted direct expansion cooling and heating systems will provide the cooling required for the Headworks facility.

#### C.1.8.8 Process Support Fume Hood

The process support area will have a small fume hood similar to a 30-in. Cole Palmer Labconco 3030000. This fume hood has a built-in exhaust fan and controls. It is compact and designed for use in a small process support space.

The HVAC system is sized to accommodate the air flow required for the hood, which is roughly 300 cfm. The exhaust is ducted to the outside of the treatment building.
C.1.9  FIRE PROTECTION

This section summarizes the preliminary fire protection systems for the OF200 MTF as well as the overall fire protection design approach. The systems described herein include the following:

- Fire suppression system water supply
- Fire suppression systems
- Fire department access
- Fire extinguishers
- Fire alarm and mass notification system (MNS)

C.1.9.1  Fire Suppression System Water Supply

A new 8-in. fire main will be routed from the Y-12 site underground fire water supply into the MTF facility at a coordinated location; a dedicated room is not provided. The water service/system riser will be located near a door with immediate outside access.

A post-indicator valve will be provided on the new fire service main. A tamper switch will be provided on the valve and connected to the building fire alarm system. The post-indicator valve will be provided with a padlock keyed to match Y-12 site standards. A double-check backflow preventer will be installed near the system riser where the fire service enters the MTF building.

The construction contractors’ fire sprinkler subcontractor will perform a fire hydrant flow test in accordance with National Fire Protection Association (NFPA) 291 requirements so that facility fire suppression systems can be hydraulically calculated.

C.1.9.2  Fire Suppression System

The MTF facility will be protected throughout by a fully automatic wet pipe sprinkler system designed in accordance with NFPA 13 requirements. The system will be hydraulically designed by the construction contractor. The sprinkler system inspector’s test drains will discharge at the exterior wall to grade, materials in concealed spaces will be noncombustible, and cabling will be in conduit or will be plenum rated.

The classification of the facility will be predominantly Ordinary Hazard Group 2. The sprinkler design area for ordinary hazard will be 1500 sf. The light hazard classification will not be used. No high pile or rack storage is anticipated. Miscellaneous storage under 12 ft in height will meet the requirements to be protected as Hazard Group 2. Hose allowance will be 100 gpm for light hazard and 250 gpm for ordinary hazard. Water velocity in the sprinkler piping cannot exceed 20 ft per second. Calculations will have a 10 psi or 10 percent safety factor, whichever is greater.

The spare head sprinkler cabinet, zone map, hydraulic design information sign, and hydraulic design data chart will be installed next to the fire riser as well as any additional requirements of NFPA 13.

Throughout the facility, sprinkler heads will be a quick response type, except in areas classified as extra hazard. Sprinklers in rooms with finished ceilings will be recessed types with
chrome-finish sprinkler heads and escutcheons. Sprinkler heads in ceilings with grid-supported tile will be centered in the ceiling grid. Sprinkler heads in rooms without finished ceilings will be upright brass sprinkler heads.

The drawings show the preliminary fire water service into the building, location of the fire riser and header arrangement, and details of the fire protection systems. The actual layout of the sprinkler piping and sprinkler head locations will not be shown on drawings. Performance specifications will outline the system design requirements and include the materials and equipment needed for the fire protection systems.

The fire sprinkler subcontractor licensed by the State of Tennessee Fire Marshal will complete the design, including piping, hanger and head locations, hydraulic calculations, etc., and will install and test all fire protection systems and materials during construction. Shop drawings and hydraulic calculations for the fire protection system will be prepared by a National Institute for Certification in Engineering Technologies (NICET) Level III- or IV-certified fire protection specialist or a Registered Fire Protection Engineer.

A lock box (KNOX-BOX) will be installed at the main entrance to the facility.

**C.1.9.3 Fire Alarm and Mass Notification System**

A combined fire alarm and MNS will be provided that will include a fire alarm control panel, mass notification control panel, fire alarm remote annunciator, local operating console, autonomous control unit, annunciator, alarm initiating devices, alarm notification appliances, signaling devices, wiring, and testing. The fire alarm system will be Underwriter’s Laboratory (UL) listed, addressable, zoned, and noncoded with full control, supervisory, alarm, signal, display, Class A pathways, and battery backup features in compliance with NFPA 72 requirements.

A solid-state, electronic fire alarm system will be installed that consists of double-action manual pull stations at mechanical and electrical rooms and at all building exits at grade; combination speakers and strobes throughout each building that illuminate clear for alarm and amber for MNS; smoke detectors in the required air-handling units in both supply and return ducts; and magnetic hold-open devices with smoke detectors for corridor fire doors as required.

Fire alarm wiring will be in a minimum three-fourth-in. conduit, factory-painted red. Signal line circuit and initiating device circuit conductors will be at least No. 18 American wire gauge (AWG) solid copper. Audible notification appliance circuit (NAC) conductors will be a minimum of No. 16 AWG solid copper. Visual NAC conductors will be at least No. 14 AWG solid copper. Conductor gauge will be increased according to voltage drop calculations submitted by the contractor for approval before installation.

The fire alarm control panel and MNS control panel will be near the fire sprinkler riser. A remote annunciator panel will not be provided unless directed otherwise by the authority having jurisdiction.

The fire alarm system audible notification will be muted upon activation of an MNS announcement.
A weatherproof horn or bell with a strobe light will be located on the exterior of the building at the fire protection fire sprinkler riser per NFPA 13 requirements.

The fire sprinkler subcontractor licensed by the State of Tennessee Fire Marshal will complete the design, including wiring, conduit and device locations, load calculations, and installation, including materials testing of the fire alarm/MNS systems. A NICET Level III- or IV-certified Fire Protection Specialist or a Registered Fire Protection Engineer will prepare the fire protection system shop drawings and hydraulic calculations.

C.1.9.4 Fire Department Access

Fire Department access is provided around the perimeter of the building per NFPA and International Fire Code requirements. The new Fire Department connection for the facility will be a freestanding type located at hard surface areas for fire apparatus and within 150 ft of a fire hydrant accessible to a fire apparatus vehicle.

C.1.10 ELECTRICAL

This section summarizes the preliminary electrical design and overall electrical design approach. New overhead 13.8-kV, 3-phase electrical lines will provide power to the Headworks and MTF areas. The Headworks tie-in point to existing Y-12 13.8-kV, 3-phase power will be pole K1225, and the tie-in point to the MTF will be at pole K791.

The project facilities have lightning protection systems designed in accordance with NFPA 780 and UL 96A standards. Lightning/surge arresters are provided in each phase of the incoming overhead lines and at the high voltage terminals of the outdoor unit substation transformers.

C.1.10.1 480-V Electrical Distribution Systems

Separate electrical services will be provided for each site (Headworks and MTF). Services will consist of an outdoor secondary unit substation consisting of an integrated assembly of the following:

- Medium-voltage fused disconnect switch
- Step-down transformer
- Low-voltage switchgear consisting of one or more circuit breakers and auxiliary devices (metering equipment, surge arresters, impedance grounding systems, etc.)

At the headworks facility, the unit substation supplies power to low-voltage, metal-clad switchgear inside the Headworks building. In turn, the switchgear will distribute power to other loads in the Headworks. At MTF, the unit substation supplies power to MCC-A and MCC-B via two feeder circuits. In turn, MCC-A and MCC-B will distribute power to MCC-C and other loads in the treatment facility. The unit substation transformer will be outdoor, dry type, cast core, pad-mounted, and have a transition structure for the high- and low-voltage connections.

The 480V systems will be designed with high-resistance grounding. Grounding resistors will be 55 ohms to limit ground fault current to 5A.
Surge protection devices will be installed for all service entrance equipment at the origin (usually a panelboard) of all separately derived systems and in all outdoor panelboards. Digital power monitors at service entrances will be programmed to send an alarm contact closure to the plant automation system (supervisory control and data acquisition [SCADA] system) upon loss of supply voltage.

Unit substations and MCCs will have solid-state, electronic-power-quality metering with the communication capability for transmitting power information to a remote location.

Each facility’s power system will be evaluated to determine the need for harmonic mitigation in accordance with Institute of Electrical and Electronics Engineers (IEEE) 519.

Switchgear feeder circuit breakers and MCC main circuit breakers will be provided with microprocessor-based adjustable trip units with long-time, short-time, and instantaneous protective elements. Ground fault protective elements are not used on high-resistance grounded systems. Arc flash maintenance switches will be provided where appropriate to reduce incident energy from arcing faults at downstream locations.

C.1.10.2 Low-voltage Motor Control Center

Electrical protection for the low voltage distribution system meets the applicable guidelines of IEEE 242 as follows:

- Starters and AFDs for 460-V motors will be equipped with molded case magnetic-only circuit breakers (motor circuit protectors) for motor short-circuit protection.
- Motors controlled by full-voltage starters will utilize microprocessor-based overload relays for overload protection. Motors controlled by AFDs will take advantage of the programming internal to the drive for overload protection.
- Non-motor feeders will be equipped with molded case breakers with thermal and magnetic trip elements for overload and short circuit protection.
- Motor operated valves will be protected by thermal overload devices.

Panelboards will be in accordance with National Electrical Manufacturing Association (NEMA) Standard PB1 and UL 67. Panelboards located indoors have NEMA Type 12 enclosures and those located outdoors have Type 3R enclosures with threaded hubs for conduits. Panelboards in washdown areas have Type 4 enclosures.

C.1.11 INSTRUMENTATION AND CONTROL

The instrumentation and control (I&C) system is intended to continuously and reliably control and monitor all facility processes. The major functions of the I&C system include the following:

- Package systems monitoring
- Continuous closed-loop control (analog proportional integral derivative control)
- Sequential/logic control (discrete equipment control)
• Alarm and event annunciation and status monitoring
• Historical data collection, storage, retrieval, and display

C.1.11.1 Design and Implementation Approach

The approach to designing an I&C system is to provide the construction contractor with detailed process and instrumentation diagrams and the information required to bid, supply, fabricate, wire, install, and interconnect the control system. The PFDs and preliminary piping and instrumentation diagrams are provided in the drawings. The construction contractor (I&C supplier) will prepare interconnecting wiring drawings as part of the shop drawing package. After the MTF facilities are constructed, the design drawings will be brought up to date and a final record set of as-built drawings prepared as part of Title III engineering will be submitted.

C.1.11.2 Control System Configuration

Over the past few years, the term SCADA has become accepted at most treatment plants to refer to a plant-wide, distributed-type process control system. For convenience, this section will sometimes refer to the MTF-wide control system as SCADA, which refers to the complete system of programmable logic controllers (PLCs) and human-machine interface (HMI) computers. There is no preference for a particular brand of PLC or HMI. Recommended brands commonly used in the industry are identified in the SCADA hardware and software table.

The PLC control processors will be distributed throughout the system as shown on the SCADA system block diagram provided in the drawings. The advantage of this distribution is that no single PLC can take down the entire system since the control processes will be distributed. If one PLC does go offline, the local subsystems can be run in the local manual mode, thus allowing some of the processes in other areas of the plant to continue functioning.

Redundant processors and power supplies are not required, but each panel will include additional space for future implementation. Each PLC panel will have a backup uninterruptible power supply (UPS) power unit. The purpose of the UPS is to provide a continuous and reliable power source to the PLCs and to prevent them from shutting down prematurely during a power outage. During a power outage, the PLCs will not be able to control the treatment system since other components in the system will be without power.

The PLC network will consist of PLCs in the following locations:

• PLC-1: Treatment Building Electric Room
• PLC-2: Treatment Building Plant Floor
• PLC-3: Headworks MCC-A (receives input/output [I/O] from Headworks MCC-B)

The SCADA system block diagram provided in the drawings depicts the major control components. The communications backbone between the various SCADA major components will be Ethernet-based.

The SCADA system will not monitor and control any remote facilities, but will be a stand-alone system. The MTF Treatment Building, however, can be connected to an outside network...
(e.g., Y-12 network through a connection provided by the Y-12 site operations prime contractor).

C.1.11.3 Plant Control System I/O List

A detailed I&C system I/O point list is part of the design. The preliminary estimated total system I/O signal count is expected to be about 1000 I/O points, including I/O monitoring points for package systems (e.g., grit system, filter presses, etc.). The preliminary I/O list is provided in the Division 40 Technical Specifications.

C.1.11.4 Reliability and Redundancy

The failure of a single I&C system component should not cause the overall SCADA system to fail. Likewise, the failure of a single PLC should not affect the operation of the entire facility, but only those subsystems associated with that particular PLC. Redundant processor controllers are not required. If a particular PLC fails, local control will continue to function.

As noted, each PLC will have its own UPS device. For critical applications, splitting multiple control signals onto separate I/O racks is recommended so components or subsystems will not fail if a single I/O card fails.

C.1.11.5 Equipment Control

All equipment controlled by the SCADA system will have a local ON/OFF/REMOTE switch. In the ON position, the equipment will operate; in the OFF position the equipment will not run; and in the REMOTE position the equipment will be controlled by the SCADA. REMOTE switch status will be monitored by the SCADA. ENABLE and PERMISSIVE interlock functions will be in the PLC software; however, personnel and equipment safety functions will be hardwired.

C.1.11.6 Motor Control Centers

Each MCC bucket will have a separate 120-V alternating current (AC) control power transformer. The RUN and STOP pilot lights will be provided on each bucket. Auxiliary run contacts must be used to connect to the SCADA. Pushbuttons or selector switches may be mounted on the MCCs.

All motor-driven equipment that is energized by an MCC starter and controlled from SCADA must have the following MCC interface:

- All motor-control devices, such as START/STOP pushbuttons and HAND/OFF/REMOTE selector switches, regardless of their location, will be energized from the MCC starter-control power transformer. Typically, the control devices will be located at the MCC rather than at the equipment.

- Control devices will be rated for a minimum of 3 amperes continuous at 120-V AC. If the starter coil requires more than 3 amperes, the MCC will be equipped with an internal, interposing control relay to handle the required load.

- If the motor control circuit has a HAND/OFF/REMOTE selector switch, an isolated contact indicating that the device is in REMOTE mode will be provided for monitoring by SCADA.
• Solenoid-operated valves, such as those for seal or dilution water, that are unique to the specific unit will be powered from the MCC, preferably from the starter-control power transformer.

• All interfaces for control and status of motor-driven equipment will be wired from the MCC.

C.11.7 Power Data Monitoring System

A complete Power Data Monitoring System (PDMS) will be provided that includes a power data monitoring field device for each MCC and substation. The system will gather electrical data on the entire unit in which it is installed (as opposed to monitoring each individual device within the MCC). The system includes the remote devices for monitoring, protection, device communication interface hardware, intercommunication wiring, software, and ancillary equipment as required.

The PDMS will monitor an array of electrical data, including such parameters as:

- Voltage line-to-line (L-L)
- Voltage line-to-neutral (L-N)
- Apparent power total
- Current
- Total harmonic distortion (THD) voltage L-L
- Power factor
- THD voltage L-N
- Real power total
- THD current
- Reactive power total
- Frequency

The PDMS will be of the same manufacturer as the PLC equipment and will use the same communication protocol as the PLC network. The data will be part of the SCADA data and be displayed on the SCADA workstations. It will support direct connection to additional computers anywhere on the network and the network will allow direct access to data provided by PDMS for implementing automatic control.

Each computer connected to the network has equal access to information provided by the power monitoring devices for centralizing data display, data logging, alarming, event recording, and other power monitoring operations. Each computer will be independent of the other computers with its own software to allow the user to retrieve and configure the information based on the user’s needs.

C.11.8 PLC I/O Signals

The PLCs will monitor and, in most cases, control all major process parameters and equipment. Monitoring and control signals will be interfaced to the PLCs at the various PLC or remote I/O cabinets throughout the MTF site. Wherever possible, the following standard signal types should be used:

- Discrete inputs: Dry contact in field rated for 120-V AC powered from 120-V AC source in the cabinet
• Discrete outputs: 16 points per card with interposing relays in the cabinet rated for 10 amperes at 120-V AC
• Analog inputs: 4 to 20 mA DC at 24-V DC into 750 ohms powered from the PLC cabinet or field
• Analog output: 4 to 20 mA DC at 24-V DC into 750 ohms powered from the PLC output module

C.1.11.9 Transmitters

“Smart” microprocessor-based field transmitters will be installed wherever possible. If handheld programmers are used to configure and calibrate instruments and transmitters, at least two of each type will be provided.

All field transmitters will be provided with a local signal indicator calibrated in percent or actual engineering units. The signal indicator should be integral to the field instrument if possible and may be an analog or discrete type; discrete indicators are preferred.

C.1.11.10 Control Panels

Package systems provide LCPs for individual package systems. In general, non-package system control panels (i.e., ACPs or local “backup” control panels) are not required. Where any panel is provided, space will be allowed for installation of future components, including redundant PLC processors and redundant PLC power supplies. At least 20 percent spare terminal blocks will be provided for future connections.

C.1.11.11 Pump and Equipment Motor-Drive Monitoring and Control

Adjustable-speed-drive systems may be AFD or DC silicon control rectifier type with the following control and monitoring functions:

• Status monitoring function to SCADA, including LOCAL/REMOTE selector switch in remote status and RUN status
• 4 to 20 mA DC speed control signal
• Common “fail” alarm signal to SCADA
• START/STOP control from REMOTE location (SCADA) when selector switch is in the REMOTE position
• Special “AFD Fail” alarms (e.g., high-temperature alarms and pump or equipment alarms) to SCADA as required for the specific application
• Local HAND/OFF/REMOTE selector switch and speed control device near the driven equipment for maintenance and testing functions
C.1.11.12 Chemical Metering Pumps

The chemical metering pumps will be monitored and controlled by the SCADA system. Unlike other pumps in the system, chemical pumps have local controls at the pump. The pumps will be AFDs where the AFD controls are located at the pump.

C.1.11.13 Uninterruptible Power Systems

Online UPSs will power the PLC enclosures and computer workstations to maintain reliable operation during power system disturbances and power outages. The UPS battery backup should have enough capacity to energize the equipment for 20 minutes after a power failure. The UPSs will not power field sensors or field equipment.

C.1.11.14 Surge Suppressors

Surge suppressors will be provided for all analog signals that originate outside buildings. All field instruments that require a 120-V power source will have 120-V surge suppressors. Power line surge suppressors will be provided for all control panels. Buildings will be provided with lightning protection systems if required by local codes.

C.1.11.15 Fiber Optic Networks

Data highway and network connections between buildings will be fiber optic. A complete MTF-wide fiber backbone system will be installed that will be used for the SCADA system. This fiber backbone system will also have spare capacity to serve the HVAC, fire alarm, security system, and other systems as required.

C.1.11.16 Field Element Selection and Application

This section provides selection and application guidelines for field instruments:

- Install bypasses around inline process flowmeters of 4-in. diameter and less if the process flow cannot be interrupted for maintenance.
- Mount analyzers so they can be removed from the process lines without disrupting the process.
- Mount transmitters for convenient reading and orient away from the sun as much as practical and provide shading.
- Furnish pressure gauges for all pump discharge piping. Other pressure gauges should be installed as required for proper process monitoring. Diaphragm or annular seals should be provided for pressure gauges for the specific fluid and pressure range being monitored.

C.1.11.17 Other Support Systems

- The emergency notification system will be designed to the Y-12 standard and interfaces with the existing Y-12 plant systems.
- The telephone and data communications system will be designed to meet the Y-12 interconnect to the existing site systems.
• The fire alarm system is currently being designed to comply with the Y-12 standard based on the assumption that OREM will utilize the Y-12 site services for fire protection.

• The MTF areas are considered as nonhazardous classification.

• The design does not require an alternate power source (standby power) for the process, mechanical, and building services electrical systems.

• The main pedestrian entrance to the treatment building will have a security card controlled entry. However, extension of the existing Y-12 site badge readers or security detection and annunciation system(s) shall not be provided. The treatment building and outdoor process areas will not be provided with any type of access control such as key cards, key pads, door switches, motion sensors, or similar equipment.

C.1.12 OTHER SUPPORTING DISCIPLINES

C.1.12.1 Nuclear Safety

The PHAR was issued in September 2015, followed by a subsequent OREM SVR approving the PHAR, to capture the project design as defined at the time. The SVR contains no conditions for proceeding to the next stage of design. Consistent with DOE O 413.3B and direction from OREM, the PHAR will transition to a Hazard Assessment Report (HAR) to support CD-2/3. The HAR will incorporate any additional design information, new hazards, or controls. After the PHAR transitions to an OREM-approved HAR, the UCD process will be utilized prior to construction to review activities covered by the HAR to ensure they are bounded and represented by the basis and screening activities of the HAR.

The PHAR hazard categorization and classification was performed in accordance with the methodology described in DOE standard DOE-STD-1027-92, Chg. 1, Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports as implemented by UCOR Nuclear Facility Safety. While there are low levels of radioactivity in the water being treated by MTF, the large volumes of water in the system during operations and the associated solids accumulating in the system and waste being generated (e.g., grit and filter cake solid waste) do not challenge the Hazard Category 3 threshold quantity. The hazard categorization of the facility is determined to be less than nuclear Hazard Category 3 ‘Radiological by inventory’.

No nuclear safety (safety class or safety significant) structures, systems, and components are required, and the inventory is expected to be exempt from a Nuclear Criticality Safety Document or a Nuclear Criticality Safety Evaluation based on the mass and concentration in the system.

While the chemicals being added are routinely used in standard industrial applications, the total facility inventory of some chemicals, including sulfuric acid being added for treatment, exceed the 40 CFR 302.4 Reportable Quantity. Therefore, the non-radiological hazard classification for the facility is High.