

**CONTRACT DELIVERABLE COVER SHEET**

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Final Plan of Work for Cherrystone Creek Watershed Dam No. 1,  
Contract # 20220728A, Pittsylvania County, VA

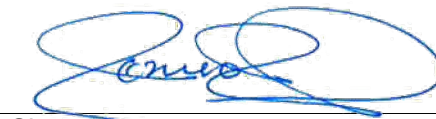
Due Date: June 8, 2023

Date of Review: June 7, 2023

Project Manager: Maridee Romero-Graves

Review Team Member(s): Jonathan Pittman, PE; Austin Spencer, PE; Maridee Romero-Graves, PE

Project Manager:



Signature

06/08/2023

Date

June 9, 2023

Mr. Chris Adcock  
Director of Public Works  
Pittsylvania County Administration Department  
1 Center Street  
Chatham, Virginia 24531

**Subject: Final Plan of Work for Cherrystone Creek Watershed Dam No. 1 Rehabilitation Design, RFP #20220505, Pittsylvania County, VA (Schnabel Reference 22210031.000)**

Dear Mr. Adcock:

**SCHNABEL ENGINEERING, LLC** (Schnabel) appreciates the opportunity to provide you with this Final Plan of Work (POW) for approval as part of the Rehabilitation Design of Cherrystone Creek Dam No. 1 (Cherrystone Dam 1) located in Pittsylvania County, Virginia. We have organized this document to include the following information in accordance with the Request for Proposal (RFP) No. 202200505, the Project Agreement Statement of Work (SOW) included with the RFP, the Supplemental Watershed Plan Number 2 and Environmental Assessment (Plan-EA) for Cherrystone Dam 1 dated August 2019, and our cost proposal dated July 20, 2022:

- **Plan of Work:** Defines project approach, goals, priorities, and work products for each task.
- **Breakdown of Fees and Staff Hours:** As defined in on our price proposal dated July 20, 2022.
- **Preliminary Project Schedule**
- **Review of Opinion of Probable Construction Cost (OPCC):** Summarizes OPCC presented in the Plan-EA.

As outlined in our cost proposal dated July 20, 2022, and approved by Pittsylvania County (Sponsor) and Virginia NRCS (NRCS) on September 13, 2022, we will provide separate Final POW documents for each dam. This Final POW covers Phase I – Plan of Work and Quality Assurance/Quality Control (QA/QC), Phase II – Supporting Documentation and Development of Design Data, Phase III – Preliminary Design, and Phase IV – Final Design, as listed in the following sections. A second price proposal and POW will be developed after completion of Phase IV – Final Design which will include our services for Permitting and Phase V – Pre-Construction and Construction Support. This phased approach will allow us to provide NRCS and Pittsylvania County with more accurate pricing for the permitting effort and the Phase V scope based on the final design and the associated estimated construction schedule.

Although we consider the list of assumptions in this Final POW to be thorough, we recognize that unforeseen changes and circumstances may occur during the course of the project. Should any required

out-of-scope work be identified, we will notify NRCS and Pittsylvania County in a timely manner and obtain the County's authorization prior to performing any out-of-scope work.

Frequent communication and coordination between Schnabel, NRCS, the County, and other project stakeholders will be key to a successful project. As such, this POW includes scope and fees for multiple design review and coordination conferences in general accordance with the SOW and as outlined under each item below. Meeting minutes will be provided for each conference.

## **1.0 PHASE 1 – PLAN OF WORK AND QUALITY ASSURANCE/QUALITY CONTROL**

### **1.1 Item 1a – Preliminary POW**

A Preliminary POW was developed in consultation with the Sponsors and NRCS and in accordance with the requirements of the SOW. The purpose of the Preliminary POW was to identify the specific goals, priorities, and work products for each phase and all associated tasks. The Preliminary POW also included a detailed estimate of fees and staff hours (labor), expenses, subcontractor costs, a project schedule for the completion of each task and phase of the project, and review of the estimated construction costs included in the Plan-EA.

The Preliminary POW was developed based on the preferred alternative for Cherrystone Dam 1 listed in the Plan-EA. The preferred alternative was developed by NRCS to meet current NRCS and VA DCR Dam Safety requirements; continue to provide flood protection, water supply and recreation to the surrounding community; extend the service life of the dam by at least 50 years; and reduce public safety risks due to a potential breach of the dam. According to the Plan EA, the major components of the preferred rehabilitation alternative for Cherrystone Dam 1 are:

- Construction of a 165-foot-wide roller-compacted concrete (RCC) spillway over the embankment;
- Closure of the existing auxiliary spillway channel with an earthfill berm;
- Widening the crest of the dam from 17 feet to 20 feet;
- Flattening the upstream slope of the dam to 3 horizontal to 1 vertical (3H:1V) to meet rapid drawdown stability criteria;
- Construction of a downstream slope stability berm;
- Replacement of the principal spillway riser and outlet structure;
- Extending the principal spillway pipe upstream and downstream to accommodate the new embankment geometry; and
- Construction of a new toe drain system.

The preliminary POW for Cherrystone Dam 1 was submitted to the Sponsors and NRCS on October 14, 2022. NRCS approved the Preliminary POW on November 14, 2022.

### **1.2 Item 1b – Quality Assurance/Quality Control (QA/QC) Plan**

- **Goals:**
  - To develop one project QA/QC Plan for both Cherrystone Dam 1 and Dam 2A as required by the SOW.
- **Approach:**
  - The submitted QA/QC Plan defines the quality assurance and control procedures to be followed by the project team throughout the duration of the rehabilitation design project;

define the roles and responsibilities for the project team; and explain how the plan will be implemented. Every deliverable required for this project, including supporting documents, figures, drawings, and computer models, will undergo this QA/QC process to ensure they meet NRCS and VA DCR requirements. The QA/QC Plan and the other services described herein will be implemented by or under the direct supervision of an experienced Professional Engineer licensed in the Commonwealth of Virginia.

- The draft QA/QC Plan was submitted to the Sponsors and NRCS for review on October 7, 2022.
- Review comments were received from the County on October 14, 2022.
- The final version of the QA/QC Plan was submitted to the Sponsors and NRCS on December 22, 2022.
- **Completed Deliverables:**
  - Final QA/QC Plan for Cherrystone Dam 1 and Dam 2A – December 22, 2022.

### 1.3 Item 1c – Review of Existing Information and Site Reconnaissance

- **Goals:**
  - To coordinate with the Sponsors and NRCS to gather and review available existing data and technical documents for the dam and appurtenances.
  - To perform an initial field reconnaissance visit at the dam to understand if and how site conditions have changed since our previous involvement with the project in 2017 and to discuss the planned field investigation activities.
- **Approach:**
  - We reviewed the existing data, including As-Built Drawings, design reports and calculations, inspection and investigation reports, the dam breach inundation study used to support the May 2022 Emergency Action Plan (EAP), and other applicable information.
  - We coordinated with the Sponsors to perform our field reconnaissance of both dams on a single day. The field reconnaissance included a visual inspection of the dam and appurtenances; review of site conditions and site access constraints for the forthcoming geotechnical investigation; and review of watershed conditions and potentially affected structures both upstream and downstream of the dams.
  - Draft Site Reconnaissance Letter Report summarizing our observations including relevant photos was submitted to the Sponsors and NRCS on November 22, 2022. No comments were received on the Site Reconnaissance Letter Report.
- **Completed Deliverables:**
  - Final Site Reconnaissance Letter Report was submitted to the Sponsors and NRCS on May 25, 2023.
- **Assumptions:**
  - According to the VA DCR Dam Safety Inventory System (DSIS), VA DCR recently approved the May 2022 EAP for Cherrystone Dam 1 submitted by Freese and Nichols. The submittal included dam breach inundation maps developed using the two-dimensional (2D) capabilities of the U.S. Army Corps of Engineers (USACE) HEC-RAS model, Version 6.1. The HEC-RAS 2D model included impacted areas due to a breach of Cherrystone Dam 1 from the dam to an area located approximately 2.4 miles upstream of Meadville Road at the Banister River crossing. Since this HEC-RAS 2D model has already been approved by VA DCR and is more recent than the one NRCS used during

the Plan-EA (a one-dimensional HEC-RAS model developed in 2009), for budgeting purposes we have assumed that the model can be used, as is, under Item 7 below and that survey of the modeled stream crossings will not be required.

- For budgeting purposes, the field reconnaissance for both dams was performed the same day as stated in the Preliminary POW.
- **Exclusions:**
  - Underwater investigations or confined space entries.
  - Video inspection of existing toe drain pipes and principal spillway conduit.

#### 1.4 Item 1d – Final POW

- **Goals:**
  - To provide a Final POW to serve as the updated basis for the rehabilitation design.
- **Approach:**
  - This draft Final POW was developed following Sponsor and NRCS review of the Preliminary POW, our review of existing information, the field reconnaissance, the geotechnical investigation, and the soils laboratory testing.
  - We will address any review comments the Sponsors and NRCS have prior to submitting the finalized version of this Final POW.
- **Proposed Conferences:**
  - A virtual Final Plan of Work Conference will be held with the Sponsors and NRCS to discuss the Final Plan of Work for both dams.
- **Priorities:**
  - No critical path items associated with this task have been identified.
- **Deliverables:**
  - Final Plan of Work

## 2.0 PHASE II – SUPPORTING DOCUMENTATION, DEVELOPMENT OF DESIGN DATA

### 2.1 Item 2 – Field Surveys and Mapping

- **Goals:**
  - To perform the professional topographic surveys and biological surveys required to support the dam rehabilitation design and subsequent construction.
- **Approach:**
  - Our subconsultant, Crutchfield and Associates, Inc. (Crutchfield) of Halifax, Virginia, performed bathymetric survey from the current survey limits on the upstream slope of the dam up to 100 feet upstream of the principal spillway riser, survey of the existing riser structure and conduit, survey of wetland delineation points discussed below, and survey of the as-drilled boring locations discussed under Item 3. If additional survey is required to complete the work, we will notify the Sponsors and NRCS as soon as possible.
  - Using the information included in the Plan-EA as a basis, our subconsultant, Wetland Studies and Solution, Inc. (WSSI), performed a biological and wetlands desktop and field review of the project area, including the reservoir, dam, and downstream area. WSSI also performed a wetlands delineation in accordance with USACE methodologies including the limits of the dam and proposed areas affected by the dam rehabilitation with an additional 100-foot buffer to account for potential design changes. WSSI also performed

a field-based habitat assessment for state and federally listed species; however, species-specific surveys are not included in this scope. If species-specific surveys are warranted based on the results of the initial habitat assessment, we will inform the Sponsors and NRCS as soon as possible. WSSI will coordinate with the USACE to obtain a Preliminary Jurisdictional Determination (PJD) for the delineated wetlands.

- Schnabel met with Crutchfield and WSSI via Microsoft Teams to review the scope of work for the bathymetric and wetlands surveys at the dam prior to their site visit.
- **Priorities:**
  - Completion of the principal spillway riser survey is a critical path activity.
- **Assumptions:**
  - Bathymetric survey and survey of the low stage weir of each riser was performed concurrently for both dams as discussed in the Preliminary POW.
  - Survey of the wetlands delineation points and the as-drilled boring locations was also performed concurrently for both dams. These surveys were performed separately from the bathymetric survey and required a separate site visit and associated travel fees.
  - Wetlands delineation for both dams were performed concurrently.
  - An investigation of the stream crossings located within the dam breach inundation area, downstream of the dam and within the HEC-RAS 2D model, was performed during our field reconnaissance discussed under Item 1c and during the geotechnical drilling (Item 3).
- **Exclusions:**
  - This item does not include a topographic survey of the dam. Survey points obtained for development of the Plan-EA and provided by NRCS on June 30, 2022, will be used to develop design drawings.
  - This item does not include survey of hydraulic cross sections and the stream crossings located downstream of the dam, within the dam breach flood inundation areas.
- **Completed Deliverables:**
  - Survey of wetland delineation and bathymetric survey in PDF and AutoCAD formats were submitted to the Sponsors and NRCS on December 6, 2022. No comments were received on this submittal, so a Final Submittal was not required.
  - Wetlands delineation report in USACE tabular format and GIS shapefiles of the delineated area.
  - Habitat/cultural assessment report.
  - As-drilled boring and/or hand auger locations survey in CSV file and AutoCAD file formats.
  - Field notes and pictures taken to accommodate the survey data.

## 2.2 Item 3 – Geotechnical Field Investigation, Interpretation and Conclusions, and Reporting

- **Goals:**
  - To prepare a Geotechnical Investigation Work Plan.
  - To perform geotechnical investigations and laboratory testing to collect data in support of the proposed rehabilitation of Cherrystone Dam 1.
  - To characterize the embankment and foundation materials for use in the rehabilitation design.
  - To prepare a Geotechnical Investigation Report.

- **Approach:**
  - Schnabel previously performed a geotechnical investigation of Cherrystone Dam 1 for NRCS in 2016. The results from our previous investigation and the geotechnical investigation performed during the original design of the dam were reviewed prior to the preparation of the scope for our geotechnical field investigation outlined below.
  - A single Geotechnical Investigation Work Plan for both dams was developed based on our understanding of the project purposes and stakeholder objectives. The Geotechnical Investigation Work Plan was submitted to NRCS and the Sponsors for review and approval on December 16, 2022. A copy of the final Geotechnical Investigation Work Plan was submitted to VA DCR for their records.
  - The investigation findings will be used to support the geotechnical engineering analyses (e.g., seepage and slope stability analyses, settlement analyses, filter compatibility analyses, etc.) required in accordance with Technical Release No. 210-60, Earth Dams and Reservoirs, as discussed under Item 4 below.
  - Our Geotechnical Field Investigation consisted of:
    - Drilling and sampling was performed by our experienced driller, Connelly and Associates, Inc. (Connelly) of Frederick, Maryland, in accordance with the SOW requirements and under the close supervision of our experienced supervisory geotechnical engineer and geologist, who were supported by our lead engineer, senior reviewers, and project personnel, who are all intimately familiar with drilling in embankment dams and associated NRCS requirements.
    - Borings B-01 and B-02 were drilled vertically from the embankment crest. The borings were drilled 68.5 feet (B-01) and 67.4 feet (B-02) through the embankment fill and then through the foundation soils, 19 feet (B-01) and 22.6 feet (B-02), before encountering bedrock. The borings were then advanced 17 feet (B-01) and 28.5 feet (B-02) into rock. The total depths of these borings were 104.5 feet (B-01) and 118.5 (B-02). In addition, two vertical auger probes, B-02A and B-02B, were drilled to the right of B-02 for installation of open standpipe piezometers in the embankment cutoff trench and the foundation soils beneath the cutoff trench, respectively.
    - Heaving materials infiltrated the augers at the bottom (approximately 82 feet below ground surface (bgs)) of the piezometer borehole B-02B. Approximately 5 feet of material entered the augers. After multiple unsuccessful attempts to remove the material from the augers, including raising and lowering the augers, driving a 3" split spoon sampler, and adding water to augers to keep the piezometric surface above the pre-drilling piezometric surface, the augers were removed from the borehole and a wooden plug was installed in the lead auger. The borehole was then drilled to depth and water was added prior to removing the wooden plug to mitigate heave during piezometer installation.
    - Two borings located at approximately the middle of the downstream slope (B-601 and B-602) to characterize Zone 2 and foundation materials were included in the Preliminary POW. However, boring B-601 was not drilled due to the addition of an offset boring (B-701A) to characterize a zone of loose sands encountered on the upstream slope. Boring B-602 was drilled vertically at the middle of the downstream slope of the embankment. The boring was drilled 26.5 feet through

the embankment fill and then 37.6 feet through the foundation soils before encountering bedrock. The total depth of the boring was 64.1 feet.

- Two borings located at the downstream toe (B-603 and B-604) to characterize the foundation materials were included in the Preliminary POW. Boring B-603 was drilled vertically at the downstream toe of the embankment. The boring was drilled through the 5.1 feet of fill and then 36.9 feet through the foundation soils before encountering bedrock. The boring was advanced 17 feet into rock. The total depth of the boring was 59 feet. Boring B-604 was not drilled since access to this boring location was not feasible due to presence of saturated soils along the right abutment contact and at the downstream toe of the dam.
  - Boring B-701 was drilled vertically from the bench near the normal pool elevation on the upstream slope. The boring was drilled 26 feet through embankment fill and then 28.1 feet through foundation soils before encountering bedrock. The total depth of the boring was 54.1 feet. Heaving alluvial sands were observed below the water table in boring B-701. Boring B-701A was drilled to the left of B-701, to characterize the potential loose sands within the zone where heaving occurred. Drilling mud was used to stabilize the borehole and mitigate heave, and SPTs were performed from 24 feet to 44 feet.
  - The permeability values of soils surrounding the piezometer screens was estimated by performing falling head (slug) testing. The testing was performed by displacing the static water level in the piezometers and recording the rate of return (recovery) to the static water level using electronic pressure transducers.
  - Constant head (packer) testing was performed in the rock intervals of the crest and embankment toe borings (borings with no piezometers) to measure the permeability of the foundation bedrock. Inflatable packers were used to isolate discrete intervals in the rock core hole, and water was injected within each interval under constant head pressure. The pressure and water flow measured during the testing was used to calculate the transmissivity of the tested interval.
  - Borings through soils were advanced to top of rock using hollow stem augers. Standard Penetrations Tests (SPTs) were performed at select intervals to evaluate the relative penetration resistance of the embankment and/or foundation soils and to collect split-spoon soil samples. Shelby tube samples of select embankment and foundation soils were obtained. Each tube sampling interval consisted of pushing two consecutive Shelby tubes to increase the likelihood of obtaining a sufficient sample length for laboratory testing. NX double-tube rock coring methods were used to core rock.
  - Best management practices (BMPs) were used to prevent or reduce any erosion and sediment transport during the geotechnical investigations.
  - Upon completion of the geotechnical investigation, the site was restored to pre-investigation conditions to the extent practical. Site restoration included repair of vehicle ruts, spreading of spoil piles, seeding and strawing of disturbed areas, and related activities.
- A Geotechnical Investigation Report was prepared to communicate the findings of our investigations to the NRCS, the Sponsors, and to parties involved during the future construction of the dam modifications. The report contains summaries of the field investigation; descriptions of local and regional geology; boring location plans, boring



logs, boring backfill records, rock core photographs, and subsurface profiles; and other geologic and geotechnical data, interpretations, and conclusions required to support the rehabilitation design. The report was prepared in accordance with the requirements of the NRCS NEM and will address each of the items listed in the SOW.

- We propose an additional one-day investigation to evaluate and obtain samples from a potential soil borrow source for use in dam rehabilitation construction. The borrow investigation will be performed following completion of the preliminary design (Phase III) once the extent of borrow needs, if any, have been defined. We have assumed that the Sponsors will provide the location of and access to a potential borrow source.
- **Priorities:**
  - Completion of the preliminary design (Phase III) for both dams to better define the quantity of borrow fill needed prior to performing the borrow site investigation.
- **Completed Deliverables:**
  - Geotechnical Investigation Work Plan submitted to the Sponsors and NRCS on December 16, 2022
- **In-Progress Deliverables:**
  - Geotechnical Investigation Report (to be submitted under Item 4 following completion of the laboratory testing)
- **Assumptions:**
  - Separate Geotechnical Investigation Reports will be provided for Dam 1 and Dam 2A.
- **Exclusions:**
  - Based on our previous experience on similar projects, a formal Stormwater Pollution Prevention Plan (SWPPP) was not required for the performed drilling activities.
  - Best Management Practices (BMPs) was used, as discussed above. The use of BMPs was addressed in the Geotechnical Investigation Work Plan.
  - A sediment sampling program is not included in this scope of work.

### 2.3 Item 4 – Rock and Soil Mechanics Testing, Evaluation, Interpretation, Conclusions and Reporting

- **Goals:**
  - To conduct laboratory testing of earth and rock materials to provide information to serve as a basis for the rehabilitation design of the embankment and auxiliary spillway.
  - To evaluate the results of the geotechnical investigation and the laboratory testing program; and to perform the necessary engineering analysis to provide recommendations for design, construction, and monitoring.
  - To perform static and seismic stability analysis in accordance with NRCS requirements.
  - To develop recommendations and design concepts to modify the existing embankment and drainage system to meet current NRCS and VA DCR criteria.
  - To prepare an updated Geotechnical Investigation Report.
  - To prepare a Geotechnical Engineering Report.
- **Approach:**
  - After completion of the geotechnical investigations, soil laboratory testing was performed by a certified laboratory, Geotechnics of Raleigh, North Carolina, in accordance with applicable ASTM standards and the requirements outlined in the SOW. Results from the laboratory testing will be used to perform and/or update the geotechnical engineering

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analyses and support related aspects of the rehabilitation design. Upon completion of the laboratory testing, the laboratory test results will be incorporated into the Geotechnical Investigation Report.

- The remaining soil and rock samples from the test borings will be stored at one of the Schnabel offices during rehabilitation design and will be available to NRCS and the Sponsors for up to two months after construction is completed. The following soil laboratory tests were performed:
    - 35 water content tests
    - 17 Atterberg Limits tests
    - 35 particle size distribution tests (with and without hydrometer)
    - 8 specific gravity tests
    - 2 three-specimen consolidated undrained triaxial compression (CU) tests with pore pressure measurements (on intact tube samples)
    - 2 one-dimensional consolidation tests (on intact tube samples)
    - 1 pinhole dispersion test
  - Following the completion of our geotechnical investigations and laboratory testing, we will update the existing geotechnical analyses and perform further geotechnical analyses to evaluate the existing condition of the dam and spillways, as necessary. Our engineering analyses will include:
    - Seismic hazard assessment of the project site;
    - Embankment and foundation seepage analyses;
    - Static slope stability and pseudo-static seismic slope stability analyses;
    - Embankment zone, embankment foundation, and embankment drain filter compatibility analyses; and
    - Review of the headcut erodibility indices for the auxiliary spillway stability and integrity analyses, discussed below.
  - Additional considerations as a part of this task will include an assessment of reservoir rim stability as required in the SOW, though based on our experience, we do not anticipate this to be an issue at this site.
  - We will provide an updated Geotechnical Investigation Report including the results of the laboratory testing.
  - We will prepare a Geotechnical Engineering Report to present the results of our analyses and associated interpretations and conclusions, which will be incorporated into the subsequent design phases described below.
- **Priorities:**
    - Completion of this task is a critical path activity.
  - **Deliverables:**
    - Geotechnical Investigation Report (Updated)
    - Geotechnical Engineering Report
  - **Exclusions:**
    - A separate Rock and Soil Mechanics Laboratory Testing Report will not be provided. The laboratory test results will be incorporated into the Geotechnical Investigation Report discussed under Item 3 above.
    - A Rock and Soil Mechanics Testing Conference, as listed in the SOW, will not be performed.

## 2.4 Item 5 – Existing Structural Conditions, Investigation, Testing, Evaluation, Interpretation, Conclusion and Reporting

- **Goals:**
  - To determine if structural analyses of the existing riser are necessary.
  - To perform, if necessary, a review of the previously performed testing and structural analyses of the riser and provide updates to stability analyses as needed.
- **Approach:**
  - According to the Plan-EA, the existing riser will be demolished and relocated to account for the flattening of the upstream embankment slope. For this reason, Item 5 will only be performed if results from Item 4 show that the current embankment does not require flattening of the upstream slope to meet NRCS stability criteria. In the event that the riser does not need to be relocated upstream, we will perform the scope of work outlined herein, to determine if the existing riser meets stability criteria, utilizing the budget allocated for the design of the new riser, which is also included in Items 8 and 9.
  - In September 2017, Schnabel performed investigations to evaluate the existing structural condition of the principal spillway and toe drain system at Cherrystone Dam 1, and as a result, we understand the general condition of these structures. For this reason and for budgeting purposes, we have assumed that no additional structural investigations or testing of these components will be required to support the rehabilitation design. Therefore, the scope of this item will be limited to a review of the findings from our 2017 investigations and the stability analyses of the riser performed by the NRCS, and updates to the stability analyses as needed. These results will be used to inform the development of the rehabilitation design described under Phases III and IV below.
- **Priorities:**
  - Complete Item 4 to determine if the embankment requires flattening of the upstream slope to determine if the structural review and analyses of the existing riser are necessary.
  - Completion of this task, if required, is a critical path activity.
- **Deliverables:**
  - We will prepare a Structural Evaluation Memorandum to present a summary of our structural review, and the results of any updated analyses.
- **Exclusions:**
  - Additional structural inspections and investigations will not be performed.
  - A Pre-Investigation Conference, as listed in the SOW, will not be performed.

## 3.0 PHASE III –PRELIMINARY DESIGN

During this phase of the project, we will use the results of the previous scope items discussed above to perform hydrologic and hydraulic analyses, geotechnical analyses, and structural analyses, and develop the preliminary design for the selected rehabilitation alternative. One of the primary objectives of this phase will be to refine the preferred alternative in the Plan-EA to reduce cost, enhance constructability, and improve long-term performance while meeting NRCS and VA DCR dam safety requirements and the purpose and need of the project.

### 3.1 Item 6 – Hydrology

- **Goals:**
  - To review and modify as necessary the hydrologic models prepared for the selected alternative presented in the Plan-EA and approved by NRCS.
- **Approach:**
  - We propose that the work associated with Item 6 be performed concurrently with Item 7. We will attend combined conferences for both items and prepare a combined Hydrologic and Hydraulic (H&H) Design Report.
  - Following the procedures in NRCS NEH Part 630, Virginia NRCS Hydrologic and Hydraulic Analysis and the Virginia Probable Maximum Precipitation Tool, Schnabel will review the SITES models developed by NRCS for the Plan-EA and the hydrologic parameters (e.g., runoff curve numbers; lag time and time of concentration; watershed boundary delineation, rainfall data, stage-discharge-storage relationships, etc.) used to evaluate existing/future conditions and to develop the rehabilitation alternatives presented in the Plan-EA. The review will be performed using the most recent available LiDAR data, existing and future land use/land cover mapping available, soils data, and topographic/bathymetric survey.
  - NRCS requires the analysis of three different storm scenarios, the principal spillway hydrograph, the standard design hydrograph, and the freeboard hydrograph. The rainfall depths for these three storm scenarios are dependent upon various factors, including the hazard potential classification of the dam, size of the dam, purpose of the dam, and/or the type of the auxiliary spillway (i.e., earthen or rock). The rainfall depths and the storm distributions for these three scenarios used in the Plan-EA will be reviewed and updated as necessary in accordance with NRCS procedures.
  - The hydrologic data and analyses will be updated, if needed, based on any changes since the Plan-EA. The SITES model will be updated as necessary and the lack of stability and integrity of the existing auxiliary spillway and effectiveness of the proposed spillway upgrades will be confirmed. The USACE HEC-HMS computer program will also be used to provide the necessary hydrologic loading information for the geotechnical and structural analyses discussed below. The results of our hydrologic review and updated analyses will be presented in a H&H Report to be discussed with the Sponsors and NRCS and finalized based on review comments received.
- **Priorities:**
  - No critical path items associated with this task have been identified.
- **Deliverables:**
  - GIS-based maps showing the watershed delineation and soils;
  - GIS-based maps showing existing and future land use coverage;
  - The results, assumptions, and methods used to perform the work associated with this Item will be incorporated in the appropriate portions of the Preliminary H&H Report.
  - Final H&H Report and appendices in digital (PDF) format.
  - Electronic model input and output files in their native formats.

### 3.2 Item 7 – Hydraulic Design and Proportioning

- **Goals:**
  - To develop the final hydraulic design of the dam and spillway system following the preferred alternative presented in the Plan EA.
  - To perform an updated dam breach analysis and develop breach inundation maps for the proposed future conditions (rehabilitated structure condition).
- **Approach:**
  - The primary purposes of this item are to develop the hydraulic design and proportioning of the dam and spillway system, develop a plan for stream diversion and care during construction, and develop dam breach inundation maps in accordance with NRCS TR 210-60 and other NRCS policies.
  - We will perform hydraulic design and proportioning of the dam and spillway upgrades using the revised SITES model described under Item 6 and the USACE HEC-HMS to model and develop control of water plans and requirements to be implemented during construction. During this item we will evaluate options to optimize the preferred auxiliary spillway layout from the Plan- EA. Limiting impacts to the reservoir pool level, particularly the water supply, will be a key factor in this evaluation. We will look at the hydraulic characteristics of the principal spillway system and design of a new impact basin that will dissipate energy and prevent erosion along Cherrystone Creek due to flows from the principal and/or auxiliary spillway.
  - We will review and update, as needed, the dam breach hydrographs and the HEC-RAS 2D model described under Item 1c. We will evaluate future conditions dam breach inundation impacts and develop future conditions dam breach inundation maps in accordance with VA DCR and NRCS requirements after completion of Item 8. The inundation maps will be developed in ArcGIS using the HEC-RAS model results for the different dam breach scenarios analyzed. We will produce high-quality, high-resolution color inundation maps at a standard scale. The inundation maps will include the latest background aerial imagery, contours, color inundation lines, north arrow, legend, scale, map projection, and index for panel maps. Impacted structure addresses will also be provided.
  - Results, assumptions, and methods from Item 7 will be incorporated in the Preliminary H&H Design Report described under Item 6.
- **Priorities:**
  - Completion of this task is a critical path activity dependent upon the modifications required to the principal spillway riser based on the results of the analyses described under Items 4 and 5 above.
- **Deliverables:**
  - See proposed deliverables under Item 6.
  - A draft Dam Breach Inundation Study Report, including Dam Breach Inundation Maps for the future condition of the dam using future land conditions in the watershed upstream of the dam, will be submitted to the Sponsors and NRCS prior to holding the Preliminary Design Review Conference required under Item 8.
  - After addressing the Sponsor and NRCS comments, two hard copies and one electronic copy of the Final Dam Breach Inundation Study Report will be provided.
  - Electronic model input and output files in their native formats.

- **Assumptions:**
  - The existing HEC-RAS 2D model will be used to develop the dam breach inundation maps for both dams.
- **Exclusions:**
  - Development of a CFD model may be appropriate to support the spillway design but is currently not included in this scope of services.
  - The scope does not include an incremental damage/consequences assessment or inflow design flood studies.
  - Hydraulic capacity evaluation of the existing spillway system.
  - Stability and integrity of the existing conditions of the auxiliary spillway.
  - Dam breach inundation study/maps for existing conditions.

### 3.3 Item 8 – Preliminary Foundation, Geotechnical, Structural, and Site Design

- **Goals:**
  - To develop a preliminary rehabilitation design of the rehabilitation measures based on the information gathered during the previous tasks.
- **Approach:**
  - We will assess effects on the Preferred Alternative included in the Plan-EA and obtain final concurrence from NRCS and the Sponsors on the Preferred Alternative prior to proceeding with Preliminary Design.
  - Once concurrence is reached, we will begin performing the various preliminary geotechnical and structural analyses necessary to support the layout and sizing of major features of the preferred dam rehabilitation alternative. Consideration will be given to subsurface, topographical, and environmental site conditions, economy, constructability, aesthetics, and operation and maintenance. These analyses will be performed following the requirements defined in the SOW and in accordance with NRCS and VA DCR requirements. Additional major items such as control of water and construction access will be considered in the development of the preliminary design. Preliminary design drawings showing the layout of major features will be developed, along with a list of material and construction specifications and cost and performance time estimates.
  - During the preliminary design, we propose to submit interim design sketches and data related to specific areas of concern to the Sponsors and NRCS on an informal basis (email) to solicit feedback, as necessary. We will also prepare a formal work product and deliverable (Preliminary Design Submittal) as requested in the SOW and as listed below. The Preliminary Design Submittal will be reviewed with the Sponsors and NRCS, and any review comments provided will be incorporated into the detailed design.
- **Priorities:**
  - Items 3 through 7 will be completed prior to starting the preliminary design.
  - Completion of this task, as well as the subsequent design tasks, is a critical path activity.
- **Deliverables:**
  - Preliminary Design Report
  - Preliminary RCC Mix Design
  - Preliminary Design Drawings
  - List of Material and Construction Specifications in NRCS format
  - Preliminary Cost and Performance Time Estimates

- Preliminary Bid Schedule
- Preliminary Construction Quality Assurance (QA) and Inspection Plan
- Updated Land Rights Map
- **Assumptions:**
  - Preliminary design submittals will be reviewed by the Sponsors and VA NRCS. We have also included a review of the preliminary design submittal by the NRCS National Design Construction and Soil Mechanics Center (NDCSMC) in Fort Worth. The purpose of this early NDCSMC review is to obtain their concurrence on the overall design approach and limit comments received following detailed design.
  - A single round of comments from the Sponsors, VA NRCS, and the NRCS NDCSMC will be addressed for Item 8. Written responses to the review comments will be provided, if requested.
- **Exclusions:**
  - Based on the information provided in the Plan-EA, it is our understanding that reservoir sediment storage capacity is adequate for the planned extended service life of the structure; therefore, no additional sediment storage investigation or analysis is proposed.

#### 4.0 PHASE IV – FINAL DESIGN

##### 4.1 Item 9 – Detailed Designs, Specifications, Cost and Time Estimates, and Design Report (90% Design Submittal)

- **Goals:**
  - To develop a detailed design of the rehabilitation measures.
- **Approach:**
  - The goal of this item is to develop a detailed design of the selected rehabilitation measures, including performing final engineering analyses required to support the rehabilitation design.
  - Comments provided by the Sponsors and NRCS on the preliminary design will be reviewed, discussed, and incorporated into the detailed design, as applicable. We will provide a Detailed Design Submittal including the deliverables listed below.
- **Priorities:**
  - The start of Detailed Design (Item 9) is dependent on the Sponsors and NRCS approval of Preliminary Design (Item 8).
- **Deliverables:**
  - Detailed Design Report
  - 90% Design Drawings
  - Material and Construction Specifications
  - Cost and Performance Time Estimates
  - Bid Schedule
  - Operation and Maintenance (O&M) Plan
  - Construction QA and Inspection Plan
  - Construction EAP
  - Erosion and Sediment Control Plan

- **Assumptions:**
  - Detailed Design will be reviewed by the Sponsors, VA NRCS, and the NRCS NDCSMC in Fort Worth.
  - Written responses will be provided to address NDCSMC design review comments.
  - We will address a single round of review comments on the submittals from Item 9. The comments will be incorporated into a revised Final Design submittal (Item 10).

#### 4.2 **Item 10 – Final Design, Specifications, Cost and Time Estimates, and Design Report (100% Final Design Submittal)**

- **Goals:**
  - To develop the final design of the rehabilitation measures.
- **Approach:**
  - After detailed design review comments are addressed, we will compile the Final Design Package for submission to the Sponsors, NRCS, and VA DCR for final approval, including the deliverables and files requested in the SOW and listed below. Any outstanding review comments, including independent review comments, will be addressed, and the design package will be finalized for construction bidding, with the exception of contract front-end documents.
- **Priorities:**
  - The start of Final Design (Item 10) is dependent on the Sponsors and NRCS approval of Detailed Design (Item 9).
- **Deliverables:**
  - Final Design Report
  - Final Design Drawings
  - Updated Material and Construction Specifications
  - Updated Cost and Performance Time Estimates.
  - Updated Bid Schedule
  - Updated Operation and Maintenance (O&M) Plan
  - Updated Construction QA and Inspection Plan
- **Assumptions:**
  - An additional review of this Final Design submittal by the NRCS NDCSMC in Fort Worth will not be required.

#### 5.0 **PROJECT FEES**

Our fees for the rehabilitation design of Cherrystone Dam 1 are summarized below and are for the specific scope of services detailed herein. These fees are the same as those presented in our price proposal dated July 20, 2022 and the Preliminary POW dated October 14, 2022. As stated in Section 2, the fees listed below are based on performing the scope of services detailed herein in conjunction with the similar scope of services for Cherrystone Dam 2A. If either project does not move forward and the work is not granted, fee adjustments will be required.



Pittsylvania County  
Cherrystone Creek Watershed Dam No. 1 Rehabilitation Design

**Table 1: Breakdown of Fees for Cherrystone Dam 1 Rehabilitation Design**

Task Item	Lump Sum Fee
<b>PHASE I – PLAN OF WORK AND QA/QC</b>	
Item 1a – Preliminary POW	\$9,500
Item 1b – QA/QC Plan	\$2,600
Item 1c – Review of Existing Information and Site Reconnaissance	\$10,100
Item 1d – Final POW	\$2,800
Conferences	\$3,900
<b>TOTAL PHASE I:</b>	<b>\$28,900</b>
<b>PHASE II – SUPPORTING DOCUMENTATION, DEVELOPMENT OF DESIGN DATA</b>	
Item 2 – Field Surveys and Mapping	\$35,200
Item 3 – Geotechnical Field Investigation, Interpretation and Conclusions, and Reporting	\$166,700
Item 4 – Rock and Soil Mechanics Testing, Evaluation, Interpretation and Conclusions, and Reporting	\$39,700
Item 5 – Existing Structural Conditions, Investigation, Testing, Evaluation, Interpretation and Conclusions, and Reporting	---
Conferences	\$5,700
<b>TOTAL PHASE II:</b>	<b>\$247,300</b>
<b>PHASE III – PRELIMINARY DESIGN</b>	
Item 6 – Hydrology	\$23,000
Item 7 – Hydraulic Design and Proportioning	\$51,700
Item 8 – Preliminary Foundation, Geotechnical, Structural, and Site Design	\$139,600
Conferences	\$9,100
<b>TOTAL PHASE III:</b>	<b>\$223,400</b>
<b>PHASE IV – FINAL DESIGN</b>	
Item 9 – Detailed Design, Specifications, Cost and Time Estimates, and Design Report (90% Design Submittal)	\$238,100
Item 10 – Final Design, Specifications, Cost and Time Estimates, and Design Report (100% Final Design Submittal)	\$38,600
Conferences	\$8,000
<b>TOTAL PHASE IV:</b>	<b>\$284,700</b>
<b>TOTAL FEE FOR SERVICES:</b>	<b>\$784,300</b>

## **6.0 OPINION OF PROBABLE CONSTRUCTION COST**

This section summarizes the Opinion of Probable Construction Cost (OPCC) developed for the preferred rehabilitation alternative for Cherrystone Dam 1 presented in the Plan-EA. We did not perform a detailed independent quantity and unit cost analysis as part of this POW but did review the previously developed OPCC for reasonableness. Key findings from our review include:

- The original OPCC presented in the “Cherrystone Site 1 Summary Planning Report - Formulation of Alternatives” (Planning Report) dated October 5, 2018 was \$11.4M.
- The original OPCC for Dam 1 included 20,350 cubic yards (CY) of roller compacted concrete (RCC). Based on a preliminary independent analysis of the information included in the Plan-EA and based on several assumptions, we estimated an RCC quantity of 10,000 to 12,000 CY.
- Adjustments to several key unit prices, including earthwork, concrete, RCC, and steel materials, were considered based on current construction trends.
- Considering these adjustments, an estimated construction cost in 2018 dollars of about \$11M is reasonable.
- Factoring in a potential 3% escalation per year from 2018 to 2024 increases this estimated construction cost from about \$11M to about \$13M.

## **7.0 SCHEDULE**

As indicated above, primary pre-design critical path activities include completion of the geotechnical field investigation (Item 3), the geotechnical engineering analyses (Item 4) to determine if the existing riser needs to be relocated, the structural review and analysis of the existing riser (Item 5) if it does not need to be relocated, and the hydraulic design and proportioning of the modified (if required) riser (Item 7).

Due to unexpected delays during the geotechnical field investigations for each dam (Item 3) and inconsistencies noted in the available survey data, the schedule submitted in the Preliminary POW was revised (see Attachments). The new schedule also provides an additional review time (5 weeks instead of 4 weeks) for the Sponsors and NRCS for Items 8 and Items 9. Last, subtasks for Item 5- Existing Structural Conditions Assessments were moved to Item 8 per NRCS phone request.

## **8.0 CLOSING**

We appreciate the opportunity to submit our POW for these services and are looking forward to working with the Sponsors and NRCS on this project. Please contact our office if you have any questions with regard to this POW.

### **SCHNABEL ENGINEERING, LLC**



Jonathan M. Pittman, PE  
Principal / Senior Vice President

RAS:MRG:JMP

Attachment: Updated Cherrystone Dam 1 and Dam 2A Project Schedule

**Cherrystone Dam 1 and Dam 2A Rehabilitation Design Schedule  
June 2023**

ID	Task Name	Duration	Start	Finish	Predecessors	2021																2022				2023				2024				2025			
						Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4								
1	<b>Overall Design Schedule (NTP of 9/13/22)</b>	<b>108.6 wks</b>	<b>Fri 5/20/22</b>	<b>Tue 6/18/24</b>																																	
2	<b>Phase I – Plan of Work and Quality Assurance/ Quality Control (QA/QC) Plan</b>	<b>38.6 wks</b>	<b>Tue 9/27/22</b>	<b>Thu 6/22/23</b>																																	
3	Kickoff meeting	1 day	Fri 10/7/22	Fri 10/7/22																																	
4	<b>Item 1a – Initial Plan of Work (POW)</b>	<b>6 wks</b>	<b>Mon 10/10/22</b>	<b>Fri 11/18/22</b>																																	
5	Initial POW for Dam 1 and Dam 2A	2.8 wks	Tue 9/27/22	Fri 10/14/22																																	
6	NRCS/Sponsor Review of Initial POW for Dam 1 and Dam 2A	4.2 wks	Mon 10/17/22	Mon 11/14/22	5																																
7	<b>Item 1b – QA/QC Plan</b>	<b>12.4 wks</b>	<b>Wed 9/28/22</b>	<b>Thu 12/22/22</b>																																	
8	QA/QC Plan	1.6 wks	Wed 9/28/22	Fri 10/7/22	5SS+1 day																																
9	NRCS/Sponsor Review of QA/QC Plan	1 wk	Mon 10/10/22	Fri 10/14/22	8																																
10	Final QA/QC Plan	9.8 wks	Mon 10/17/22	Thu 12/22/22	9																																
11	<b>Item 1c – Review of Existing Information and Site Reconnaissance</b>	<b>34.6 wks</b>	<b>Tue 9/27/22</b>	<b>Thu 5/25/23</b>																																	
12	Review of Available Data	4 wks	Tue 9/27/22	Mon 10/24/22	5SS																																
13	Field Reconnaissance for Dam 1 and 2A	1 day	Fri 10/21/22	Fri 10/21/22	12FF-1 day																																
14	Field Reconnaissance Letter Reports for Dam 1 and Dam 2A	4.3 wks	Mon 10/24/22	Tue 11/22/22	13																																
15	NRCS/Sponsor Review of Field Reconnaissance Letter Reports	4 wks	Tue 11/22/22	Tue 12/20/22	14																																
16	Final Field Reconnaissance Letter Reports for Dam 1 and Dam 2A	3 days	Tue 5/23/23	Thu 5/25/23																																	
17	<b>Item 1d – Final Plan of Work (POW)</b>	<b>4 wks</b>	<b>Fri 5/26/23</b>	<b>Thu 6/22/23</b>																																	
18	Final POW for Dam 1 and Dam 2A	2 wks	Fri 5/26/23	Thu 6/8/23	16,35																																
19	NRCS/Sponsor Review of Final POW for Dam 1 and Dam 2A	1 wk	Fri 6/9/23	Thu 6/15/23	18																																
20	Finalize Final POW for Dam 1 and Dam 2A	1 wk	Fri 6/16/23	Thu 6/22/23	19																																
21	<b>Phase II – Supporting Documentation, Development of Design Data</b>	<b>67.9 wks</b>	<b>Fri 5/20/22</b>	<b>Thu 9/7/23</b>																																	
22	<b>Item 2 – Field Surveys and Mapping</b>	<b>28.5 wks</b>	<b>Tue 11/1/22</b>	<b>Thu 5/18/23</b>																																	
23	Field Surveys and Mapping for Dam 1 and Dam 2A	5.2 wks	Tue 11/1/22	Tue 12/6/22																																	
24	NRCS/Sponsor Review of Survey Submittal	2 wks	Wed 12/7/22	Tue 12/20/22	23																																
25	Review Conference with NRCS and Sponsor	1 day	Wed 12/21/22	Wed 12/21/22	24																																
26	Final Survey Files (Bathymetry and Wetlands)	1 wk	Thu 12/22/22	Wed 12/28/22	25																																
27	Re-Survey Structures due to Diff with NRCS Survey	1.5 wks	Tue 5/9/23	Thu 5/18/23																																	
28	<b>Item 3 – Geotechnical Field Investigations and Testing</b>	<b>16.6 wks</b>	<b>Tue 10/25/22</b>	<b>Thu 2/16/23</b>																																	
29	Field Investigation Plan for Dam 1 and Dam 2A (includes Rock and Soil Mechanics Testing Plan)	4 wks	Tue 10/25/22	Mon 11/21/22	12																																
30	NRCS/Sponsor Review of Field Investigation Plan for Dam 1 and Dam 2A	2.1 wks	Tue 11/22/22	Tue 12/6/22	29																																
31	Final Geotechnical Field Investigation Work Plan	1.6 wks	Tue 12/6/22	Fri 12/16/22	30																																
32	Review Conference with NRCS and Sponsor	1 day	Thu 1/5/23	Thu 1/5/23	31FS+2.7 wks																																
33	Geotechnical Field Investigation	6 wks	Fri 1/6/23	Thu 2/16/23	32																																
34	<b>Item 4 – Rock and Soil Mechanics Testing</b>	<b>28.9 wks</b>	<b>Fri 2/17/23</b>	<b>Thu 9/7/23</b>																																	
35	Laboratory Testing (still waiting on some lab results)	10 wks	Fri 2/17/23	Thu 4/27/23																																	



