Cripple Creek & Victor Gold Mining Company
Squaw Gulch VLF Phase 1 (9,450' to 9,550' Bench)
Final Report
Quality Assurance Monitoring & Test Results
October 2015

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PROJECT REPORT ACRYONYMS

Abbreviation	Definition
ADR	Adsorption Desorption Recovery
ADS	Advanced Drainage System
AMEC	AMEC Environment & Infrastructure, Inc.
Amec Foster Wheeler	Amec Foster Wheeler Environment & Infrastructure, Inc.
Ames	Ames Construction, Inc.
ASTM	American Society for Testing and Materials
CC&V	Cripple Creek & Victor Gold Mining Company
cfs	Cubic Feet per Second
CP	Concrete Plugs
CPe	Corrugated Polyethylene
CQA	Construction Quality Assurance
CQC	Construction Quality Control
CRF	Cemented Rockfill
CSB	Coarse Shaft Backfill
DCF	Drain Cover Fill
DRMS	Division of Reclamation, Mining and Safety
ECA	ECApplications, Inc.
HDPE	High Density Polyethylene
HVSCS	High Volume Solution Collection System
IFC	Issued for Construction
LDF	Leak Detection Fill
LDS	Leak Detection System
LGP	Low Ground Pressure
LLDPE	Linear Low Density Polyethylene
MLRB	Mined Land Reclamation Board
psi	Pounds per Square Inch
PSSA	Pregnant Solution Storage Area
ROC	Record of Construction
SLF	Soil Liner Fill
SSF	Select Structural Fill
SGVLF	Squaw Gulch Valley Leach Facility
SSMS	Single-sided microspike
SF	Structural Fill
VLF	Valley Leach Facility
UF	Underdrain Fill

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1.0 INTRODUCTION

The Cripple Creek & Victor Gold Mining Company (CC&V) operates the Cresson Project, located in Teller County, Colorado, near the city of Victor. CC&V was owned and managed by AngloGold Ashanti (Colorado) Corp. (AngloGold Ashanti) and was recently purchased in 2015 by Newmont Mining Corporation. The Cresson Project is a gold mining and ore processing facility which comprises open pits, crushers, a lined Valley Leach Facility (VLF), gold recovery plant, and associated infrastructure, all of which were designed and constructed to meet or exceed the requirements established by C.R.S. §34 32 101 et seq. and regulations promulgated there under by the Mined Land Reclamation Board (MLRB).

The work associated with the Cresson Project is being performed under specific criteria established in Amendment No. 10 of Permit Number M-1980-244, as approved by the MLRB. This report documents the Construction Quality Assurance (CQA) and Construction Quality Control (CQC) services provided by Amec Foster Wheeler Environment & Infrastructure (Amec Foster Wheeler) from November 2014 through September 2015 for the Squaw Gulch Valley Leach Facility (SGVLF) Phase 1, between the 9,450 foot and 9,550 foot benches, which is defined in Section 1.6. The general site location is presented on Figure 1, and the Construction and Geomembrane Installation Limits are presented on Figure 2.

1.1 Project Description

The initial Cresson VLF Project was designed in 1993 and constructed in phases since 1994 under Amendment Nos. 6, 7, 8, and 9 to Mining Permit M-1980-244. This certification report addresses the addition of approximately 31.18 acres (1.36 million slope-adjusted square feet) plan area, constituting a portion of the earthen and synthetically lined area of a new valley leach facility. This area is referred to as the SGVLF Phase 1 (9,450 foot bench to 9,550 foot bench), and was designed to meet the criteria presented and approved in Amendment No. 10 of Permit Number M-1980-244.

Ames Construction Inc. (Ames) was the earthworks contractor for the Project. They performed construction activities from November 2014 through September 2015. Agru America manufactured the geomembrane used to construct the PSSA. Tensar manufactured the geogrid used in the underground workings remediation. ECApplications, Inc. (ECA) installed geomembrane liner from June 2015 through September 2015. Messrs. Ron Roberts, Ron DiDonato, Jeff Gaul, and Scott Redabaugh represented CC&V as the Construction Manager and Construction Superintendents, respectively. All quantities and testing frequencies presented in this report are current as of September 2015, which represents completion of the Phase 1 VLF 9,450 foot to 9,550 foot bench, as detailed in this report.

1.2 Construction Quality Assurance/Construction Quality Control

Amec Foster Wheeler provided CQA and CQC monitoring and testing services, and prepared this report describing the results for the Phase 1 VLF 9,450 foot to 9,550 foot bench. Record of construction drawings and supporting CQA monitoring and testing documentation are presented in appendices attached to this report.

1.2.1 CQA Monitoring of Earthworks

Amec Foster Wheeler provided CQC testing and CQA testing and monitoring of earthworks for the Phase 1 VLF 9,450 foot to 9,550 foot Project. CQA testing and monitoring of earthworks was provided for in-place materials in accordance with the AMEC Earthworks CQA Plan (Section 1400.1 of the project technical specifications; see Appendix E). The earthworks material specifications for this project are summarized in Table 3. CQC earthworks test results were provided to support the contractor during the manufacturing of materials and prior to material placement. The CQC test results are not included in this report as these tests were intended to assist the contractor in materials preparation rather than record testing. All CQA testing results are included.

Amec Foster Wheeler provided CQA laboratory and field testing, and monitored earthworks construction activities as follows:

- Observe and document historic underground working remediation within the Phase 1 footprint, including verification that Ames excavated underground workings to the minimum specified dimensions and placed coarse shaft backfill (CSB), concrete plugs (CP), cemented rockfill (CRF), or structural fill (SF) as specified on the Issued for Construction (IFC) Drawings. Note that remediation of all underground workings located within the Phase 1 VLF footprint are complete and included with this report.

- Amec Foster Wheeler monitored topsoil stripping, site grading, slope re-contouring, and SF placement, to include lift thickness, moisture conditioning, temperatures, compactive effort, in-place nuclear density testing, or monitored placement according to the method specification, and use of suitable SF materials. The materials were monitored during placement to confirm that the subgrade surface was unyielding, free from unsuitable and organic materials and was acceptable for soil liner fill (SLF) placement. Amec Foster Wheeler performed CQA laboratory testing of grain size and Atterberg limits.

- Amec Foster Wheeler monitored construction of the Leak Detection System (LDS), including verification that Ames excavated the trench to the minimum required dimensions and placed materials as specified. Laboratory testing performed by Amec Foster Wheeler consisted of grain size and Atterberg limits of the Leak Detection Fill (LDF) placed in the LDS.

- Observe and document construction of secondary and tertiary underdrains, including verification that Ames excavated the trenches to the minimum required dimensions and grades, and placed the materials according to the project technical specifications. Amec Foster Wheeler performed CQA laboratory testing of grain size, Atterberg limits, and moisture content of underdrain fill (UF) and select structural fill (SSF).
- Observe and document SLF placement including observation of depth verification performed by Ames, grain size, moisture conditioning, and compaction of the material. Amec Foster Wheeler performed in-place nuclear density and moisture testing and CQA laboratory testing of grain size, moisture content, Atterberg limits, Proctor, and permeability. Amec Foster Wheeler also provided visual monitoring of the SLF surface preparation and moisture conditioning for geomembrane placement to include a rolled, compacted surface free of desiccation cracks, abrupt grade changes, and sharp stones. Observation of excavation, backfill, and compaction of anchor trenches occurred as part of SLF placement.
- Observe and document drain cover fill (DCF) placement above the 80-mil double-sided microspike LLDPE geomembrane within Phase 1 VLF (9,450 foot to 9,550 foot bench) to include verification of lift thickness, grade control, removal of deleterious materials, and that care was exercised in DCF placement to avoid geomembrane damage. Amec Foster Wheeler performed CQA laboratory testing of grain size and Atterberg limits.
- Observe and document installation of HVSCS piping.
- Monitor and document the ambient air temperatures and the temperatures of the fill materials, including SLF, in accordance with the project technical specifications. The ambient air and fill temperatures monitored during fill activities are presented on Tables 1 and 2, respectively. Note: The ambient air and fill temperatures are reported through September 2015. Reporting of this data is continued from the PSSA ROC report issued November 2014 by AMEC.

1.2.2 CQA/CQC Monitoring of Geosynthetics Installation

Amec Foster Wheeler provided CQA monitoring of geosynthetics used for Phase 1 VLF (9,450 foot to 9,550 foot bench). CQA services consisted of performing geosynthetics inventory and checking quality control certifications prior to geosynthetics deployment. CQA activities were performed in accordance with the Geosynthetics CQA Plan (Section 1400.2 of the project technical specifications, located in Appendix E). Geosynthetics CQA activities included:

- Inventory of geosynthetic materials delivered to the project site
- Review and approval of manufacturer and third party conformance certificates
- Observation of geotextile installation

- Observation and documentation of geomembrane installation
- Observation and documentation of trial welds
- Observation and documentation of defects and repairs
- Observation and documentation of destructive and non-destructive testing

1.3 Project Coordination

CQC and CQA activities were directed by the Amec Foster Wheeler Project Resident. The Project Resident for the construction of Phase 1 VLF (9,450 foot to 9,550 foot bench) between November 2014 and March 2015 was Mr. Tim Burkhard, April 2015 was Michael Moore, and from May 2015 to present, Mr. Robert Redd. The Project Manager, Ms. Andrea Meduna, PE, or Brett Byler, PE, made periodic site visits to resolve technical issues and to review Amec Foster Wheeler activities. Appendix C presents a summary of the Amec Foster Wheeler staff on-site during the construction period.

Representatives of CC&V, Ames, ECA, and Amec Foster Wheeler conducted pre-construction, daily, and weekly coordination meetings throughout the construction period.

1.3.1 Daily Construction Summary Reports

Amec Foster Wheeler prepared daily construction summary reports as well as photographic documentation (Appendix B) throughout the project to document the key elements of construction and the CQA activities. On-site CQA personnel and the Project Manager discussed construction activities on a regular basis; in addition, field personnel prepared daily observation reports. Amec Foster Wheeler submitted these daily summary reports to CC&V. Daily reports are not included in this report, but were available for the Colorado Division of Reclamation, Mining and Safety (DRMS) review during the course of the project.

1.3.2 Weekly Construction Summary Reports

Amec Foster Wheeler prepared weekly construction summary reports which were submitted to CC&V and to the DRMS. Weekly reports from the period of mid-November 2014 through mid-September 2015 are presented in Appendix D. Weekly construction summary reports are continued from the PSSA ROC report issued November 2014 by AMEC.

1.4 Project Technical Specifications

All work was performed in accordance with the design plans and project technical specifications presented in Amendment No. 10 of Mining Permit M-1980-244 and subsequent revisions, as approved by DRMS. IFC Drawings relevant to the construction are presented in the Drawings section of this report, and project technical specifications are presented in Appendix E. Any deviations from the IFC drawings or project technical specifications are discussed in Section 7.0 of this report.

1.5 Record Survey Documentation

Ames provided the record of construction drawings for the activities associated with the Phase 1 VLF (9,450 foot to 9,550 foot bench) construction. A Colorado Registered Professional Land Surveyor prepared the record drawings presented in Appendix A. The Surveyor's professional license is presented in Appendix F. Ames also provided locations for SLF density tests, SLF depth verification, geomembrane panels, and destructive tests of geomembrane seams, which were used by Amec Foster Wheeler to develop test summaries and the geomembrane panel record of construction drawings (Drawing Nos. 6, 7, and 8 in Appendix A).

1.6 Certification Boundary

Figure 2 presents the Construction and Geomembrane Installation Limits of the Phase 1 VLF (9,450 foot to 9,550 foot bench) that is being certified by this report. The certification boundary includes only a portion of the Phase 1 VLF footprint and includes remediation of historic underground workings; site grading; closure drain installation; underdrain installation; SLF placement and compaction; installation of 80-mil double-sided microspike (DSMS) low linear density polyethylene (LLDPE) geomembrane; and DCF placement.

A second ROC report will be submitted to DRMS in 2015 and will include the area of the Phase 1 VLF completed during the 2015 construction season above the 9,550 foot bench.

2.0 SUMMARY OF EARTHWORK CONSTRUCTION

Earthworks activities associated with the Phase 1 VLF (9,450 foot to 9,550 foot bench) included the following:

- Historic underground workings remediation including excavation, confirmatory drilling, and installation of CSB, CP, or CRF.
- Site grading and subgrade preparation including cut and placement of SF
- Blasting of materials for remediation of underground workings and site grading
- Secondary, and tertiary underdrain construction, including trench excavation, installation of 12 oz/yd^2 geotextile, placement of UF and SSF
- LDS installation including placement of 12 oz/yd^2 geotextile, leak detection pipe, and LDF material
- SLF installation, including placement and compaction, depth verification testing, and preparation of SLF surface for geomembrane deployment
- DCF placement above the 80-mil DSMS geomembrane layer and around the HVSCS

Ames generally used the following equipment during construction:

- Caterpillar D6 Low Ground Pressure (LGP) Dozer
- Caterpillar D7 LGP Dozer
- Caterpillar D8 LGP Dozer
- Caterpillar D9 LGP Dozer
- Caterpillar D9 Dozer
- Caterpillar D10 Dozer
- John Deere Skidsteer
- Caterpillar 750 Skidsteer
- Bobcat Skidsteer
- Caterpillar 950 Loader
- Caterpillar 988 Loader
- Caterpillar 992 Loader
- Caterpillar 993 Loader
- John Deere 544 Loader
- Caterpillar 14H Motor Grader

- Caterpillar CS563 Compactor
- Caterpillar CS663 Compactor
- John Deere 35D Excavator
- Caterpillar 312 Excavator
- John Deere 200 Excavator
- Caterpillar 304 Excavator
- Caterpillar 330 Excavator
- Caterpillar 345 Excavator
- Caterpillar 375 Excavator
- Caterpillar 385 Excavator
- John Deere 850 Excavator
- John Deere 120 Excavator
- Tamrock Track Mounted Drill
- Sandvik Track Mounted Drill
- Caterpillar 740 Haul Truck
- Caterpillar 777 Haul Truck
- Water Trucks

Weather data for the Phase 1 VLF (9,450 foot to 9,550 foot bench) construction activities from the period of mid-November 2014 through end of Phase 1 VLF (9,450 foot to 9,550 foot bench) construction in mid-September 2015 are presented in Table 1.

2.1 Underground Workings Remediation

Historic underground workings within the footprint of the entire Phase 1 VLF footprint were remediated following the recommended remediation plans presented on IFC Drawing Nos. A60 through A67 in the Drawings section of this report.

Figures and a summary of the historic underground workings remediation are presented in Appendix M.1. The table shows the underground working identification, location (northing and easting), type of working, remediation quantities, and comments. The following sections provide a summary of the general remediation methods for the historic underground workings within the Phase 1 VLF footprint. The record drawing of the underground working locations is presented in Appendix M.2.

2.1.1 Remediation of Shafts, Stopes, and Shallow Surface Pits

The following is a general approach used to remediate isolated shafts and shallow surface pits:

Open Workings:

For open workings, the excavations were backfilled with CSB to approximately 10 feet below the finished surface grade. The surface of the CSB was compacted using the bucket from a Caterpillar excavator. A minimum 3-foot-thick CP was cast into the shaft and allowed to cure for a minimum of 7 days. A minimum 7-foot-thick layer of CRF was then placed onto the CP. SF was then placed to the final grade as needed. In some cases, the excavation did not require placement of CSB prior to placement of the CP and CRF.

Collapsed Workings

For collapsed workings, collapsed materials were excavated to a depth of 25 feet below finished grade. The excavations were either backfilled with CSB to approximately 3 feet below the soil/bedrock interface or shaped for placement of a CP. The surface of the CSB was compacted using the bucket from a Caterpillar excavator. A minimum 3-foot-thick CP was cast into the shaft and allowed to cure for 7 days. A minimum 7-foot-thick layer of CRF was then placed over the CP. After the CRF was allowed to cure, SF was then placed to the final grade as needed.

Shallow Surface Pits

Shallow surface pits that were less than 25 feet below the final SLF grade were excavated to bedrock or pit termination. The pits were then backfilled with compacted SSF and SF to the bottom of the SLF layer. In some cases, shallow surface pits were completely removed during slope re-contouring and required no further remediation.

2.1.2 Remediation of Lateral/Inclines/Adits

A number of laterals and adits were identified within the Phase 1 VLF footprint. Per the remediation recommendations, historic underground workings were identified within 50 feet of the existing grade elevation and remediated. Workings that were 50 feet or more below the final grade were not remediated.

Remediation for laterals and adits consisted of drilling nominal 3-inch-diameter blast holes into the crown pillar (the rock between the ground surface and the roof of the working) using a pneumatic hammer track drill rig. The blast holes were loaded and the crown pillars blasted into the void. For some of the shallower workings, the blasted material was excavated and replaced with compacted fill. For deeper blasted laterals that could not safely and fully be excavated, three layers of geogrid separated by a layer of SSF was placed 15 feet beyond the mine working limits.

All blast holes that did not intercept the historic underground working or were not incorporated in the blast were completely grouted with bentonite slurry prior to blasting the crown pillar and remediating the working.

Historic underground working remediation activities within Phase 1 VLF were performed from February 2013 through August 2015.

2.2 Underdrains

2.2.1 Secondary Underdrain System

Ames constructed approximately 632 linear feet of secondary underdrain. Record Drawing No. 3 shows the location of the secondary underdrain system. Details of the secondary underdrain system can be found on IFC Drawing A250 and a plan view of the locations within the Phase 1 VLF (9,450 foot to 9,550 foot bench) on IFC Drawing A200. The cross-section dimension of the secondary underdrain was 4 feet wide by 2 feet deep, providing a cross-sectional area of 8 square feet as shown on IFC Drawing A250. Ames excavated each secondary underdrain trench to the minimum dimensions, and placed geotextile and UF in the trench. SSF was then placed over the geotextile to a minimum depth of 6 inches. The secondary underdrain geosynthetic installation is discussed further in Section 3.1. Approximately 234 cubic yards of UF, 14 cubic yards of SSF, and 9,470 square feet of geotextile were used to construct the secondary underdrain.

2.2.2 Tertiary Underdrain System

Ames constructed 2,840 feet of tertiary underdrain. Record Drawing No. 3 shows the location of the tertiary underdrain system. Details of the tertiary underdrain system can be found on IFC Drawing A250. The cross-section dimension of the tertiary underdrain was 3 feet wide by 2 feet deep, providing a cross-sectional area of 6 square feet as shown on IFC Drawing A250. Ames excavated each tertiary underdrain trench to the minimum dimensions, and placed geotextile and UF in the trench. SSF was then placed over the geotextile to a minimum depth of 6 inches. The tertiary underdrain geosynthetic installation is discussed further in Section 3.1. Approximately 632 cubic yards of UF, 316 cubic yards of SSF, and 25,566 square feet of geotextile were used to construct the tertiary underdrain.

2.3 Site Grading

Prior to SF placement, Ames moisture conditioned and compacted the subgrade surface of the fill areas. Amec Foster Wheeler monitored the preparation of the subgrade and verified that it met project technical specifications. In native ground, the in-situ material was scarified to a depth of approximately 6 inches prior to SF placement. The SF material was placed in approximately 2-foot-thick loose lifts and compacted with a minimum of four passes by a smooth drum vibratory roller. Ames placed approximately 82,264 cubic yards of SF for site grading in and around the Phase 1 VLF (9,450 foot to 9,550 foot bench).

2.4 Subgrade Preparation

Prior to SLF placement, Ames moisture conditioned and compacted the surface of the 2014/2015 Squaw Gulch VLF with a smooth drum vibratory roller. The quality of the finished surface was maintained until SLF was placed.

2.5 Leak Detection

Ames constructed approximately 1,618 linear feet of leak detection trench within the Phase 1 VLF (9,450 foot to 9,550 foot bench). The as-constructed LDS is shown on Record Drawing No. 5 in Appendix A.

Detail V on IFC Drawing A260 shows a typical leak detection trench section. Ames excavated the trench to a minimum of 1-foot by 1-foot cross-sectional dimension, and at a minimum one percent slope gradient. Ames placed 40-mil smooth LLDPE geomembrane material, a layer of 12-oz/yd^2 non-woven geotextile material, one 3-inch diameter perforated corrugated polyethylene (PCPE) pipe, and LDF in the trench. Ames placed approximately 60 cubic yards of LDF, 8,090 square feet of 40-mil smooth LLDPE geomembrane, 8,090 square feet of 12-oz/yd^2 non-woven geotextile, 1,611 linear feet of PCPE, and 7 feet of solid DR13.5 HDPE pipe for continuation outside of the certified area. The LDS geosynthetics installation is discussed further in Section 3.2.

2.6 Soil Liner Fill

Based on neat line survey, Ames placed and compacted approximately 49,642 cubic yards of SLF to the project technical specifications. Record Drawing No. 2 in Appendix A presents the as-built surface of the SLF.

Ames processed the SLF from both the Cameron and Squaw borrow areas for the Phase 1 VLF (9,450 foot to 9,550 foot bench) construction from February 2013 through June 2014. The borrow material was worked through a custom-designed rotary mill and screen to remove oversized material from the SLF and to uniformly condition the material prior to stockpiling.

Ames began placing SLF for the Phase 1 VLF (9,450 foot to 9,550 foot bench) October 2014 and completed placement in September 2015. The SLF was compacted to a minimum thickness of 12 inches by a smooth drum vibratory compactor. Amec Foster Wheeler witnessed depth verification tests performed by Ames to confirm appropriate fill thickness. Areas where the SLF thickness was found to be non-compliant with the project technical specifications were re-worked and re-tested until the area was compliant. The depth verification is discussed further in Section 4.2.4. The specified minimum density was 95 percent of the maximum dry density at -2 percent to +3 percent of optimum moisture content as determined by standard Proctor tests performed by Amec Foster Wheeler. Areas of the SLF that failed to meet the moisture density requirement were moisture conditioned, re-compacted, and re-tested until passing results were achieved.

2.7 Phase 1 VLF (9,450 foot to 9,550 foot bench) Composite Liner System

The Phase 1 VLF (9,450 foot to 9,550 foot bench) is a single geomembrane composite liner system:

- The composite liner system in the Phase 1 VLF (9,450 foot to 9,550 foot bench) consists of a minimum of 12 inches of compacted SLF overlain by a layer of 80-mil DSMS LLDPE geomembrane.
- The HVSCS is installed over the geomembrane liner. The HVSCS consists of HVSCS piping and DCF placed at a minimum of 2 feet thick. The HVSCS is discussed further in Section 2.8.

The installation of the geomembrane layers for the Phase 1 VLF (9,450 foot to 9,550 foot bench) began October 2014 and was completed in September 2015. ECA installed approximately 1,340,345 square feet (neat line) of 80-mil DSMS LLDPE geomembrane liner according to the project technical specifications.

Geomembrane installation for the Phase 1 VLF (9,450 foot to 9,550 foot bench) is discussed further in Section 3.3. Ames anchored geomembrane in an anchor trench measuring 3-feet-deep by 2-feet-wide (see IFC Drawing A220 for details). Ames backfilled the anchor trenches with suitable anchor trench backfill material. In places where future geomembrane liner covers the anchor trench, SLF material was used to backfill the top 12 inches of the anchor trench. Ames placed anchor trench backfill in maximum 12-inch-thick compacted lifts. Anchor trench backfill was compacted with a hand operated, minimum of 500 pound, vibratory compactor and “Jumping Jack” compactors, or a smooth drum vibratory roller, if appropriate, to the project technical specifications.

2.8 High Volume Solution Collection System

The HVSCS is comprised of HVSCS piping and drain cover fill. The HVSCS piping layout and details are presented on IFC Drawings A400 and A410.

Ames installed approximately 13,395 linear feet of 4-inch-diameter perforated CPe tertiary HVSCS pipe, 576 linear feet of 8-inch-diameter, 1,440 linear feet of 12-inch-diameter, and 2,106 linear feet of 24-inch-diameter perforated CPe secondary HVSCS pipe

Ames began installing the perforated CPe HVSCS pipe in April 2015 and completed in September 2015. Pipe locations are shown on Record Drawing No. 4 in Appendix A. Ames placed DCF under the pipe haunches and kept pipes in place during DCF placement.

2.9 Drain Cover Fill

Ames began placing DCF in April 2015. DCF placement was in progress (i.e., not completed) in the Phase 1 VLF between the 9,450 foot and 9,550 foot benches at the submittal of this report. The DCF was processed by Ames from September 2013 through November 2014 by screening crushed overburden material from the Cresson Project over a vibrating 1-½-inch screen to remove oversize material. Ames placed approximately 10,624 cubic yards (neat line) of DCF per the project technical specifications. The material was placed in a minimum 2-foot-thick lift over the geomembrane and in a 4-foot-thick lift where Caterpillar 740 haul trucks travelled over the geomembrane during construction. During fill placement, Polyvinyl Chloride (PVC) grade markers with end caps to protect the geomembrane from damage were placed at grade breaks and on a maximum 50 foot wide by 50 foot long grid. After DCF placement, PVC grade markers were removed and Ames performed any additional final grading. Ames placed DCF in an uphill direction on any slopes steeper than 4H:1V.

3.0 GEOSYNTHETICS INSTALLATION

Geosynthetics installed consisted of geotextile and geomembrane. Non-woven geotextile (12 oz/yd^2) manufactured by TenCate Geosynthetics was used to construct the secondary and tertiary underdrains within the limits of the Phase 1 VLF (9,450 foot to 9,550 foot bench). The geomembrane liner system includes 80-mil LLDPE DSMS LLDPE geomembrane manufactured by Agru America. The 40-mil LLDPE smooth geomembrane was used in the LDS.

3.1 Underdrain System

Geosynthetics installation for the secondary and tertiary underdrains was performed by Ames and included deployment of 12 oz/yd^2 non-woven geotextile. Ames installed approximately 35,036 square feet of geotextile to construct the underdrains. Underdrain construction is discussed further in Section 2.2.

3.2 Leak Detection System

Ames installed approximately 8,090 square feet of 40-mil smooth LLDPE geomembrane and 8,090 square feet of 12-oz/yd^2 non-woven geotextile for construction of the LDS. To construct the LDS, Ames placed a layer of 40-mil smooth LLDPE geomembrane in the trench and placed geotextile over the geomembrane. After the piping and the LDF were placed in the trench, the geotextile was wrapped around the fill with a minimum 1-foot overlap as shown on Detail V of IFC Drawing A260.

3.2.1 40-mil Smooth LLDPE Geomembrane

The 40-mil Smooth LLDPE geomembrane liner was used to construct the leak detection trench. The liner was installed in long “strips” with a 5-foot overlap. Liner conformance testing was performed on the geomembrane. The conformance testing is presented in Appendix I.7. An Amec Foster Wheeler representative was present during installation and construction of the leak detection trenches.

3.3 Phase 1 VLF (9,450 foot to 9,550 foot bench) Geomembrane Liner System

Geomembrane installation activities for the geomembrane liner system include deployment; seaming; and non-destructive and destructive testing of 80-mil DSMS LLPDE geomembrane. Ames anchored geomembrane at the limits of the bench in a minimum 2-foot-wide, by 3-foot-deep anchor trench. All geomembrane was placed on compacted and approved SLF. Geomembrane panels were designated with a “P” followed by an individual panel number. Some panels were deployed outside of this report’s approval area, but numbering remained consecutive. A total area of 1,423,241 square feet of primary geomembrane liner was deployed. See ROC Drawing Nos. 6, 7, and 8 in Appendix A for the as-built panel layout.

4.0 EARTHWORK CQA TESTING AND MONITORING

The following sections summarize results of the earthwork CQA testing and monitoring performed by Amec Foster Wheeler.

Amec Foster Wheeler performed CQA testing of in-place materials used for construction of the Phase 1 VLF (9,450 foot to 9,550 foot bench) project. Table 4 presents specified and observed CQA testing frequencies. Figure 2 shows the construction and geomembrane installation limits and coordinate system used to locate tests.

In accordance with the AMEC Earthworks CQA Plan (Section 1400.1 of the project technical specifications in Appendix E), when an Amec Foster Wheeler monitor observed deficiencies, the monitor determined the nature and extent of the problem and notified Ames and/or CC&V. Amec Foster Wheeler then performed additional testing to define the extent of the deficient area. Ames corrected deficiencies to meet the requirements of the project technical specifications and Amec Foster Wheeler re-tested the corrected area(s) prior to any additional related work. The following sections include discussions of the deficiencies encountered.

Discussions in Section 4.0 and subsequent subsections represent the footprint contained within the 9,450 foot to 9,550 foot bench unless otherwise noted.

4.1 Results of Laboratory Soils Testing

Amec Foster Wheeler performed laboratory testing of soils during all earthworks aspects of the construction at Amec Foster Wheeler's on-site soils laboratory. To verify that the earthwork materials used during construction met project technical specifications, Amec Foster Wheeler performed the following tests in accordance with the American Society for Testing and Materials (ASTM):

- Grain size distribution (ASTM D1140 for material finer than the No. 200 sieve, and ASTM C117 and C136 for coarse material)
- Moisture content (ASTM D2216)
- Atterberg limits (ASTM D4318)
- Standard Proctor compaction (ASTM D698)
- Permeability (ASTM D5084, Method D)
- In-place density testing (ASTM D6938)
- Soil description (ASTM D2488)

The laboratory test results are summarized in Tables 5 through 10 and individual laboratory test results are presented in Appendix H.

4.1.1 **Grain Size Distribution**

Amec Foster Wheeler analyzed the grain size distribution (gradation) of SF, SSF, leak detection fill (LDF), UF, SLF, and DCF. The results of the gradation analyses are presented in Appendix H.1 and summarized in Tables 5 through 10. Grain size distribution (gradation) was performed on CSB and the analyses are presented in Appendix M.5 and the individual test results presented in Appendix M.6.

Amec Foster Wheeler performed eight CQA gradations of SF. The actual testing frequency (approximately one test per 10,283 cubic yards) exceeded the minimum specified testing frequency of one test per 50,000 cubic yards. The SF CQA gradation results met the project technical specifications; the results are presented in Appendix H.1 and summarized in Table 5.

Amec Foster Wheeler performed two CQA gradations of SSF. The actual testing frequency (approximately one test per 1,655 cubic yards) exceeded the minimum specified testing frequency of one test per 50,000 cubic yards. The SSF CQA gradation results met the project technical specifications; the results are presented in Appendix H.1 and summarized in Table 6.

Amec Foster Wheeler performed one CQA gradation of LDF. The actual testing frequency (approximately one test per 60 cubic yards) exceeded the minimum specified testing frequency of one test per 10,000 cubic yards. The engineer approved Ames' request to use LVSCF in lieu of LDF, however the sample was still called LDF. The LDF CQA gradation results met the project technical specifications; the results are presented in Appendix H.1 and summarized in Table 7.

Amec Foster Wheeler performed two CQA gradations of UF. The actual testing frequency (approximately one test per 433 cubic yards) exceeded the minimum specified testing frequency of one test per 5,000 cubic yards. The UF CQA gradation results met the project technical specifications; the results are presented in Appendix H.1 and summarized in Table 8.

Amec Foster Wheeler performed 13 CQA gradations of SLF. The actual testing frequency (approximately one test per 3,819 cubic yards) exceeded the minimum specified testing frequency of one test per 4,000 cubic yards. The SLF CQA gradation results met the project technical specifications; the results are presented in Appendix H.1 and summarized in Table 9.

Amec Foster Wheeler performed seven CQA gradations of DCF. The actual testing frequency (approximately one test per 14,375 cubic yards) exceeded the minimum specified testing frequency of one test per 20,000 cubic yards. The DCF CQA gradation results met the project technical specifications; the results are presented in Appendix H.1 and summarized in Table 10.

4.1.2 Moisture Content

Amec Foster Wheeler measured the moisture contents of SF, SSF, LDF, UF, SLF, and DCF as part of the CQA program. Moisture content data is presented in Tables 5 through 10. Note the oven moisture content testing for SLF was calculated with the nuclear gauge reading to produce accurate density and moisture contents.

4.1.3 Atterberg Limits

Amec Foster Wheeler performed Atterberg limits testing of fill materials. All fill materials, with the exception of SLF and some SF, were non-plastic. The SF, SSF, LDF, UF, SLF, and DCF samples tested met project technical specifications for Atterberg limits. Atterberg limits test results are presented in Appendix H.1 and summarized on Tables 5 through 10.

Amec Foster Wheeler performed eight CQA Atterberg limits of SF. The actual testing frequency (approximately one test per 10,283 cubic yards) exceeded the minimum specified testing frequency of one test per 50,000 cubic yards. The SF CQA Atterberg limits results met the project technical specifications; the results are presented in Appendix H.1 and summarized in Table 5.

Amec Foster Wheeler performed two CQA Atterberg limits of SSF. The actual testing frequency (approximately one test per 1,655 cubic yards) exceeded the minimum specified testing frequency of one test per 50,000 cubic yards. The SSF CQA Atterberg limits results met the project technical specifications; the results are presented in Appendix H.1 and summarized in Table 6.

Amec Foster Wheeler performed one CQA Atterberg limits of LDF. The actual testing frequency (approximately one test per 60 cubic yards) exceeded the minimum specified testing frequency of one test per 10,000 cubic yards. The LDF CQA Atterberg limit results met the project technical specifications; the results are presented in Appendix H.1 and summarized in Table 7.

Amec Foster Wheeler performed two CQA Atterberg limits of UF. The actual testing frequency (approximately one test per 433 cubic yards) exceeded the minimum specified testing frequency of one test per 5,000 cubic yards. The UF CQA Atterberg limits results met the project technical specifications; the results are presented in Appendix H.1 and summarized in Table 8.

Amec Foster Wheeler performed 13 CQA Atterberg limits of SLF. The actual testing frequency (approximately one test per 3,819 cubic yards) exceeded the minimum specified testing frequency of one test per 4,000 cubic yards. The SLF CQA Atterberg limits results met the project technical specifications; the results are presented in Appendix H.1 and summarized in Table 9.

Amec Foster Wheeler performed seven CQA Atterberg limits of DCF. The testing frequency (approximately one test per 14,375 cubic yards) exceeded the minimum specified testing frequency of one test per 20,000 cubic yards. The DCF CQA Atterberg limits results met the project technical specifications; the results are presented in Appendix H.1 and summarized in Table 10.

4.1.4 Proctor Compaction Tests

Since the majority of the SF for the Phase 1 VLF project contained more than 30 percent retained on the ¾-inch sieve, no Proctor compaction tests were performed on the SF material. Per project technical specification 2200 Section 3.06, Subsection B, SF containing more than 30 percent retained on the ¾-inch sieve is placed using a method specification and cannot be tested using a standard Proctor (due to the high rock content).

Amec Foster performed 13 CQA standard Proctor compaction tests of SLF in order to compare in-place densities and moisture contents with laboratory derived values of maximum dry density and optimum moisture content. The actual testing frequency (approximately one test per 3,819 cubic yards) exceeded the minimum specified testing frequency of one test per 4,000 cubic yards. The SLF CQA compaction test results met the project technical specifications; the results are presented in Appendix H.2 and summarized in Table 9.

4.1.5 Permeability Tests

Amec Foster Wheeler performed 13 permeability tests of SLF. The actual testing frequency (approximately one test per 3,819 cubic yards) exceeded the minimum specified testing frequency of one test per 4,000 cubic yards. Testing was performed with a flexible-wall permeameter with back-pressure saturation and a constant rate of flow (ASTM D5084, Method D). The SLF was re-compacted to the in-place density measured during nuclear density testing and the corresponding moisture content (as determined from oven-dried samples). The nuclear density value measured in the field was corrected for coarse particles according to ASTM D4718. Laboratory tests yielded coefficients of permeability for the CQA samples, all of which meet or exceed the permeability specification of 1×10^{-6} cm/sec maximum. The SLF CQA permeability results met the project technical specifications; the results are presented in Appendix H.3 and summarized in Table 9. Discussions above represent the footprint contained within the area between the 9,450 foot and 9,550 foot bench.

4.2 Field Testing and Monitoring

Amec Foster Wheeler observed earthworks fill operations to verify lift thickness, adequate compaction, ambient air and fill temperatures and acceptable moisture contents. Holes made in the SLF during testing were backfilled and tamped with fine bentonite powder. Amec Foster Wheeler standardized the nuclear gauges at the start of each day according to ASTM D6938.

4.2.1 Underground Workings (includes all of Phase 1 VLF)

Amec Foster Wheeler monitored remediation of all Phase 1 VLF underground workings, including verification that excavations were performed to minimum required dimensions, and that CP, CRF, SF, and CSB were installed as specified. Please note that this section encompasses all of the Phase 1 VLF footprint.

Concrete Plug and Cemented Rockfill

Amec Foster Wheeler observed and documented testing of approximately 1,198 cubic yards of concrete for slump, air entrainment, temperature, placement time, and compressive strength. All tests met the compressive strength specification. The results are summarized in Appendix M.3 and individual concrete test reports are presented in Appendix M.4.

Amec Foster Wheeler observed the placement of CRF, including verification of all batch tickets adhering to the approved mix design.

Coarse Shaft Backfill

Amec Foster Wheeler observed and documented testing of 8,057 cubic yards of CSB and performed grain size distribution (gradations) and Atterberg limits on the material. Amec Foster Wheeler performed two CQA gradation and Atterberg limit tests. No testing frequency is specified for CSB. The CQA earthworks testing summary is presented in Appendix M.5 and individual test reports are presented in Appendix M.6.

4.2.2 Underdrains

Amec Foster Wheeler verified that the underdrains were constructed as specified in the IFC Drawings and project technical specifications. UF material was placed a minimum of 2 feet deep by 4 feet wide in the secondary underdrain trenches and 2 feet deep by 3 feet wide in the tertiary underdrain trenches. All oversized and unsuitable material was removed from the UF prior to final placement. Amec Foster Wheeler monitored the installation of the geotextile in the underdrains, ensuring that the geotextile overlap was adequate, and a minimum of 6 inches of SSF was placed on the top of the geotextile.

4.2.3 Structural Fill

Amec Foster Wheeler monitored subgrade preparation, including verification that Ames compacted the SF with a smooth drum vibratory compactor. It was also verified that Ames removed protruding rocks from the SF surface prior to SLF placement, the fill was moisture conditioned during placement, and the final surface was smooth and unyielding prior to SLF placement.

The majority of the SF material contained more than 30 percent by weight larger than ¾-inch, and was placed by method specification per project technical specification 2200, Section 3.06 Subsection B. Amec Foster Wheeler verified that the maximum particle size of the SF did not exceed 24 inches and that lifts were not larger than 1-½ times the maximum particle size. It was also verified that Ames made a minimum of four passes with a 10-ton static drum weight smooth drum vibratory roller.

4.2.4 Soil Liner Fill

Field testing for SLF included monitoring of placement and preparation of the finished SLF surface for geomembrane deployment, testing in-place moisture and density with a nuclear gauge, and monitoring depth verification.

Field Monitoring

Amec Foster Wheeler observed SLF placement to verify lift thickness, adequate compaction, acceptable moisture conditions, final compacted thickness, and suitability for geomembrane deployment. Amec Foster Wheeler CQA personnel identified angular particles, ruts, desiccation cracks on the SLF surface and brought these flaws to the attention of Ames for repair prior to geomembrane deployment. Ames completed repairs by placing fines from the SLF processing plant or from temporary stockpiles of fine SLF to smooth and re-compact the fill surface in areas that were observed to be rough or inadequate for geomembrane deployment, as discussed in Section 2.6. Amec Foster Wheeler and ECApplications approved the final surface of SLF prior to geomembrane deployment.

Moisture Density Test Results

Amec Foster Wheeler performed a total of 143 in-place moisture-density tests of SLF. The field moisture content and density test results were compared to the standard Proctor dry density and optimum moisture content values of material with similar gradation and plasticity characteristics. Proctor dry density and optimum moisture content values for samples with greater than 10 percent plus ¾-inch were tested to ASTM D4718 to facilitate direct comparison to nuclear density values. The actual moisture-density testing frequency of approximately one test per 347 cubic yards exceeded the minimum specified testing frequency of one test per 500 cubic yards per project technical specifications. Nuclear density tests performed are summarized in Table 11. Any failing areas were reworked, re-compacted, and re-tested to meet project technical specifications. The number of retests was not used to determine the testing frequency. Holes made in the SLF during testing were filled by tamping fine SLF or bentonite material into the holes, as specified.

Depth Verification

Ames performed SLF depth verification using a drill. A total of 85 depth checks were performed to verify that the minimum 12-inch-compacted depth had been achieved. Amec Foster Wheeler monitored the SLF depth verification tests and documented the results. Depth verification holes were filled using bentonite. All compacted SLF thicknesses as measured by the verification holes met or exceeded project requirements. The testing frequency of 2.8 holes per acre exceeded the minimum specified testing frequency of two holes per acre. The SLF depth verification results are presented in Table 12.

4.2.5 Drain Cover Fill

Amec Foster Wheeler provided visual monitoring of DCF placement. One Amec Foster Wheeler monitor and at least two Ames laborers were present monitoring each dozer, unless two dozers were within approximately 50 feet of each other during placement. Amec Foster Wheeler verified that wrinkles in the geomembrane did not fold over, that PVC grade markers were placed on a maximum 50-foot by 50-foot grid and at grade breaks, and that material met project technical specifications. Amec Foster Wheeler continuously inspected the geomembrane during DCF placement, marked areas for repair, if required, and verified that all repairs were completed to project technical specifications. After final grading, Amec Foster Wheeler monitored removal of PVC grade markers.

Please note that placement of the DCF material within the Phase 1 VLF 9,450 foot to 9,550 foot bench is on-going at the time of the report submittal. The DCF quantities were estimated based on the area of the 9,450 foot to 9,550 foot bench footprint multiplied by a depth of 2 feet and adding in a 10 percent overage.

4.2.6 Temperature Monitoring

Amec Foster Wheeler monitored ambient air temperatures every hour when temperatures were approaching freezing. The lowest and highest daily temperatures are summarized in Table 1.

During placement of fill materials, when the ambient air temperature was less than 32°F for longer than 1 hour in the previous 24 hours, Amec Foster Wheeler was required to monitor the fill temperatures at depths of 3 inches and 6 inches, at a frequency of 6 tests per acre, and calculate the average fill temperature from the lower temperature of the 3 inch and 6 inch tests. Amec Foster Wheeler verified that no frozen material was placed during construction. Fill temperature monitoring is summarized in Table 2.

5.0 GEOSYNTHETICS QC SUBMITTALS

Geosynthetics QC submittals reviewed by Amec Foster Wheeler included installation personnel résumés, geomembrane resin certificates, geomembrane roll certificates, welding rod certificates, and geotextile certificates. Amec Foster Wheeler's inventory control, summarizing QC certification received for each roll of geomembrane liner received for the Project are presented in Appendix I.2 and Appendix I.3. Geosynthetic material used for construction met project technical specifications.

5.1 Geomembrane Installation Personnel Résumés

Amec Foster Wheeler reviewed the résumés of ECA installation personnel to verify the installation superintendent and the seaming personnel possessed sufficient geomembrane installation experience as required by the project technical specifications. Review of the installation personnel résumés indicated key personnel had sufficient experience to meet or exceed project technical specifications. Geomembrane personnel résumés are presented in Appendix I.1.

5.2 Geomembrane QC Documents

Geomembrane QC documents submitted by ECA to Amec Foster Wheeler include resin supplier certificates and geomembrane manufacturer resin certificates, geomembrane roll certificates, and welding rod certificates. Amec Foster Wheeler reviewed QC documents prior to geomembrane placement and verified the documentation was complete and the material properties and QC testing frequency required by the project technical specifications were met.

5.2.1 Resin QC Certificates

LLDPE polymer raw material (resin) QC certificates were provided by the resin manufacturer, Chevron Phillips Chemical Company, at a frequency of one per rail car shipment. Geomembrane used on this project was produced from five batches of resin. The geomembrane manufacturer also performed density and melt index tests of the resin supplied by Chevron Phillips Chemical Company to confirm material properties prior to geomembrane manufacture. Amec Foster Wheeler verified these certificates prior to geomembrane placement and they are presented in Appendix I.6 and Appendix I.7.

5.2.2 Roll QC Certificates

ECA provided QC manufacturer certificates for each roll (approximately one every 10,000 square feet) of LLDPE geomembrane used for the project, exceeding the required minimum frequency of one per 150,000 square feet of geomembrane. Amec Foster Wheeler reviewed the QC certificates to verify QC testing of the geomembrane met the project requirements. Geomembrane was placed only when complete QC documentation was provided and determined the test results met or exceeded project technical specifications. The 40-mil LLDPE smooth geomembrane QC roll certificates are presented in Appendix I.5 and the 80-mil LLDPE DSMS geomembrane QC roll certificates are presented in Appendix I.4.

5.2.3 Welding Rod QC Certificates

Welding rod certification consisted of resin QC documents for the resin used to manufacture the extrusion welding rod material for the Project. The welding material used for the liner was produced from four batches of resin. Not all resin lots used to produce the welding rod resin were from the same resin lots as the 80-mil LLDPE geomembrane. Amec Foster Wheeler's review of the QC certification indicates the resin used to manufacture the welding material met project technical specifications. The welding rod QC certificates are presented in Appendix I.8.

5.3 Geotextile QC Documents

Geotextile, manufactured by TenCate, was used during construction of the underdrain systems as well as the LDS. Amec Foster Wheeler's review of the QC certificates indicates the geotextile met project technical specifications. Geotextile QC certificates are presented in Appendix I.9.

5.4 Geogrid QC Documents

Geogrid, manufactured by Tensar, was used during remediation of the underground workings. Amec Foster Wheeler had TRI perform conformance testing on a sample from each resin lot, lots that met the project technical specifications were used for remediation. Geogrid QC certificates are presented in Appendix M.7 and the conformance testing results are presented in Appendix M.8.

6.0 GEOMEMBRANE CQA TESTING AND MONITORING

The following sections describe the CQA activities performed by Amec Foster Wheeler for the geomembrane installation.

In accordance with the AMEC Geosynthetics CQA Plan (Section 01400.2 of the project technical specifications in Appendix E), when an Amec Foster Wheeler monitor observed deficiencies, the monitor determined the nature and extent of the problem by performing additional testing to define the extent of the deficient area. ECA and/or CC&V were notified of the deficiency for repairs. ECA corrected deficiencies to meet the requirements of the project technical specifications, and Amec Foster Wheeler re-tested the corrected deficiency prior to any additional related work.

CQA activities conducted by Amec Foster Wheeler during the installation of the LLDPE geomembrane consisted of the following:

- Conformance sampling and testing of the geomembrane
- Observation and approval of the SLF surface prior to deployment of 80-mil DSMS LLDPE geomembrane
- Observation and documentation of geomembrane deployment, including verifying sheet thickness and overlap, documenting the approximate panel length and width, and documenting panel layout
- Observation of trial seam sample testing and documentation of results
- Observation and documentation of field seaming
- Identification of destructive seam sample test locations, observation of destructive seam sample testing, and documentation of test results
- Observation and documentation of geomembrane repairs
- Observation and documentation of non-destructive pressure testing of fusion seams and vacuum testing of extrusion seams and repairs

The following sections present a detailed description of each of the above activities.

6.1 Geomembrane Conformance Testing

Geomembrane manufactured by Agru America was installed in Phase 1 VLF (9,450 foot to 9,550 foot bench). A TRI/Environmental (TRI) (Amec Foster Wheeler subcontractor) representative sampled geomembrane at the Agru plant in Fernley, Nevada for conformance testing. Samples were sent to TRI’s geosynthetic laboratory for conformance testing. Geomembrane rolls were not used on the project until approved by Amec Foster Wheeler based on conformance test results.

Prior to the 80-mil LLDPE DSMS geomembrane arrival to site, Amec Foster Wheeler performed 45 conformance tests on the geomembrane, at a frequency of one test per 147,095 square feet. The conformance testing includes all of the geomembrane on-site, not just what was used between the 9,450 foot and 9,550 foot bench. Conformance testing for the 80-mil DSMS LLDPE geomembrane used to construct the liner system met project technical specifications. Conformance test results for the 80-mil DSMS LLDPE are presented in Appendix K.1.

Prior to the 40-mil LLDPE smooth geomembrane arrival to site, Amec Foster Wheeler performed 1 conformance test on the geomembrane, at a frequency of one test per 134,435 square feet. The conformance testing includes all of the geomembrane on-site, not just what was used between the 9,450 foot and 9,550 foot bench. Conformance testing for the 40-mil smooth LLDPE geomembrane used to construct the liner system met project technical specifications. Conformance test results for the 40-mil smooth LLDPE are presented in Appendix K.2.

6.2 Deployment Monitoring

Geomembrane panel deployment monitoring performed by Amec Foster Wheeler included:

- Observation of panel surface condition and panel overlap
- Assignment of panel numbers
- Verification of factory roll number and receipt of complete certification prior to allowing deployment
- Measurement of sheet thickness
- Documentation of deployed panel lengths
- Development of panel layout record drawing

Prior to the deployment of geomembrane, Amec Foster Wheeler and ECA verified that the SLF surface was free of soft spots, protrusions, angular particles, abrupt grade changes, and loose soil. Amec Foster Wheeler and ECA also verified the surface had been proof-rolled and was free of desiccation cracks. Where the surface of the SLF did not meet project technical specifications, Ames repaired the area and re-compacted the surface. Amec Foster Wheeler prepared SLF surface acceptance forms. After inspections of the finished surface, an Ames, Amec Foster Wheeler and CC&V representative signed the acceptance forms. The SLF surface acceptance certificates are presented in Appendix G.

Amec Foster Wheeler assigned each geomembrane panel a number. Geomembrane panels were designated with a “P” followed by an individual panel number. Some panels were deployed outside of this report's approval area, but panel numbering remained consecutive.

Amec Foster Wheeler marked the panel designation and roll number directly on each panel after deployment. Ames surveyed all panel intersections and destructive seam sample locations. Using these points Amec Foster Wheeler generated the record drawings for the geomembrane, showing the panel layout and destructive testing locations. These are presented as Record Drawing Nos. 6, 7, and 8 in Appendix A.

During geomembrane deployment, Amec Foster Wheeler measured the geomembrane sheet thickness with calibrated callipers. Sheet thickness was measured at five random locations along the edge of each geomembrane panel. The average thickness specified for the 80-mil geomembrane exceeded 80 mils. Project technical specifications for 80-mil geomembrane required that the average of the five thickness measurements be no less than 80 mils, and that no individual measurement be less than the nominal thickness minus 10 mils (i.e., 70 mils). The thickness monitoring provided by Amec Foster Wheeler indicated that all of the panels met or exceeded project requirements.

Amec Foster Wheeler personnel measured deployed panel lengths using a measuring wheel. Recorded lengths were approximate, and do not reflect any trimming or adjustments made for final placement or anchor trench lengths.

Amec Foster Wheeler personnel observed the surface of each deployed panel and logged any penetration defects and marked them on the panel. Section 6.4 provides further discussion of repairs. Personnel confirmed the overlap of each panel with adjacent panels was sufficient for seaming; any insufficient panel overlaps were logged as defects and marked for correction.

Geomembrane liner deployment observations are presented in Appendix J.1.

6.3 Seaming

The double wedge fusion weld was the principal seaming method employed by ECA during liner installation. ECA fusion seamed (welded) geomembrane on the same day it was deployed. Amec Foster Wheeler personnel observed trial seam tests, monitored seaming equipment temperatures and speed, and provided visual observation of the seaming procedures. Personnel observed the entire lengths of all seams, patches, and other repairs either during seaming, or shortly after completion.

6.3.1 Trial Seam Monitoring

ECA performed trial seams to monitor the performance of the seaming apparatus and operator under actual site conditions. Each welding operator and his apparatus produced trial seams prior to the beginning of each day's seaming operation, after all work activity stoppages, and in the event that devices were disconnected from power and re-energized.

ECA cut 1-inch-wide samples (coupons) from each trial seam and tested the coupons with a field tensiometer. ECA tested each double wedge fusion trial seam twice for peel adhesion (peel) and once for bonded seam strength (shear). Tests were conducted on fusion welds on both the inner and outer tracks of each peel coupon. ECA tested each extrusion trial seam twice for peel and once for shear.

Amec Foster Wheeler personnel observed trial seam sample testing and documented test results. Tensile testing of each trial seam coupon was observed to verify project yield strengths were met during shear testing and failure did not occur in the weld during peel testing. When trial seams did not meet project technical specifications, Amec Foster Wheeler verified the welding apparatus was not used until two consecutive trial seams performed by the same technician/apparatus combination met project technical specifications. The trial seam test results for extrusion and fusion seaming are presented in Appendix J.2. ECA used one tensiometer during the project and one spare tensiometer was maintained on site. Tensiometer certifications are presented in Appendix L. Figures 3 and 4 show the codes used to designate passing and failing test results.

6.3.2 Seaming Observations

Amec Foster Wheeler personnel observed seams before, during, and after welding. Each seam was checked for adequate overlap prior to welding and to verify the seam area was dry and clean of any debris.

Amec Foster Wheeler documented ECA personnel performing the seaming and the seaming equipment used. Following the completion of seaming and repairs, Amec Foster Wheeler checked the full length of each seam to verify no additional repairs were required. In the event additional repairs were needed, the location was marked on the geomembrane, location documented, and ECA completed the repair. Once ECA completed repairs, an Amec Foster Wheeler representative verified the repair met project technical specifications. All seams were inspected for quality and completion. Amec Foster Wheeler personnel conducted a final walk through and inspection of the geomembrane surface and completed acceptance forms to verify completion of geomembrane liner per project technical specifications. The geomembrane liner acceptance notifications are presented in Appendix J.7.

Amec Foster Wheeler recorded observations made during seaming. The geomembrane layer and the fusion and extrusion welding met project technical specifications; and a summary is presented in Appendix J.3.

6.4 Defect and Repair Observations

Amec Foster Wheeler inspected geomembrane panels for damage that may have occurred during manufacture, transport, deployment, or installation as discussed in Section 6.2. Damage noted (during or after deployment) by an Amec Foster Wheeler representative was documented on a defect log. Amec Foster Wheeler observed all panels and seams to verify defects were repaired prior to DCF placement.

The summaries of defects and repairs, including the approximate locations of each repair, are presented in Appendix J.4.

6.5 Destructive Testing

Amec Foster Wheeler selected destructive test locations of fusion and extrusion seams based on ECA's completion of welding for the geomembrane, various working conditions, and on seaming observations (e.g., suspicion of a defective weld). ECA obtained and tested 147 liner fusion seam destructive samples and 28 extrusion seam destructive samples within the Phase 1 VLF (9,450 foot to 9,550 foot bench).

ECA constructed approximately 63,382 lineal feet of geomembrane liner fusion welded seams. The specified minimum frequency of destructive testing was one test per 500 lineal feet of weld. Amec Foster Wheeler identified, and ECA obtained, destructive samples from the panel seams at a frequency of one destructive test sample per 432 lineal feet of fusion welded seam. The actual test frequencies exceeded project requirements.

ECA constructed approximately 5,019 lineal feet of geomembrane liner extrusion welded seams. The specified minimum frequency of destructive testing was one test per 500 lineal feet of weld. Amec Foster Wheeler identified, and ECA obtained, destructive samples from the panel seams at a frequency of one destructive test sample per 179 lineal feet of extrusion welded seam. The actual test frequencies exceeded project requirements.

The summaries of destructive test results for fusion and extrusion seams presented in Appendix J.5. Record Drawing Nos. 6, 7, and 8 presented in Appendix A and show the destructive test sample locations.

6.6 Non-Destructive Testing

ECA performed non-destructive seam testing on completed seams and geomembrane repairs. Non-destructive testing for seams included pressure testing of fusion-welded seams and vacuum testing of extrusion-welded seams and repairs. Amec Foster Wheeler monitored and documented the non-destructive testing.

Prior to pressure testing fusion seams, ECA heat sealed both ends of the air channel between the two tracks of the double-wedge weld. A pressure gauge was inserted in one end of the sealed channel; the channel was pressurized to approximately 30 pounds per square inch (psi) using an air pump. After pressure stabilization, Amec Foster Wheeler Personnel monitored the gauge for a minimum of 5 minutes. The maximum allowable pressure drop was 3 psi over a 5 minute period. After the 5 minute period was completed, ECA cut the opposite end of the seam with the gauge left in place. If the gauge pressure dropped to zero, the seam was determined to be continuous. In cases where the seam was found to be discontinuous (evident by no pressure drop at gauge upon cutting the opposite end of the seam), the seam was subdivided into shorter sections until continuous seam sections were located and passing pressure tests were performed. Failed portions of seams were capped.

If a pressure test failed, ECA checked the seam section for leakage, and repaired and re-tested the seam or capped it. If ECA was unable to find the leak, the seam was divided into two sections, each section being tested to locate the area of concern. This subdivision process was repeated until the leak location was identified. If the leak area was not located, ECA capped the seam and vacuum tested the repair.

ECA tested extrusion welded seam sections and repairs with a vacuum box. Prior to vacuum box testing, a soap and water solution was applied to the seam section. The vacuum box was placed over the seam area and energized with a pump capable of creating a vacuum of not less than 5 psi. ECA and Amec Foster Wheeler observed the action of the vacuum on the seam for a minimum of 10 seconds. Each consecutively tested seam length was overlapped a minimum of 3 inches. If soap bubbles appeared, Amec Foster Wheeler marked and documented the leak location. ECA repaired the leak and vacuum tested the repair. This procedure was also followed to test extrusion welds associated with repairs and patches.

The seam non-destructive test summaries (fusion pressure tests) are presented in Appendix J.6. Extrusion seam vacuum test verification is presented in the Extrusion Welding Summary in Appendix J.3.

Amec Foster Wheeler personnel conducted a final walk through and inspection of the installed geomembrane surface and completed acceptance forms to verify completion all repairs of the geomembrane liner prior to DCF placement. The geomembrane liner acceptance notifications are presented in Appendix J.7.

7.0 Project Deviations

7.1 Drawing Deviations

During construction several adjustments were made in the field to fit actual site conditions during construction. A list of those changes are discussed below.

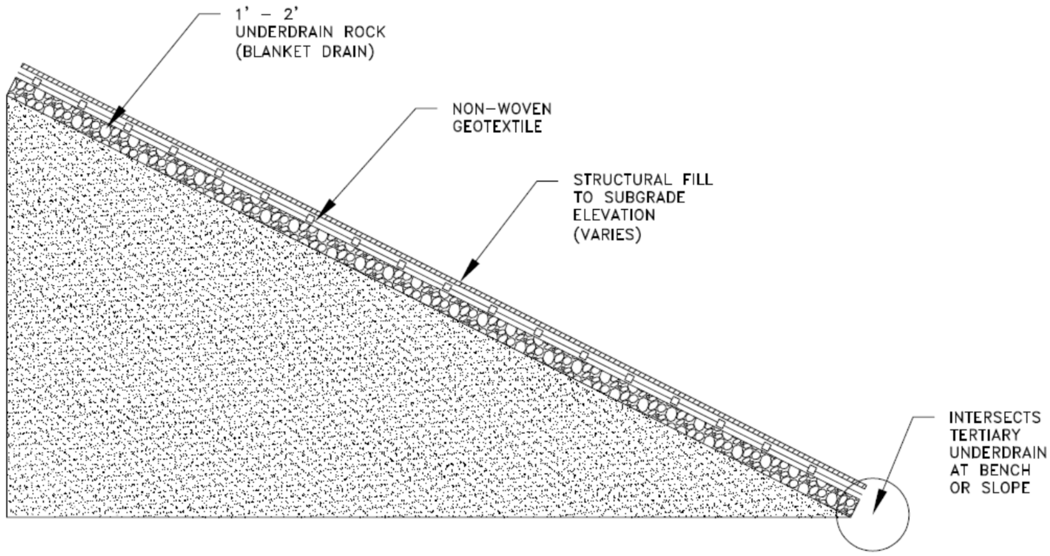
- Localized changes in grading occurred throughout the project during construction. These slight deviations have been recorded in the ROC drawings in Appendix A. These changes occurred to adjust to actual field conditions to better accommodate the design intent.

- Localized changes in underdrain and HVSCS pipe alignments occurred throughout the project during construction. These slight deviations have been recorded in the ROC drawings in Appendix A. These changes occurred to adjust to actual field conditions to better accommodate the design intent.

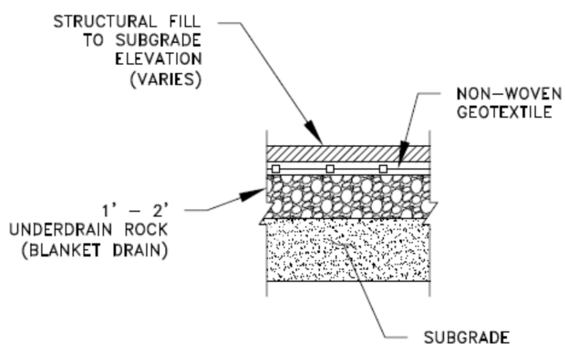
- Details 2 and 3 on IFC Drawing A220 indicate a fusion weld between the phased liner connections. An extrusion weld was used instead and is acceptable.

- On ROC Drawing 3 in Appendix A, there are three locations shown referred to as blanket drains, a profile and section of these drawings is shown in the figure below. The blanket drains were used to capture several natural ground water springs in close proximity to one another and direct the water to the tertiary underdrain piping system.

- The SLF containment berms on the southwest limits are greater than 2H:1V; this area will never be loaded with ore or be leached.



UNDERDRAIN PROFILE DETAIL



UNDERDRAIN SECTION DETAIL

- A lined cut-off tertiary underdrain was constructed on the east slope to "catch" and direct natural groundwater springs to the underdrain piping system. This was added due to small amount of fall available to intercept the exiting tertiary drain. By using a small amount of liner in an isolated section, Manning's Roughness Coefficient is decreased which allows for a flatter slope.

- The leak detection location was adjusted on the east side of the Phase 1 VLF to move it out of the 9,550 foot construction bench.

The above drawing additions or deviations meet the intent of the SQVLF design as permitted.

7.2 Project Technical Specification Deviations

During construction, requests were made by the contractor (Ames) to deviate from the project technical specifications. Below is a summary of the project technical specification deviations.

- Section 02776 (Appendix E) of the project technical specification states “The rolls (of liner) shall be stored on a prepared surface (not wooden pallets) and should not be stacked more than two rolls high”. Amec Foster Wheeler allowed the rolls of liner to be stacked three rolls high provided safety measure were in place to prevent rolls from shifting at any time and personnel refrain from climbing on the rolls to access the lifting straps.

- The resin certificates provided for the welding rod do not match the resin lots used during production of the 80-mil DSMS LLDPE geomembrane; however, the resin lots that were used are acceptable per project technical specifications. Extrusion weld integrity was verified with trial welds and destructive tests.

- Concrete test W1 (summary of underground working concrete testing located in Appendix M.3) as part of the underground workings had a slump outside of the project technical specifications. Due to the unique and challenging situation of potentially having to remove the concrete from a working, it was agreed upon to wait for compressive strength test results. If the concrete compressive strength was achieved, the concrete was to remain in place. Having a lower slump is not necessarily indicative of bad concrete, it either had a lower water to cement ratio or the concrete had begun curing. Slump is estimated to decrease 2 inches per hour. Amec Foster Wheeler determined the concrete was acceptable based on the passing compressive strength tests results.

- Amec Foster Wheeler allowed the use of Low Volume Solution Collection Fill material in place of LDF. The properties of the two materials are very similar, and both materials meet both the required specifications (refer to Section 02200 in Appendix E).

- Section 02200 in Appendix E states “Contractor shall place Low Volume Solution Collection Fill at a rate such that no single area of 350,000 square feet of geomembrane liner is exposed to ultraviolet light for more than 180 days”. Panels

P1 through P123 were deployed at the end of the 2014 construction season, were not covered with DCF material as required, and consequently were left exposed over 180 days. Amec Foster Wheeler required conformance testing to be completed on each resin lot (two) that was deployed during this time. It was determined that the material was still well within the allowable standards of non-exposed geomembrane liner. Copies of the conformance testing are located in Appendix K.3.

8.0 CONCLUSIONS

In accordance with our responsibilities as the Engineer of Record and as the Quality Assurance Consultant for construction of the Phase 1 VLF (9,450 foot to 9,550 foot bench) Project, and per the requirements of the various applicable DRMS approvals, Amec Foster Wheeler attests that it observed and performed the required CQA activities during construction. Based on daily communications with Amec Foster Wheeler personnel, observations made during on-site visits, and review of the laboratory and field test results, Amec Foster Wheeler attests that the Project was constructed in compliance with the design plans and project technical specifications as described in this document.

Sincerely,

Amec Foster Wheeler Environment & Infrastructure, Inc.

Robert Redd
Project Resident (April 2015 through November 2015)

Andrea L. Meduna, PE
Certifying Engineer

alm/ALM

FINAL CERTIFICATION

SQUAW GULCH VALLEY LEACH FACILITY PROJECT
QUALITY ASSURANCE
PHASE 1 VLF (9,450 FOOT TO 9,550 FOOT BENCH)
TELLER, COUNTY, COLORADO

I, Andrea L. Meduna, a Registered Professional Engineer in the State of Colorado, hereby certify that the construction of the Squaw Gulch Valley Leach Facility Phase 1 VLF (9,450 foot to 9,550 foot bench) Area Project was completed in compliance with the drawings and project technical specifications approved as part of Permit Number M-1980-244, Amendment No. 10 as well as subsequent changes as approved by the Office of Mined Land Reclamation.

Amec Foster Wheeler
Environment & Infrastructure, Inc.

COLORADO LICENSED ANDREA L. MEDUNA 48325 PROFESSIONAL ENGINEER

10/12/2015

Andrea L. Meduna, PE CO. No. 48325

October 12, 2015

Date