Santaquin EB Debris Basins

Select a period to highlight at right. A legend describing the charting follows.

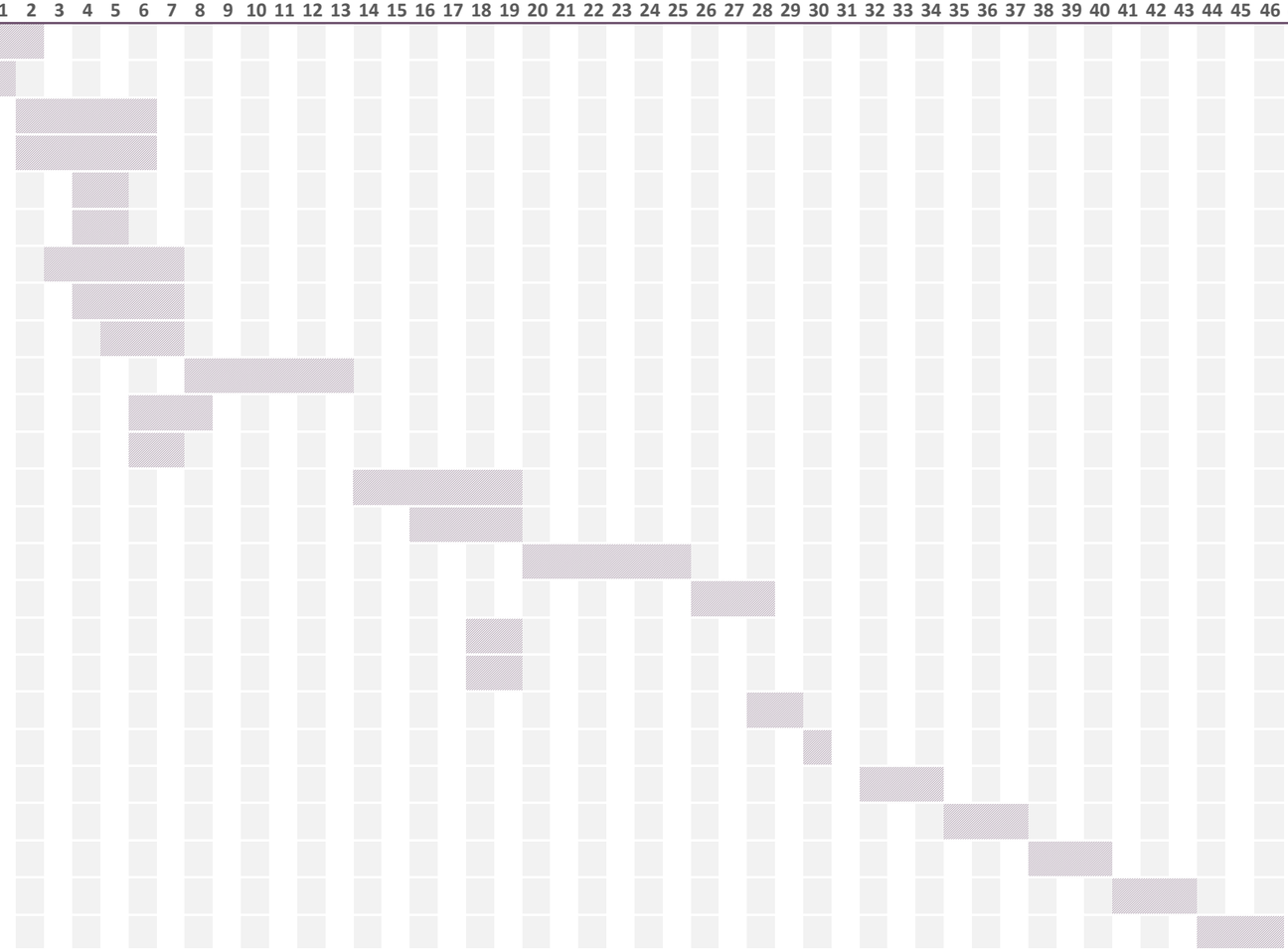
Period Highlight: #

Plan Duration | Actual Start | % Complete | Actual (beyond plan) | % Complete (beyond plan)

ACTIVITY	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Quality Control Plan	1	2			0%
Right to enter property	1	1			0%
Geotechnical and Geologic investigation	2	5			0%
Geotechnical Analysis	2	5			0%
Geotechnical Investigation Report	4	2			0%
Field Survey	4	2			0%
Hydrology and Hydraulics	3	5			0%
Structural Design	4	4			0%
Preliminary Design Submittal	5	3			0%
NRCS Review	8	6			0%
Emergency Action Plan	6	3			0%
O&M Plan	6	2			0%
Final Design	14	6			0%
Final Design Report	16	4			0%
NRCS Review	20	6			0%
Approved For Construction Design Plans, Repor	26	3			0%
Bid Schedule	18	2			0%
Construction Specs, M&P	18	2			0%
Construction SWPPP	28	2			0%
Bidding and Award Phase	30	1			0%
Construction of Basin 1	32	3			0%
Construction of Basin 2-3	35	3			0%
Construction of Basin 4	38	3			0%
Construction of Basin 5	41	3			0%
Construction of Basin 6	44	3			0%

Months

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47



SANTAQUIN FLOOD CONTROL PLANNING DESIGN WORK

HORROCKS ENGINEERS

	Geotechnical						Hydrology, Hydraulics, Dam Design, PI and Management										CE and Inspection					Structural							
	Principal Engineer	Project Engineer	Project Engineer	Project Geologist	Field Geologist	Senior Geologist	Principal Engineer IV, P.E.	Associate Engineer III, P.E.	Engineering Intern II	Engineer III, P.E.	Public Involvement Specialist IV	Survey Row Tech	Sr. Licensed Surveyor II	Surveyor	Design Technician IV	Sr. GIS Analyst	Administrative Assistant	RE (Principal Engineer V)	Field Technician IV	Sr. Field Technician/ Lab Materials Testing	Office Technician	Surveyor	Sr. Principal Engineer III	Engineer IV, P.E.	Engineer III, P.E.	Engineer, P.E.	Engineering Intern	CAD Technician	Total Hours	Total Labor Cost
	Hiram Alba	Danny Brown	Scott Seal	Sofia Agopian	Ashley Peay	Tim Thompson	Todd Awerkamp	Jacob O'Bryant	Alec Van De Graaff	Ruston Carter	Macey Mortimer	Joe Carr	Lonnie Olson	Staff	Lisa Jimenez	Zach Starkey	Cathy Laycock	Dave Dillman	Wade Tayor	Travis Bair	Office Technician	Surveyor	Bob Hendershot	Brett Brady	Jens Hurst	Andrew Pratt	EIT	Brenda Hunsaker		
Task Description	$185	$155	$155	$130	$130	$155	$190	$162	$90	$150	$73	$117	$181	$103	$117	$120	$92	$215	$110	$143	$79	$99	$261	$178	$168	$110	$99	$78		
Contract Administration, Progress Reports							24	200																					224	$36,924
Coordination With Propery Owners								19			50																		69	$6,706
Quality Control Plan								14	24																				38	$4,427
Meetings		42					42	42	19	42	20													41					248	$38,057
Topographic Survey and Processing												10	10	150															170	$18,430
H&H: Finalize Basin Sizing								79	99	125																			303	$40,389
H&H: Reservoir Routing								19	19	64																			102	$14,355
H&H: Principal Spillway Design								19	34	75																			128	$17,351
H&H: Aux. Spillway Design								19	39	115																			173	$23,783
Hazard Classification								7	14	24																			45	$5,982
Breach Analysis Updates								30	14	40																			84	$12,095
Geologic Investigations				210		18																							228	$30,090
Subsurface Investigations	12	175			48																								235	$35,585
Plan of Investigation	15			22		27																							64	$9,820
Foundation Investigations					10																								10	$1,300
Borrow Area Investigations					25																								25	$3,250
Borings																													0	$0
Geologic Report				85		80																							165	$23,450
Laboratory Testing						70																							70	$10,850
Preliminary Report	21																												21	$3,885
Final Report	10	15	30																										55	$8,825
Hydraulic and Hydrologic Design (included in 5)															49														49	$5,751
Hydraulic Details and Plans								9	39	39					49														136	$16,552
Structural Design															14														14	$1,643
Preliminary Design Report								3	19	19							4												45	$5,405
Final Design								9	39																				48	$4,969
Layout, Hydraulic and Hydrologic Design															115														115	$13,496
Structural Design-Project Management																							23	59					82	$16,524
Structural Design-General Coordination																									79				79	$13,249
Structural Design-30% Design																							7	31	63	63	47	79	290	$35,623
Structural Design-60% Design																							7	47	71	103	95	159	482	$55,177
Structural Design-100% Design																							15	47	43	63	47	63	278	$35,965
Structural Design-Pre-Construction Meetings																								39	39				78	$13,492
Structural Design-Submittal and RFI Review																								19	19	39	39		116	$14,707
Construction Drawings								40	40	145					190			14											429	$57,065
Construction Specifications								4	20	34								14											72	$10,542
Bid Schedule							4		14	38																			56	$7,705
Cost Estimate							4		4	24								11											43	$7,076
Construction Performance Time Estimate																		11											11	$2,365
Quality Assurance Plan																		24	19										43	$7,253
Construction Pollution Prevention Plan (CPPP)								3	24	9							1												37	$4,085
Emergency Action Plan (EAP)								40	20	80							1												141	$20,327
Operation and Maintenance Plan (O&M)								15	40	40							1												96	$12,103
Final Design Report							4	5	14	30							1												54	$7,410
Deliverables for Final Review and Approval									14	34							4												52	$6,713
Final Deliverables							9	30	10	20																			69	$10,459
Landrights Work Maps (Update)								9	34			50	50			40													183	$24,233
Coordination with Property Owners/Planning								60	10	10	100																		180	$19,367
Conferences, Review and Approval		10					10	10		10														9					49	$8,172
Bid Assistance							3	11																9					23	$3,955
Public Involvement Direct Costs (mailers, etc.)																													0	$980
Direct Costs (travel, mileage, etc.)																													0	$3,500
Design Subtotals	**58**	**242**	**30**	**317**	**83**	**195**	**100**	**696**	**603**	**1017**	**170**	**60**	**60**	**150**	**417**	**40**	**12**	**74**	**19**	**0**	**0**	**0**	**52**	**301**	**314**	**268**	**228**	**301**	**5,807**	**$791,416**
Construction Administration							40				45							590											675	$137,719
Construction Engineering								40	40									670											750	$154,101
Construction Inspections/Testing																			2895	575	145	145							3,760	$427,139
Construction Geotechnical Oversight	10	40	40																										90	$14,250
Direct Costs (travel, mileage, etc.)																													0	$3,500
Construction Subtotals	**10**	**40**	**40**	**0**	**0**	**0**	**40**	**40**	**40**	**0**	**45**	**0**	**0**	**0**	**0**	**0**	**0**	**1,260**	**2,895**	**575**	**145**	**145**	**0**	**0**	**0**	**0**	**0**	**0**	**5,275**	**$736,710**
																												Total Design and Construction Engineering		***$1,528,125***

Engineering Design Statement of Work

For the

Santaquin Watershed
Utah County, Utah

NRCS is requesting engineering design assistance to perform all tasks necessary in accordance with the following Statement of Work to plan, design, and prepare construction drawings and specifications for the Santaquin Watershed, Utah County, Utah.

Objective: Engineering design is to provide structural improvements having the quality and durability required for the economic life of a structure at the least total cost consistent with functional requirements. Engineering designs are to be determined by comparative design studies and cost estimates prepared with full consideration of the landscape, topography, foundation, and other site conditions including environmental quality, and the economy and feasibility of construction, operation, and maintenance. Economic comparisons of alternative designs are to be determined by the amortized average annual cost of installation (including costs of landrights), operation, and maintenance. Environmental comparisons are to consider ecological, cultural, and aesthetic values.

It is assumed that the comparative analysis studies were completed as part of the Environmental Assessment and will not need to be redone.

NRCS will complete the following tasks as it relates to completion of the Engineering Design:

1. Analyses necessary to determine the correct dam hazard classification
2. Provide any available as-built design data, drawings, and any current completed investigation analysis results as it pertains to the selected watershed study area.
3. Provide all data and documentation, as available, used for completion of the Environmental Document (Plan/EA/EIS) and selection of the proposed alternative as documented in the Final Plan-EA/EIS.

The selected Planning-Engineering Contractor shall perform the following tasks-where needed:

1. Analyses to determine the condition and functionality of the principal spillway system under seismic loading.
2. Evaluation of the condition of the embankment and foundation.
3. Analyses to determine the condition and functionality of the auxiliary spillway system alternatives.
4. Preparation of a complete analysis of costs, impacts and benefits of all alternatives.
5. Development of a Land Rights Work Map for the selected alternative.
6. Development of an updated Emergency Action Plan template for the sponsors to complete.
7. Other agreed-to tasks.

After the review and approval of the design recommendations by NRCS, the Contractor will complete construction drawings and specifications. Any proposed changes in release rates, dimensions, or

elevations will be in conformance with the final Watershed Plan/EA or EIS document, and will be documented in the Design Engineers Report, and approved in writing by NRCS.

Work submitted by the CONTRACTOR to NRCS for review will be discussed at conferences scheduled for that purpose. CONTRACTOR will notify NRCS at least seven (7) calendar days in advance of the time for each conference. When such conferences are held, CONTRACTOR will prepare notes summarizing discussions and decisions reached and, within ten (10) calendar days following the conference, submit one (1) electronic copy of the notes via email to the NRCS Project Manager and Administrative Contact.

It is assumed general project meetings will last one hour on a biweekly basis during design and production portions of the project. Meetings will generally be held at Horrocks Engineers office in Pleasant Grove, with an option to join virtually.

Liaison with NRCS is the responsibility of the CONTRACTOR to ensure NRCS concurs in the selection of alternate designs, alternate appurtenances, or other matters affecting the development of general or specific elements of the design. The CONTRACTOR will submit a memorandum that includes a full presentation of pertinent facts and copies of computations, sketches, notes, and drawings that are necessary for NRCS to perform a complete review of the proposal. Such memoranda will be incorporated into the design report.

EGINEERING CONTRACTOR - STATEMENT OF WORK

Table of Contents

1 General

1.1 NRCS will transmit all documentation used for completion of the specific Authorized PL566 Watershed Plan. The document will contain the approved/proposed alternative developed as per NRCS policy. The proposed alternative will be used to determine any further analysis required to produce a Final Engineering Design Report for the proposed measures documented in the Final Plan-EA/EIS.

1.2 The Contractor will designate a project manager and he/she will be fully aware of the requirements of this Statement of Work, submitted by the Contractor and incorporated into the agreement, including the budget and work schedule. Liaison with NRCS is the responsibility of the Contractor to ensure that NRCS is aware of and concurs with the progress of the study, formulation and selection of alternatives, and other matters concerning the development of the plan and environmental document.

1.3 The Contractor will maintain a record of all notices, computations, drawings, and other pertinent data developed for the work. Assumptions made shall be clearly stated, and all sources of reference data will be included in project record. This record will be neatly recorded, indexed, and organized into a technical report or set of planning folders. The technical report or planning folders can be provided as electronic files or as paper files in topical folders to the NRCS Project Manager.

1.4 The Contractor is responsible for obtaining permission to enter all private lands to conduct resource inventories, gather data, conduct engineering or cultural resource surveys, conduct geologic investigations, or for any other project related reason. Within the sponsor's permanent easement or land rights, the Contractor as a representative of the NRCS and, therefore, of the local watershed sponsor(s) has permission to enter onto the existing land rights and complete all needed work. Outside the sponsor's permanent easement, the Contractor, assisted by the local watershed sponsor, will document permission using a simple, signed agreement and will file them in the planning folders.

1.5 NRCS will furnish or make available to the Contractor the technical reference material listed in Appendix I and, in addition, will furnish the following project specific data. The following listed material shall be returned to NRCS at the completion of the contract except those materials provided on CD-ROM. The Contractor will follow all pertinent regulations pertaining to dams. The Contractor is also responsible for obtaining all needed non-NRCS computer programs along with the program's documentation (i.e. US Army Corps of Engineers HEC-RAS and HEC FDA programs).

- Watershed Agreement
- Supplemental Watershed Agreement(s)
- Watershed Plan
- Supplemental Watershed Plan(s)
- Environmental Impact Statement or Environmental Assessment
- Land Rights Map
- As-Built drawings
- Existing NRCS survey data
- Existing NRCS maps
- Existing geology reports
- Existing soil index testing data
- Existing soil mechanics testing

- Existing design material
- Existing investigation reports
- Existing biological opinions and site inventories
- Existing cultural resource surveys, sampling or recovery reports

2 Quality Control Plan

2.1 The Contractor shall coordinate with NRCS staff to submit a Quality Control Plan (QCP). The QCP will:

- Describe procedures that will be implemented by the Contractor to assure quality control;
- Include an explanation of the responsibilities of each member of the Contractor's design staff and review team;
- The Contractor shall assure the professional qualifications of contractors whose services the Contractor will procure.

2.2 The QCP shall be submitted to NRCS for review and approval as an initial item of work. The Contractor is responsible for ensuring that product development and independent technical review for the design and specifications are carried out in accordance with the approved QCP. The QCP will be updated as needed.

3 Meetings

3.1 The Contractor shall attend meetings with the project sponsors and others as necessary during the design/planning effort to gather and impart information.

3.2 Formal public meetings are meetings held expressly for the NRCS planning effort. Such meetings will be hosted by the project sponsor(s) but will require the Contractor's discipline leader's attendance to explain any design alternatives for the project and documentation of input from the public.

It is assumed that no formal public meetings will be held; they were part of the Environmental Assessment Phase.

3.3 Normally, NRCS will keep sponsors updated on project progress during the sponsor's routine monthly meetings. However, periodically one or more of the Contractor staff will need to attend these meetings to update the sponsor or to collect specific information from the sponsor's governing board.

3.4 Travel costs for these meetings will be estimated and included in the Contractor budget.

4 Field Surveys

4.1 The Contractor shall utilize existing NRCS surveys where appropriate (LiDAR) or perform such measurements and ground surveys as may be required to complete planning of this project. This may require establishing centerlines, developing topographic information, collecting profiles and cross-sections for various lines and structures, and furnishing documentation of the field surveys in the form of electronic media and notes. All survey notes shall follow the format of good surveying practice.

4.2 Accuracy and Precision.

4.2.1 All measurements and ground surveys shall be located with Universal Transverse Mercator (UTM) coordinates. Benchmarks shall be on the North American Datum 1983 (NAD 83) for horizontal and North American Vertical Datum 1988 (NAVD 88) for vertical unless otherwise approved by NRCS.

It is assumed that State Plane Coordinate systems are also acceptable as a survey coordinate system.

4.2.2 The Contractor may use a traditional transit field survey methods or photogrammetry to compile any required survey data.

4.2.3 The Contractor shall be responsible to do checks to see that all errors of closure and tolerances are met. NRCS will be free to spot-check any or all information provided to determine compliance with the requirements.

4.3 Permanent Control Points.

4.3.1 A permanent brass cap in concrete or other permanent bench mark shall be used and tied into all surveys carried out in this contract.

4.3.2 The location, description, and elevation of this bench mark shall be accurately recorded in the notes and described in relation to fixed landscape features.

4.4 Deliverables.

4.4.1 An electronic or paper copy of all survey notes shall be furnished. Electronic files shall be in PDF or Microsoft Office format.

4.4.2 An electronic or paper copy of all maps and drawings shall be furnished. Electronic files shall be in AutoCAD DWG or ASCII DXF or ArcGIS format. AutoCAD DWG files shall be purged to remove unused blocks and drawing objects. A layer table or legend (defining layer names and layer contents, such as contours, trees, roads, etc.) shall be provided. So that exact duplicates can be produced, AutoCAD files shall contain a named view and paper space for each map or drawing and ArcGIS files shall contain a View and Layout for each map or drawing, s. DEM, TIN or TNN data shall be on a separate drawing layer in the AutoCAD DWG file or supplied as a separate AutoCAD DWG or ArcGIS format file.

4.4.3 Point data, such as the locations of survey control points, spot elevation, drill holes, excavations, etc., shall be provided in a comma-delimited text file using a point-north-east-elevation-description (PNEZD) format.

4.4.4 The electronic files shall be supplied on a CD or DVD.

5 **Hydrology and Hydraulics**

5.1 The work shall consist of all operations needed to complete the hydrologic and hydraulic analyses presented in the approved Plan of Work and shall include the following determine the hazard classification for the dam, hydrologic analyses, hydraulic analyses, prepare flood plain maps, and develop breach flood inundation map or Emergency Evaluation Plans.

5.2 The Contractor, in coordination with NRCS, shall review the site data provided for accuracy and completeness and shall determine if hydrologic and hydraulic analyses are needed to complete the planning of this project.

Hydrologic methods used in the Environmental Assessment will be a basis for the hydrologic analysis during design.

5.3 The Contractor will evaluate the hydraulics using the projected future conditions for all alternatives or plans.

5.4 Hazard Classification

5.4.1 The hazard classification shall conform to the policies outlined in the National Engineering Manual parts 520.23, 520.27 and 520.28 and TR-60 as well as requirements of the Utah Office of the State Engineer, Dam Safety. Note: Design criteria can be based on Hazard Classification.

5.4.2 The breach discharge and mapping shall be developed using procedures in TR-60.

5.4.3 The hazard classification shall consider the impact of future development within the breach inundation flood plain.

5.5 Hydrology and Hydraulics Analyses

5.5.1 This work shall consist of developing inflow hydrographs, outflow hydrographs hydraulic stream routing and hydraulic routing and proportioning of the dam, and a hydrology and hydraulics report.

5.5.2 As a minimum and using WinTR-20 or SITES, the Contractor shall review inflow hydrographs for the 2-, 5-, 10-, 25-, 50-, and 100-year 24-hour storms; the 100-year 10-day storm, the stability design storm, and the freeboard storm. *(With and without scenarios for the NED)*

Hydrographs developed during the Environmental will be used as a basis for this analysis.

5.5.3 For basin capacity calculations, a Sediment Survey and volume calculations shall be completed. The Contractor Project Geologist/Hydrologist and/or Soil Mechanics Engineer will review the sediment yield to the basin under projected future conditions.

5.5.4 Procedures and criteria in TR-60 shall be the minimum acceptable for proportioning the earthen dam and associated spillways.

5.5.5 Using TR-20 or SITES, the inflow hydrographs shall be routed through the planned or existing dam and downstream through the study area. This will provide outflow hydrographs and stream routing downstream of the dam. Uncontrolled drainage areas downstream of the dam shall be included in the analyses.

5.5.6 Water surface profiles for the routed storms shall be completed using HEC-RAS and the hydrology and hydraulic models with sensitivity analysis shall be run through several iterations so that the models provide consistent results. The breach hydrograph shall be developed using procedures in TR-66 and shall be routed downstream using the HEC-RAS model. This routing shall extend from the dam to the downstream cross section where flood plain of the breach hydrograph is equivalent to the flood plain of the 100-year, 24 hour storm. If development exists downstream from this location and is below the 100-year flood level, the routing must be extended until the depth and velocity of flood water from the breach hydrograph no longer creates a loss of life hazard or property as indicated in TR-60.

Because there are no downstream channels, it is assumed that a HEC-RAS model and associated water surface profiles will not be needed. It is assumed that FLO-2D and/or SRH-2D may be used in place of HEC-RAS 2-D for downstream flooding.

5.5.7 The hydrology and hydraulics report shall be a narrative summary of all procedures and assumptions. Alternative analyses runs shall be summarized in the report. Supporting data and inputs must be provided to NRCS. Consideration of pertinent stream gages will be utilized to determine appropriate Time of Concentrations and Runoff Curve Numbers.

5.5.8 Electronic data files will be cleaned or purged so that only final input, output and associated files are delivered to the NRCS. Electronic data files for final alternative analyses will also be delivered. The electronic data files shall be delivered on DVD.

5.6 Flood Plain and Breach Inundation Maps

5.6.1 For the recommended alternative, flood plain mapping downstream of the dam shall be developed for eight 24-hour storm events (2, 5, 10, 25, 50, 100, 200, 500 year events) and shall show the plan or aerial view only.

It is assumed that these maps have already been completed as part of the EA and do not need to be regenerated as part of final design.

5.6.2 The breach inundation map delineates the area affected by a catastrophic failure of the dam and shall show the following flood plains: Freeboard hydrograph, Breach hydrograph and 100-year, 24-hour hydrograph. The map shall provide an aerial view and profile with water surfaces shown.

5.6.3 The flood plain mapping shall be plotted with an orthophoto base at a maximum scale of 1:4,800 (1" = 400'). Flood plain mapping shall be in an AutoCAD DWG or ASCII DXF format on CD-ROM.

5.7 Deliverables

5.7.1 An electronic or paper copy of the hazard classification memorandum shall be furnished. Electronic files shall be in PDF or Microsoft Office format.

5.7.2 The hydrology and hydraulics report shall be furnished. Electronic files shall be in PDF or Microsoft Office format.

5.7.3 Electronic copies of all data and modeling files shall be furnished in their native format. If software, other than NRCS programs, Microsoft Office, AutoCAD, ArcGIS, is needed to use, display, or evaluate the data files, the Contractor shall provide the needed software. The Contractor will discuss any such needed software with NRCS during development of the Plan of Work so that arrangements for NRCS purchases of copyrighted software can be made.

5.7.4 An electronic or paper copy of the flood plain and breach inundation maps.

5.7.5 The electronic files shall be supplied on a DVD.

6 Geologic Investigations

6.1 The work shall consist of all operations as necessary to complete the geologic investigation of a dam or other similar structure where there is a need in order to develop a combined Plan-NEPA document and to complete the approved Design Plan of Work.

6.2 The Contractor shall review the site data provided and shall determine if geologic investigations are needed to complete the planning of this project and shall incorporated needed work into the approved Plan of Work.

6.3 The Contractor's geologist shall have previous experience in the geological investigation of dams and spillways. The project geologist shall meet the minimum requirements outlined in NEM Part 531, Geology.

6.4 The geologist shall develop an investigation plan and submit it to NRCS, who will review, suggest changes, discuss those suggestions to resolution and approve within 5 working days.

6.5 NRCS requirements for geologic investigation and sampling are stipulated in the NEM Part 531 and Geology Note 5, dated 1991. Additional requirements are contained in TR-60 and NEH Section 8. Refer to Appendix IV for NRCS geotechnical terms and preferences.

6.6 The geologist shall log all test holes, rock cores, rock outcrops, and excavations and shall direct the investigation in the field.

6.7 When 75 percent of the work at a site has been completed or at least ten days prior to the anticipated completion of the investigation, the geologist shall notify the NRCS geologist, and they will schedule a field review. The field review will discuss progress, review the recorded logs and sampling, and agree on remaining work to complete the investigation.

7 Subsurface Investigations

7.1 This phase of the work shall consist of performing subsurface investigations, field testing, and obtaining samples for laboratory testing in accordance with American Standard Testing & Materials (ASTM) D 420 as necessary to provide data adequate to serve as a basis for design of the project works. Such field testing shall include testing for dispersive clays and collapsible soils.

8 Plan of Investigation

8.1 Not less than 5 working days prior to the start of detailed subsurface investigations, the Contractor shall meet with NRCS and present a Preliminary Plan of Investigation. The preliminary plan of investigation shall include the plan of operations proposed for accomplishing the work and shall be based on consideration of all available data, a physical reconnaissance of the site and other investigations as the Contractor may deem appropriate.

8.2 The preliminary plan of investigation must be of such scope as to show clearly that the work may be effectively accomplished in accordance with the requirements of the contract. The preliminary plan of investigation shall include, but not be necessarily limited to: a preliminary drawing of the site showing the location of each of the site components; the proposed location and depth of drill holes and/or excavations; the proposed location and depths of field tests; the proposed location and depths of disturbed and undisturbed samples; the personnel to accomplish the work; the equipment to be used in accomplishing the work; and the schedule proposed for carrying out the work within the allotted performance time.

8.3 Soil sampling methods shall conform to the requirements of the applicable ASTM methods. Soils shall be identified and classified by means of the Unified Soil Classification System as prescribed in ASTM D 2487 and D 2488.

9 Site Preparation

9.1 Site preparation shall consist of preparing drill rig travel ways, stream crossings, and drill rig setup locations on abutments and flood plains and the removal of trees and brush. It shall also include replacement of excavated material where feasible. All dozer operations shall be conducted in such a manner as to produce a minimum amount of erosion and to prevent sediment and other pollutants from entering nearby lakes, waterways or streams. The location of stream crossing shall be as shown on the site map. Moving equipment to the site(s) is considered mobilization.

10 Foundation Investigations

10.1 Sufficient borings will be made in the foundation to accurately delineate and describe foundation materials and conditions to a sufficient depth where materials and/or conditions will

have no adverse effect on the stability and performance of the structure from the standpoint of strength, consolidation, or seepage.

10.2 Undisturbed samples of representative and critical materials encountered in the foundation will be collected and tested. Undisturbed samples will be approximately 5" in diameter or larger unless smaller sized samples are approved by NRCS. Cohesive soils too soft to be recovered with a Shelby tube type sampler shall be secured with a piston type sampler or equivalent. All undisturbed samples shall be handled, preserved, packed and transported in a manner that will prevent changes in moisture content (except for the removal of free water) or physical condition between the time they are collected from the foundation and delivered to the testing facility.

10.3 Standard penetration tests shall be performed in accordance with ASTM D 1586 in representative foundation borings. In uniform soils, penetration tests may be performed at depth intervals not exceeding five (5) feet. In non-uniform soil deposits, penetration tests shall be performed continuously from the surface to a depth equal to the height of the dam and at intervals not exceeding five (5) feet below this depth until blow counts of 30 in cohesive soils and 50 in non-cohesive soils are encountered. The depth investigated need not exceed three (3) times the height of the dam. Standard penetration tests shall not be applicable to cohesive materials which are not at or near saturation and to materials which contain 10% or more gravel.

11 Borrow Area Investigations

11.1 Borrow areas may not be shown on the maps provided. If borrow areas are not shown or if the designated areas do not provide sufficient usable borrow, the Contractor and NRCS shall jointly locate and secure an appropriate borrow area. Borrow areas shall be explored and representative samples recovered. The volume of borrow (including auxiliary spillway excavation if applicable) shall be "proved out" by exploration and shall exceed the estimated required volume by at least 30 percent. When making computations of borrow material available, excavated side slopes of 4:1 shall be used.

11.2 Materials to be excavated from the auxiliary spillway shall be fully described and classified as to methods required for excavation and shall be sampled and tested for use as earth or rock embankment materials.

11.3 Excavated materials to be used in the embankment that contain more than 5% larger than No. 4 sieve will be sampled and tested according to Technical Release Numbers 26 and 27. Samples representing each kind of borrow material available for use shall be collected for laboratory testing according to ASTM D 420. For the site investigated, the Contractor shall prepare a sample list itemizing all undisturbed and disturbed samples collected.

11.4 The Contractor shall preserve all drill holes for at least 24 hours to determine whether ground water is present or whether ground water levels have stabilized (two successive readings taken at least one hour apart remain the same). The Contractor shall provide temporary covers, plugs, fences, barricades, lights, markers, or other measures consistent with the hazard involved to prevent injury to humans or livestock.

11.5 Recording of Investigation Results

11.6 A log of each test hole and/or excavation in accordance with ASTM D 5434 shall be recorded. Holes will be numbered in accordance with the following numbering system. Abbreviations used in recording and plotting logs shall be as listed below. The numbering system and abbreviations shall be shown on the drawings. Plan, profile, and cross section views shall be

plotted to delineate location of the holes and subsurface conditions. The format and content shall be adequate for the purpose of the investigation in accordance with accepted geologic practice.

TEST HOLE NUMBERING SYSTEM

Hole Locations	Combination Rig	Power Auger	Hand Borings	Trench or Excavations	Natural Outcrops, Streambanks
Centerline of Dam	1 - 49	51 - 99	1001 - 1099	2001 - 2099	3001 - 3099
Borrow Area	101 - 149	151 - 199	1101 - 1199	2101 - 2199	3101 - 3199
Emergency Spillway	201 - 249	251 - 299	1201 - 1299	2201 - 2299	3201 - 3299
Principal Spillway	301 - 349	351 - 399	1301 - 1399	2301 - 2399	3301 - 3399
Stream Channels	401 - 449	451 - 499	1401 - 1499	2401 - 2499	3401 - 3499
Exploratory Borings	501 - 549	551 - 599	1501 - 1599		
Foundation Drain	601 - 649	651 - 699	1601 - 1699	2601 - 2699	3601 - 3699
Miscellaneous	701 - 749	751 - 799	1701 - 1799	2701 - 2799	3701 - 3499

ABBREVIATIONS

B.	Bedded or Bedding	Nod.	Nodule or Nodular
Ch.	Chalk or Chalky	Part.	Partings
Cng.	Conglomerate	Sat.	Saturated
Cs.	Claystone	Str.	Streaks
C.T.	Caved To	Sh.	Shale or Shaly
Flg.	Flagstone or Flaggy	Ss.	Sandstone
Int.	Interbedded	T.	Thin
Lay.	Layer or layers	U.A.D.	Unable to Auger Deeper
Len.	Lens or Lenses	U.D.B.D.	Unable to Drt Barrel Deeper
Ls.	Limestone	U.E.D.	Unable to Excavate Deeper
Ma.	Marl or Marly	Vug.	Vugular
Mat.	Matrix	Wtr.	Water Level as Encountered
Ms.	Siltstone		

12 Borings

12.1 Wash borings, probing, fishtail bits, roller bits, flight augers, helical augers, unverified geophysical soundings and other similar borings shall be considered adequate only for determining rough bedrock profiles. Auger borings (except large diameter bucket augers) or small diameter split spoon borings, with or without supplemental geophysical soundings, shall be considered adequate only for determining bedrock profiles or rough soil profiles. Core borings (including push tube and piston samplings) of medium to large diameter, excavations, test trenches, or inspection holes shall be considered adequate for determining detailed profiles. Bucket augers (6” or larger in diameter) shall be considered adequate for detailed profiles of

uniform, non-gravelly materials. Large diameter (12" or more) bucket auger borings shall be considered adequate for this purpose in very coarse or very mixed materials. Auger borings shall be drilled so that representative materials from depth intervals not to exceed two (2) feet are recovered for logging.

13 Bedrock Profile

13.1 A bedrock profile determined by borings, probing, or soundings shall be verified by means of trenches or large diameter inspection holes at any point or in any zone where the founding of a structural element on rock is critical to the stability or functional integrity of the structure and/or when needed to estimate grouting or dental concreting requirements.

14 Vane Shear Tests

14.1 NRCS will require in-situ vane shear tests when saturated, cohesive foundation soils cannot be properly sampled for laboratory testing. Vane shear tests shall be conducted with equipment and methods equivalent to those presented in ASTM D 2573.

15 Permeability Tests

15.1 Tests to determine the permeability of foundation materials on site, including bedrock, shall be conducted in drill holes using the appropriate boundary conditions, shape factors, and techniques outlined in National Engineering Handbook, Section 8, or other methods approved by NRCS.

16 Safety

16.1 Borings and other excavation (if needed) shall be so excavated, braced, and supported (or cased) as to safeguard the work and the workers and to provide that ground adjacent to the excavation will not slide or settle so as to cause damage to adjacent existing improvements. the Contractor shall furnish, place, and subsequently remove such supporting installations as needed.

16.2 When drill holes or other excavations are left open at the end of a day's work or for observation after completion of work, the Contractor shall provide temporary plugs, covers, fences, barricades, lights, markers, or other measures consistent with the hazard involved, to prevent, injury to humans or livestock, and to protect the other installations.

17 Changes in Plan and Completion of Work

17.1 During the progress of the investigation, the Contractor shall promptly notify NRCS of any unexpected conditions encountered that would direct a material change in his proposed plan or scope of investigation. In this event, the Contractor will furnish NRCS with copies of a revised plan and scope of investigation for NRCS review.

18 Site Cleanup

18.1 Upon completion of the work at each site, the Contractor shall do the following:

- Securely plug all borings and backfill any excavations which are not required for future observations.
- All borings shall be filled in conformance with Utah state regulations and ASTM D 5299 except for all borings that do not penetrate an aquifer shall be backfilled with drill cuttings from the original drilling. However, when borings are backfilled in this manner, the hole shall be capped with a rock, metal cover, or other durable, nontoxic material. This cover must overlap the diameter of the boring by at least 3 inches and must be buried at least 2 feet below the ground surface. Above the hole cover, the hole shall be filled with compacted silts and clays. Restore the land surface to the original grades (except for access roads).
- Remove from the site all scrap or abandoned equipment, materials, and supplies of any nature.
- Repair or replace all damaged fences to their original or better condition.
- Surveys necessary to determine the locations and elevations of all test holes (bored or excavated) during the site investigations shall be completed at this time.

19 Seismic Assessment

19.1 Contractor will transmit the seismic report to NRCS for engineering design consideration. As part of this investigation, a map is to be prepared showing the location and intensity or magnitude of all intensity V or magnitude 4 or greater earthquakes of record, and any historically active faults, within a one-hundred kilometer radius of the site(s). The 100-kilometer radius may need to be expanded if a large historic earthquake or seismically active zone may affect the dam site. The report shall also summarize other possible earthquake hazards such as ground compaction, landslides, excessive shaking of unconsolidated soils, liquefaction and seiches. The report shall address the seismic criteria in TR-60, NEM Part 531, the current building code or the Utah Office of the State Engineer, whichever is applicable upon review.

19.2 Upon completion of the seismic assessment, NRCS may direct additional investigations, explorations or analysis.

20 Geologic Report

20.1 Contractor will transmit the Geologic Report to NRCS for engineering design consideration. A detailed geologic report shall be prepared. This report will generally conform to the guidelines in the NEM, Part 531, Geology, and to the example geologic report being furnished as a guide. This report shall include a narrative discussion interpreting the geologic conditions at the site and their possible relation to the suitability of the site and to the design, construction, and operation of the proposed structure. Any anticipated problems likely to result from the geologic conditions, such as foundation weaknesses, seepage problems, difficult excavation, or other problems shall be discussed in the report. Any measures considered necessary to correct adverse conditions or utilize favorable conditions also should be discussed in the report. The data resulting from field or laboratory tests, such as permeability tests or standard penetration tests shall also be reported and interpreted. The results of surface and ground water investigations shall be discussed.

20.2 The report shall include recorded logs of investigations and a site geology map using the reservoir topographic map as a base. The map shall show the locations of all excavations, test holes, and drill holes. It shall show the surficial geology, location of bedrock outcrops, springs,

seeps, and any other pertinent information. Bedrock contour maps, ground water contour maps, or other illustrations appropriate to the site shall be included as necessary. Plotted profiles and cross section of subsurface conditions shall be furnished and shall include the locations of undisturbed and disturbed samples and field tests. The seismic assessment shall be included as part of the geology report. The geology report shall be prepared and signed by the project geologist. If the geologic maps and drawings are generated in electronic form, NRCS shall supply the Contractor with those maps and drawings in both electronic media and hard copy.

20.3 Geologic data shall be in AutoCAD, ArcGIS, ASCII DXF, or gINT format . http://www.gintsoftware.com/ . The geologic data shall include all borings, excavations, drill holes, baselines, benchmarks, monuments, etc.

20.4 A layer table (legend) shall be submitted defining layer names used to describe various components of the drawing, such as contours, trees, roads, etc.

20.5 The data files shall be supplied on a CD or DVD.

21 Investigation Report

21.1 Contractor shall transmit the Investigation Report to the NRCS. The investigation report shall include preliminary embankment slopes, pool elevations, a zoning plan, and other information required for setting up a testing program, establishing testing pressures, rates, and other items for completing soil tests. The purpose for which samples were obtained, the potential use of the soil represented by the samples, and the expected use for the test results are to be explained.

21.2 The zoning plan shall include a drawing of the proposed cross-section of the dam and the quantities of materials, including the auxiliary spillway excavations, represented by the various samples. The drawing shall also show the disposition of the various materials in the zones.

21.3 The investigation report shall be signed by the author and shall be attached at the end of the narrative geology report section.

22 Soil Mechanics

22.1 The Contractor shall review the site data provided for accuracy and completeness and shall determine if soil mechanics testing and analysis is needed to complete the planning and design of this project. Soil mechanics testing and analysis incorporated into the approved Plan of Work.

22.2 The work shall consist of performing soil mechanics and other physiochemical tests adequate to serve as a basis for design and construction control of the structure and appurtenances. The soil testing program shall include both index and complex testing when appropriate. All testing shall be done on samples that represent the range of materials at the site. Testing methods shall be compatible with the type of engineering analysis made and the field conditions that will exist.

23 Testing Plan

23.1 The Contractor shall review any existing reports, proposed testing plans, completed testing plans and existing testing results prior to formulating the laboratory testing program for this specification. The Contractor shall submit for review and approval a plan detailing the number and kinds of tests to be performed, the sources of the materials to be tested, and a schedule for

completion of the testing program. The plan shall include narrative statements indicating the purpose for making the proposed tests, the proposed use of the test results, and a reference to the delineated materials represented by the samples to be tested.

23.2 When the index testing (Ex. grain size, Atterberg limits, specific gravity, compaction, relative density) has been completed and prior to commencing complex testing, the Contractor and NRCS will review the testing program and results, and agree on remaining needs and testing requirements.

24 Sample Handling

24.1 The following conditions apply to all soil samples that are going to be used in the testing:

24.2 Samples will be packaged and transported in accordance with ASTM D 4220 or D 5079.

24.3 Soil samples shall be inspected prior to testing and their general condition noted. Any unusual conditions shall be reported. Any sample disturbance shall be described and, in the case of tube samples, the amount of wash material, compression, or other distortion shall be measured and reported. Any other information that the testing organization feels is pertinent to the engineering application of the test result shall be reported.

24.4 Soil samples shall be tested as soon as possible after they are received by the laboratory in order to reduce storage time and possible disturbance from unnecessary handling. Particular care is to be taken with undisturbed samples to assure that the water content (except for removal of free water) and physical condition does not change prior to testing. If undisturbed samples are to be stored in excess of seven days before testing, they must be removed from the tubes, waxed, and stored in a room with controlled, high humidity.

24.5 The laboratory shall visually describe samples and classify each according to the Unified Soil Classification System (ASTM D 2487 or ASTM D 2488). A log of an undisturbed sample shall be made if changes in the character of the soil are noted within the sample. This log shall show the exact location of test samples.

25 Laboratory Testing

25.1 All necessary soil tests shall be made on a sufficient number of samples to provide adequate data for design and subsequent construction control.

25.2 Soil testing shall be done in accordance with the methods or procedures listed for the following tests. If other procedures are used or other tests are deemed necessary, they shall be those generally accepted by the soil engineering profession and approved by NRCS prior to beginning the test.

25.3 Grain Size Analysis of Soils - Method ASTM D 422

25.4 Atterberg Limits - Method ASTM D 423 and D 424

25.5 Specific Gravity - Method ASTM D 854

25.6 Compaction (moisture-density) - Method ASTM D 698

25.7 Determine the specific gravity of the soil and develop the complete saturation (zero air voids) curve over the full range of the test.

25.8 When ASTM D 698 - Method C is used, the percentages of material between the 2 inch and No. 4 sieve size will not be replaced as specified in Note 2.

25.9 When materials are subject to breakdown and degradation when compacted, a separate and new sample will be used for each point on the compaction (ASTM D 698 - Method A -Note 1).

25.10 Method ASTM D 1557 shall be used when so designated by NRCS or when requested by the Contractor and approved by NRCS.
25.11 Relative Density of Cohesionless Soils - Method ASTM D 204.
25.12 Permeability - U.S. Army Corps of Engineers, EM 1110-2-1906, Appendix VII
25.13 Dry Unit Weight - U. S. Army Corps of Engineers, EM 1110-2-1906, Appendix II
25.14 Consolidation and Permeability - Method ASTM D 2435 or USBR Designation E-15. The minimum sample size shall be 2 1/2 inches in diameter by 1 inch thick.
25.15 Foundation samples tested for design will be saturated at the start of the test unless a collapse potential exists. If collapse is suspected, the samples will be loaded normally until the overburden pressure plus the load of the embankment is reached. The sample will then be saturated with the collapse measured and then normal testing can be resumed.
25.16 Load increments sufficient to define the preconsolidation pressure of overconsolidated foundation soils will be used.
25.17 Load increments will be added to 32,000 psf or until the straight line or virgin portion of the void ratio-pressure curve is obtained.
25.18 At least one point will be determined on the unload or rebound portion of the void ratio-pressure curve for foundation samples.
25.19 Water content, density, and degree of saturation will be determined both before and after testing. This will require a specific gravity determination.
25.20 All consolidation-time curves will be included in the report. Consolidation results will be plotted as void-ratio versus log of pressure. Overburden pressure, preconsolidation pressure (if any), and compression index will be shown on void ratio versus pressure plot for foundation samples. The coefficient of consolidation will be computed and shown.

26 Shear

26.1 Triaxial Compression - Procedures described in "Soil Testing for Engineering" by T. William Lambe or "The Triaxial Test" by Bishop and Henke or EM 1110-2-1906 Appendix X.
26.2 Direct Shear — Procedures described in "Soil Testing for Engineers" by T. William Lambe or U.S. Army Corps of Engineers EM 1110-2-1906 Appendix IV

26.3 Special requirements:
26.3.1 The shear test parameters defined in TR-60 shall be used.
26.3.2 Shear tests on materials with maximum particle sizes less than 3/4" diameter will be triaxial compression tests except for those nonplastic soils that cannot be trimmed or remolded for triaxial testing.
26.3.3 Specimens shall be saturated by back pressuring. A B—parameter (ratio of change in pore pressure to change in stress) of 0.95 or more shall be obtained.
26.3.4 Consolidated-undrained tests at saturation will be made with pore pressure measurement for critical and representative foundation samples.
26.3.5 Consolidated-undrained tests at saturation with pore pressure measurements will be made for critical and representative samples of materials proposed for use in each zone of the embankment. Average placement moisture content may be made on critical and representative samples of materials proposed for use above the fully developed phreatic line in the downstream shell.

26.3.6 Unconsolidated-undrained tests of embankment materials at average placement moisture and of foundation materials at saturation will be made if sampling and testing reveal the presence of foundation strata which necessitates analysis of stability for the end of construction condition. Samples will be tested to failure or to a maximum strain of 15%, whichever occurs first, and the stress-strain curves will be included in the report.

26.3.7 The maximum deviator stress will be used as the failure criterion. Failure may not exceed 15% strain.

26.3.8 A minimum of three stress circles from three separate specimens shall constitute a shear test.

26.3.9 Water content, dry density and degree of saturation shall be determined for each specimen before and after testing.

26.3.10 Visual differences between specimens will be noted, and visual failure condition of each specimen also will be noted. Plots of Mohr's circles and the envelope(s) for total stress (and effective stress when measured) will be given in the report.

27 Dispersion

27.1 Laboratory Dispersion Test - Procedures described in "Piping in Earth Dams of Dispersive Clay" by James L. Sherard, Rey S. Decker, and Normal L. Ryker; Proceedings of the Specialty Conference on the Performance of Earth and Earth-Supported Structures, Purdue University/June 1972/ASCE.

27.2 Pinhole Test - Procedures described in "Pinhole Test for Identifying Dispersive Soils" by James L. Sherard, Lorn P. Dunnigan, Rey S. Decker, and Edgar F. Steele; Journal of the Geotechnical Engineering Division, Proceedings of the American Society of Civil Engineers, Volume 102, No. GT1, January 1976.

27.3 Both the Laboratory Dispersion and Pinhole Tests shall be conducted on each sample for which dispersion data is presented. The presentation and analysis of data generated by these two tests shall constitute a complete test unit.

28 Soluble Salts

28.1 If soluble salts are thought to be present based on field logging, a soil conductivity test shall be used for screening purposes. A 12.5 gram sample of soil is immersed in 250 milliliters of distilled water. If the eC is greater than 300 microsiemens a Gravimetric Salt test will be performed. The Gravimetric Salt test takes 10 milliliters of solute, which is evaporated at 60^{o} Centigrade and weighed on an analytical balance. If the evaporate is greater than 4% than the test is redone with a more dilute solution until the value drops below 4% by weight. The National Soils Laboratory has some procedural guidelines for these tests.

28.2 If any sample is thought to contain soluble salts the sample should be dried in an oven with a temperature of 60^{o} Centigrade so that the chemically bound water is not released.

29 Testing Report

29.1 The Contractor shall furnish to NRCS a summary of all index testing (grain size, Atterberg limits, specific gravity, compaction, relative density) using NRCS Form 354 prior to undertaking other soils testing. As part of this submittal, the Contractor shall recommend any

needed changes to the testing plan. A meeting shall be held to discuss and concur in the remaining laboratory testing to be done.

29.2 The Contractor shall furnish to NRCS a report presenting all laboratory test data; interpretation and analytical analysis of tests; narrative discussion of conditions pertinent to design, construction, and performance of the works, and design recommendations for those elements of the project dealing with earth or earth-rock construction.

29.3 **Interpretations, Analyses and Recommendations**

29.4 The Contractor shall evaluate the results of the geological investigation and the soil mechanics testing program and perform the necessary analyses to develop a geotechnical report. The analyses and report shall be in accordance with the requirements of the following divisions of this specification and shall be adequate to provide design, construction, and monitoring recommendations for all elements of the project.

29.5 The complete geotechnical report shall summarize all analyses made and recommendations for the design, construction, and monitoring of the structure(s). The report shall include all information required in the appropriate division of this specification and any additional data considered by the Contractor to be relevant to the design. Unless otherwise specified, all computation and other material adequate to document the work shall be furnished to NRCS.

29.6 **Analysis Requirements**

29.7 The geotechnical analysis shall determine and document the following items:

29.8 **(a) Summary of Material and/or Site Parameters**

29.9 The Contractor shall include a summary of material strength, consolidation, permeability, and identification properties. The summary shall include, as appropriate, sections on foundation bedrock, foundation soils, proposed dam fill materials, dam auxiliary spillway materials and any other fills that may be appropriate. The basis for any assumed parameters shall be adequately documented if substantiated by actual borings and field or laboratory tests. The report shall include a narrative summary accompanied by appropriate drawings and tabular summaries of data.

29.10 **(b) Dam Foundation Cutoff**

29.11 Based on results of the geological investigation, field permeability tests, laboratory permeability tests, and estimates of permeability, the Contractor shall analyze the existing cutoff wall and provide results to NRCS.

29.12 **(c) Foundation Preparation (Soil)**

29.13 Recommendations for treatment of the soil foundation shall be based on results of field and/or laboratory test, soil mechanics analyses and site geology.

29.14 Recommendations for removal of undesirable material shall include: (1) rationale for the recommendations; (2) the extent, both lateral and vertical, of recommended removal; (3) suggested field procedures for identifying materials to be removed, and (4) alternative methods of treatment considered.

29.15 Recommendations for methods other than removal for treating undesirable foundation soils shall include a rationale for selection of the alternative, including cost consideration and details of recommended procedures adequate for design.

29.16 Foundation removal shall be identified on plotted cross sections and profile of the embankment alignment that includes plotted logs of test holes. Other design parameters may be included in a narrative report.

29.17 Recommendations for treatment methods other than removal shall be included in the narrative report and shall be accompanied by sufficient sketches or drawings to document the design and to form a basis for construction drawings and specifications.

29.18 **(d) Foundation Preparation (Rock)**

29.19 Recommendations shall be based on the nature of bedrock materials as determined from the foundation investigation and the appropriate laboratory tests and analyses performed.

29.20 Recommendations for pressure grouting, dental grouting, slush grouting, gunnite protection, cleaning operations, or other special treatments shall include a rationale for selection of the method or methods of treatment, including cost considerations and details of the treatment methods adequate to provide the basis for design.

29.21 A narrative summary of the rationale and the treatment methods recommended shall be included. For complicated foundation problems requiring extensive treatment, the narrative shall be accompanied by graphical and/or tabular illustrations which can be used to document the design and to form a basis for construction drawings and specifications.

29.22 **(e) Principal Spillway Analysis**

29.23 Analysis shall include:

(1**)** Foundation for the conduit;

(2**)** Parameters for estimating joint extensibility using the procedures in TR-18;

(3**)** Parameters for calculating loading on the conduit using the procedures in TR-5;

(4**)** Protection against piping along the conduit including filter, drainfill material, and anti-seep collars; and

(5) Riser tower for seismic loads using a response spectra analysis based on ASCE 7-05 and design in accordance with applicable portions of ACI 350-08. Other applicable loading and design parameters are subject to NRCS approval.

29.24 A narrative summary of recommendations shall be included in the report. Necessary computations and narrative documentation supporting the analysis of the above-mentioned items shall be included.

29.25 **(f) Dam Slope Stability Analysis**

29.26 Stability analysis shall be performed within the general guidelines shown in TR-60, with the following additional provisions:

29.27 (1) The stability condition at the end-of-construction need not be analyzed if, in the opinion of the Contractor, and mutually agreed to by NRCS, it would be less critical than the steady seepage or sudden drawdown condition.

29.28 (2) Partial pool conditions shall be analyzed for municipal or irrigation reservoirs where fluctuations of the normal pool level may be expected. Most limiting shear strength parameters shall be used and the minimum acceptable safety factor shall be 1.5.

29.29 (3) Analyses may be made using a computer program that has the capability of searching for the most critical failure surface. Pertinent information of the computer program to be used and the method of analysis it employs shall be furnished to NRCS for reveiw. If non-computer procedures are used, sufficient trials shall be made to determine the most critical failure surface for each condition analyzed. The use of computer methods of analysis other than those furnished will be subject to the approval of NRCS.

29.30 (4) For the sudden drawdown analyses, an acceptable alternative to the use of a composite strength envelope for embankment soils may be used if approved by NRCS.

29.31 (5) Minimum acceptable safety factors for the design selected shall be as outlined in TR-60.

29.32 (6) Assumptions used regarding the selection of shear parameters and the appropriate type of analysis shall be clearly stated. Assumptions used in developing an assumed phreatic surface and any uplift shall be clearly stated and shown.

29.33 A graphical and/or tabular summary of the results of the slope stability analysis shall be included in the report. Only the most critical failure surfaces for each condition analyzed need be shown in the summary. A narrative summary of the rationale used in selecting methods of analysis, any assumptions pertinent to the analysis, and selection of design recommendations to improve stability shall be included in the report.

29.34 **(g) Settlement Analysis *(if applicable)***

29.35 The settlement analyses shall be based on geological site conditions, engineering properties determined by laboratory tests, or by documented reference to data that can be correlated. Calculations shall be made for any potential differential settlement problems in a direction both transverse and parallel to the fill centerlines.

29.36 Recommendations based on laboratory tests, correlations, and calculations made shall include, but not necessarily be limited to: (1) maximum settlement in the foundation/cutoff trench and embankment; (2) estimated percentage of total settlement occurring during construction; (3) settlement beneath the principal spillway conduit; and (4) alternatives correcting problem situations, including shaping of natural slopes, excavation and removal of highly compressible deposits, pre-wetting or removal of collapsible soils, or other special procedures such as pre-loading and staged construction of soft clays.

29.37 A narrative summary of conditions analyzed and assumptions made, together with results of the analyses, shall be included in the report. Any correlations used shall be clearly stated.

29.38 **(h) Dam Seepage Analysis**

29.39 Based on the Phase II Report for Millsite Dam, the existing filter material was listed

29.40 Seepage analyses shall be based on site geology, soil and rock properties determined from field and laboratory tests, or on documented assumed properties based on correlation to similar, previously tested materials.

29.41 Analyses shall be by appropriate graphical or numerical methods suitable to the complexity and hazard of the site conditions. Assumptions or models used shall be clearly stated. Procedures listed in Soil Mechanics Notes No. 5 and No. 7 may be used.

29.42 Recommendations shall include, but shall not necessarily be limited to: **(**1**)** embankment and/or foundation drains, **(**2**)** dimensions and recommended gradation of materials for each drainage zone, **(**3**)** lateral and vertical extent of drainage installation with respect to embankment, and **(**4**)** any special measures required for treating uplift or large seepage quantities such relief wells, blanketing of reservoir areas, or seepage berms.

29.43 Evaluate as-built embankment filter. Any needed rehab elements need to be designed in accordance with National Engineering Handbook, Part 633 and applicable State requirements. Seepage quantities shall be estimated, as necessary, to ensure that drainage zones and collection pipes are adequately sized and for use in a water budget analysis of the reservoir, where appropriate. Procedures of Soil Mechanics Note No. 3, or other procedures generally accepted by the engineering profession, may be used.

29.44 A narrative summary of the methods employed in the analysis of seepage and of recommended design measures, accompanied by suitable illustrations, if appropriate, shall be included in the report to document the design and to form a basis for construction drawings and specifications. Illustrations of flow nets or other models used in the analyses shall be included.

29.45 **(j) Dam Seismic Assessment**

Horizontal acceleration at the project site shall be estimated by generally accepted seismic risk procedures. Design accelerations shown in TR-60, NEM Part 531, special studies, the current building code or the Utah Office of the State Engineer, shall be reviewed. Higher values may be used if considered advisable by the Contractor. Assumptions and methodology employed in arriving at the estimate shall be clearly stated.

The liquefaction potential of saturated, cohesionless sand and silt foundation soils shall be evaluated by procedures outlined in Youd, L.T. and Idriss, I.M., 1997, Proceedings of the MCEER Workshop on Evaluation of Liquefaction Resistance of Soils, National Center for Earthquake Engineering Research, Technical Report NCEER-97-0022, SUNY-Buffalo, 276p, or by other methods approved by NRCS.

Defensive design measures to be considered shall include, but not be limited to:

(1) Embankment drains and transition zones,
(2) Increased top width and freeboard, and
(3) Foundation removal or improvement.

A narrative summary of the results of the seismic evaluation shall be included in the report. Significant design recommendations shall be summarized and illustrated as necessary to document the design and to form a basis for construction drawings and specifications.

29.46 **(j). Dam Instrumentation**

29.47 The Contractor shall evaluate the need to monitor performance of the structure. The degree of uncertainty in the assumptions made during design and the hazard class of the structure shall be considered in evaluating the need for instrumentation.

29.48 Consideration of instrumentation shall include, but not be limited to instruments needed to: (1) measure pore pressures during construction; (2) detect movements of structural elements; (3) measure effectiveness of seepage control measures; and (4) measure seismic events.

29.49 If instrumentation is not recommended, a summary statement indicating the rationale for arriving at this decision shall be included.

29.50 A narrative summary of the recommendations, together with any necessary illustrations, shall be included in the report to document the design and to form a basis for construction drawings and specifications.

29.51 **(k) Dam Auxiliary Spillway Evaluation (Soil Materials)**

29.52 Parameters required for analysis of auxiliary spillway breaching using procedures of NEH Part 652 shall be provided. These parameters shall include, but not limited to: unified soil classification, plasticity index, d_{15}, percent clay, dry bulk density, void ratio, liquidity index, and dispersion values.

29.53 The parameters shall be based on in-situ laboratory tests on samples representative of the most erodible soil at any location in the bulk length of the spillway to a depth of 30 feet below finished grade or to the base of the embankment, whichever is lowest in elevation.
29.54 Supplemental tests needed to assess the erosion resistance of auxiliary spillway soils shall be performed and their effects on auxiliary spillway design analyzed using the Earth Spillway Erosion Model (NEH Part 628.51) as encoded in SITES.
29.55 Recommendations for cut slope configuration in excavated auxiliary spillways shall be based on appropriate engineering property tests and/or correlations, together with a stability analysis of the slope using accepted procedures.
29.56 Recommendations for other special spillway features to accommodate drainage, stability berms, local topography or rock formations to mitigate unusual problems shall be clearly documented and justified.
29.57 A narrative and/or tabular summary of data, accompanied by appropriate sketches and drawings that adequately convey recommendations for design, shall be included in the report.
29.58 A summary of any stability analyses performed, together with assumed material properties and computational methods employed, shall be furnished. Assumptions as to water table or soil profiles shall be clearly stated.
29.59 Appropriate drawings shall be furnished for special design features recommended, together with sufficient narrative to document the design and to form a basis for construction drawings and specifications.
29.60 Complete computations and computer printouts for the stability analyses are not required. However, this information shall be made available to NRCS on request.

29.61 **(l) Dam Auxiliary Spillway Evaluation (Rock)**

29.62 Analyses of rock material properties shall be based on geological information, rock cores, and appropriate engineering tests.
29.63 Slope stability analyses, if performed, shall be based on material property tests or assumptions, as mutually agreed to by the Contractor and NRCS. Computational method and other assumptions employed regarding rock profiles, cross sectional configurations, water tables, or the like, shall be clearly stated.
29.64 A summary of the analyses and recommendations for design shall be included in the report to document the design and to form a basis for construction drawings and specifications. Appropriate geologic maps and drawings to document conclusions concerning the features of the rock shall be included.
29.65 Stability analyses, if performed, shall be summarized using appropriate sketches, drawings, and narrative aids to describe the analyses. Assumptions as to material properties, profiles, the water table, and computational methods employed shall be clearly stated and shown graphically where appropriate, in order to document the design and to form a basis for construction drawings and specifications.

30 Preliminary Report

30.1 The Contractor shall submit to NRCS original and 3 copies of a preliminary report for review and acceptance. The report shall contain all calculations and documentation that was used to develop the design recommendations. NRCS representatives will review the preliminary recommendation report and schedule a meeting to discuss the report with the Contractor.

31 Final Report

31.1 The Contractor shall submit original and 6 copies of the final report to NRCS.

32 Alternative Designs

32.1 The Contractor shall prepare alternative designs needed to complete the planning of this project.

32.2 The scope of the work shall be that which is necessary to formulate and analyze alternatives for the plan document. The Contractor will be required to identify a recommended alternative, and shall study both action and no action alternatives; flood proofing and/or decommissioning shall be considered as appropriate. Multiple action alternatives may be required, depending upon project circumstances. Sufficient design work shall be completed to size the dam, reservoir, and spillways. Stability analysis of the auxiliary spillways shall be completed.

Because this work was already completed during the Environmental Assessment phase and a preferred alternative was selected, it is assumed that information is sufficient

32.3 Cost estimates for each alternative, including operation and maintenance costs shall be developed in sufficient detail to allow comparisons and recommend an alternative for implementation. Work completed under this section shall conform to NRCS and State of Utah policy.

32.4 The Contractor shall define the area needed to implement the recommended alternative and shall develop the Land Rights Work Map.

33 General Design Considerations

33.1 The work will consist of all operations described herein to design and prepare the construction drawings and specifications, quantities, bid schedule, design report, cost estimate, operation and maintenance plan, and other related documents for the installation, repair or rehabilitation of a floodwater retarding structure and its appurtenances. The design will have the required capacities to store sediment, beneficial use water, and floodwater.

33.2 The design will conform to the objectives, provisions, and requirements of the respective watershed plan and to all federal, state and local laws, codes, rules and regulations. The design will provide for an installation that will function to accomplish the intended purpose; provide for the safety of the public; be economical to construct, operate and maintain; be compatible with the specific site conditions; and provide a visual resource that enhances the adjacent landscape and is aesthetically appealing.

33.3 The Contractor will report to NRCS any omissions, discrepancies, or inadequacies in the data furnished by NRCS as a basis for design. The need for supplementary data or additional investigations will be conveyed to NRCS in writing with suggestions for corrective actions.

33.4 The Contractor will maintain a record of all notices, computations, drawings, and other pertinent data for the design. These records will be neatly recorded, indexed, and organized into the following design folders.

General Data	Hydrology	Landscape
Geology	Sedimentation	Land rights
Drainage	Structure	Emergency Action Plan
Survey	Quantity Computations	Operation and Maintenance
Soil Mechanics	Specifications	Correspondence

33.5 Assumptions made as a basis for design shall be clearly stated, and all sources of reference data will be listed in the design report.

34 Preliminary Design

34.1 The Contractor shall review and verify the adequacy of the site data material furnished by the Sponsor/s or NRCS. The preliminary design must develop the general features of the structural installation including the selection of the most suitable types of structures, the optimum layout and arrangement of the elements of the structural system, and the types and locations of appurtenances. These general features must be determined by considering geologic and topographic site conditions and economy and feasibility of construction, operation, and maintenance. Design criteria and standards for all elements of the project shall comply with the NRCS technical material furnished. When it becomes necessary to depart from NRCS criteria and standards, the request shall be submitted to NRCS for approval. The design shall comply with all local and state rules and regulations necessary to gain approval by state regulatory agencies.

34.2 The minimum reservoir capacities for the purposes of storing sediment, beneficial use, and floodwater shall be as shown in Table 3 of the watershed plan or higher if required by flood routing of TR-60 storm hydrology.

34.3 Procedures and criteria in TR-60 shall be the minimum acceptable for checking the elevations of the earth dam and associated spillways.

34.4 The Contractor shall prepare and submit copies of the preliminary design to NRCS for review. The submittal shall include preliminary design work for the complete structure and appurtenances and shall include, as a minimum, the following information:

35 Layout

35.1 Structure site topographic maps needs to show in detail the layout of the embankment, spillways, drainage system, outlet basin, and other appropriate appurtenances.

35.2 Cross sectional view of the embankment along the centerline of its structural spillway showing lines, grades, and elevations of the embankment, structural spillway (including riser, barrel, seepage control and outlet), foundation excavation, and outlet basin and channel.

35.3 Profile views along centerline of dam, drain and spillway(s) showing geologic data in profile and pertinent design data and construction details.

35.4 Cross section views of the embankment, outlet channel, spillway(s), and any other sections necessary to illustrate the work to be performed. Embankment cross sections shall show the zoning plan with a tabulation of material types, placement densities, and moisture content for each zone.

36 Hydraulic and Hydrologic Design

36.1 When hydraulic and hydrologic data is furnished by NRCS, the Contractor shall review and revise it as necessary to meet applicable NRCS criteria and available data. The Contractor shall perform computational checks as necessary to verify that coordinates of design hydrographs and flood routings (fixing the design elevations and discharges) are mathematically correct.

36.2 Hydraulic and hydrologic data not furnished but required for proper functioning and design of the structure shall be prepared by the Contractor and shall conform to the criteria and standards of NRCS technical materials. Copies of hydraulic and hydrologic data and computations shall be included in the report.

37 Structural Design

37.1 Only the structural details essential to the study of alternate designs shall be developed in preliminary design. Structural dimensions shall be sufficiently refined to allow reasonable estimates of quantities and costs. Structural design shall conform to the criteria and guides contained in the NRCS technical material.

38 Miscellaneous

38.1 A fencing plan shall be prepared for the dam and spillways.

38.2 The Contractor shall prepare the necessary applications for the 401 and 404 permits to be reviewed and finalized by the sponsors.

It is assumed these permits will not be needed as part of this project.

39 Preliminary Design Report

39.1 The report shall be assembled in a manner that will facilitate a thorough engineering review and understanding of the proposed design. In addition to layout, hydraulic and hydrologic design, and structural design, the report shall include:

39.1.1 A narrative description of the project.

39.1.2 A summary of data used as a basis for design.

39.1.3 A summary of design criteria used to include stability analyses of earth materials.

39.1.4 Drawings and/or sketches sufficient to define all essential elements of design.

39.1.5 A summary of alternate layouts and designs considered and a detailed description of the alternate chosen. The summary shall clearly demonstrate the reasons for the choice.

39.1.6 Computations and design notes developed during the preparation of the preliminary design.

39.1.7 A preliminary set of the construction specifications (complete with items of work and construction details), material specifications, bid schedule, cost estimate and performance time estimate.

39.2 A meeting for review of the work accomplished under this step will be held with the Contractor and NRCS.

40 Final Design

40.1 Following review and approval of the preliminary design, the Contractor shall prepare the final design.

40.2 This work shall consist of completing the design and preparing a complete set of construction drawings, construction specifications, quantity calculations, cost estimate, bid schedule, construction performance time, design report, construction pollution prevention plan, quality assurance plan and an operations and maintenance plan.

41 Layout, Hydraulic and Hydrologic Design

41.1 Layout shall consist of presenting the items outlined for the preliminary design with changes incorporated by the more detailed design analysis and NRCS comments.

42 Structural Design

42.1 Structural design shall consist of incorporating NRCS's comments on the preliminary design and completing the structural analysis as may be required for final and complete dimensioning of the structure.

43 Construction Drawings

43.1 The Contractor shall prepare final construction drawings using AutoCAD and shall present all details necessary for construction.

43.2 Drawings shall conform to the drafting standards set forth by NRCS. NRCS standard drawings shall be used where applicable.

43.3 The drawings shall contain projected plan, elevation, and isometric views with adequate explanatory notes, specification references, and dimensions to ensure construction in accordance with the intent of design. There shall be adequate steel schedules, drawings, and bending diagrams to facilitate fabrication and proper placement of all steel, including trash racks, reinforcing bars, valves, etc.

44 Construction Specifications

44.1 The Contractor shall prepare construction and material specifications for the dam and appurtenances. Unless otherwise approved by NRCS, specifications shall conform to standard NRCS specifications contained in National Engineering Handbook, Part 642.

45 Bid Schedule

45.1 The Contractor shall prepare a bid schedule listing all items of work for which payment is to be made. The format shown in National Engineering Handbook, Part 642, shall be followed when preparing the bid schedule.

46 Cost Estimate

46.1 The Contractor shall prepare an estimate of construction costs for each item listed in the bid schedule.

46.2 The cost estimate shall be an itemized list for the significant items of work showing the item, specification number, quantity, unit cost, and total cost. The items used in the cost estimate shall be the same as the bid items on the bid schedule and specifications.

46.3 Cost data shall be logically and clearly presented. Up-to-date prices shall be used. Costs shall be determined for completed work and shall include furnishing and installing materials, transportation, labor, overhead, profit and any other items incidental to the work.

47 Construction Performance Time Estimate

47.1 An estimated construction performance time schedule shall be prepared by the Contractor showing the major items of work, the items that may be performed concurrently, and the estimated performance time to complete each item. The performance time will be based on the estimated amount and types of equipment required to do the job, weather, holidays, and sponsor preferences.

48 Quality Assurance Plan

48.1 The quality assurance plan must document the quantity, quality, and timeliness for providing appropriate quality assurance. The components of the plan are:

48.1.1 Section 1 - Inspection Requirements
48.1.2 Section 2 - Timing of Inspection
48.1.3 Section 3 - Skills Needed to Perform Inspections
48.1.4 Section 4 - Staff Hours Needed to Perform Inspections
48.1.5 Section 5 - Testing Equipment and Facilities Needed

48.2 The plan will assure that adequate quality control and quality assurance measures are planned. NRCS Construction Specification 94 and the Quality Assurance Plan must be in accord.

49 Construction Pollution Prevention Plan (CPPP)

49.1 The CPPP should focus on: providing a site description that identifies sources of pollution to storm water discharges; and, identifying and implementing appropriate measures to reduce pollutants in storm water discharges. In order to accomplish this, the CPPP should contain the following:

- Site Description, including the following:
- Sources of pollution affecting water quality
- Construction activities expected
- Sequence of major activities disturbing soil
- Area(s) to be disturbed
- Runoff coefficient from post construction site conditions
- Site map with drainage patterns identified and
- Name of the receiving waters
- Controls to Reduce Pollutants
- Erosion and sediment controls
- Storm water management intentions
- Specified other controls (404, dust, access roads, et cetera) and,
- State, local, or other requirements

49.2 The plan must also address maintenance procedures for the required facilities and details for inspection.

50 Emergency Action Plan (EAP)

50.1 If a dam is designed and an EAP is required, that document will be completed by the Contractor in accordance with the NEM, Part 520, Section 520.27, the National Operation and Maintenance Manual and the Utah Office of the State Engineer. The final EAP will be completed before construction.

51 Operation and Maintenance (O&M)

51.1 An operation and maintenance plan shall be prepared to summarize the inspection and maintenance needs to ensure the dam will operate adequately for its design life. The plan shall include numerous operation, maintenance, and repair features of all component parts. The plan shall also identify the approximate yearly cost estimate to execute the O&M plan.

52 Final Design Report

52.1 The Contractor shall prepare and furnish to NRCS copies of the final design report.

52.2 The report shall be a bound volume consisting of design notes pertinent to final design including computations, sketches, drawings, specifications, quantity estimates, bid schedule, cost estimate, performance schedule, and other data pertinent to final design and not included in the preliminary design report.

52.3 Data relating to final design but presented in the preliminary design report may be referenced in the final design report.

52.4 The report shall be sectionalized and indexed (hyper-linked bookmarks) in a logical manner. The number of sections required will vary with the scope and complexity of the design; however, the organization of the report shall generally conform to the following outline:

- Work Plan
- Geologic Investigation Report

- Soil Mechanics Report

Design Report

Summary
Authority
Description of job
Design objective
Basis for design
General basic data
Hydrology
Foundation design
Instrumentation
Cost estimate
Construction considerations
Hydrology
Structural design
Environmental considerations
Construction drawings
Specifications
Bid schedule
Location and layout
Hydraulic design
Embankment design
Spillway Erodibility Indices
Construction schedule
O & M requirements

Design Analysis Appendices

Hydraulic Design
Geotechnical Design ➔ ➔ Seepage and control; Stability Analysis; Foundation Embankment; Instrumentation
Spillway Erodibility Indices
Structural Design
Instrumentation
Instructions to the Engineer

Construction Drawings
Specifications
Bid Schedule
Cost Estimate
Construction Schedule
O&M Plan
Quality Assurance Plan

53 Deliverables for Final Review and Approval

53.1 NRCS will review the final design before the Contractor/NRCS review meeting. NRCS will initiate this review meeting.

- Four copies of the following:
  - Construction specifications.
  - Construction drawing sheets and the draft Utah Office of the State Engineer filing sheet.
  - Operation and Maintenance Plan
  - Final Design Report and its appendices
  - Bid schedule
  - Cost estimate and supporting data

- Construction performance time
- Construction Pollution Prevention Plan
- Draft Emergency Action Plan
- Quality Assurance Plan
- Utah Office of the State Engineer Check List

54 Final Deliverables

54.1 Upon final approval of the Deliverables for Field Check, Review and Approval, the Contractor shall furnish the following items to NRCS:

54.2 Printed Documents:

- Five bound copies and one original of the Final Design Report and its appendices signed and sealed by the designer.
- Five bound copies and one original (34 inch x 22 inch) of all construction drawing sheets signed and sealed by the designer.
- Five bound copies and one original construction specifications signed and sealed by the designer.
- Six copies of the accepted bid schedule.
- Two copies of the accepted cost estimate signed and sealed by the designer and supporting data.
- Six copies of the accepted construction performance time.
- Five bound copies and one original of the accepted Operation and Maintenance Plan.
- Five bound copies and one original of the accepted Construction Pollution Prevention Plan.
- Six bound copies of the accepted Draft Emergency Action Plan.
- Five bound copies and one original of the accepted Quality Assurance Plan.

54.3 Electronic Documentation

- The data files shall be supplied on a DVD.
- One copy of all CAD generated construction drawings sheets of the accepted, final plan using pdf format.
- One copy of all text prepared with a word processor suitable to be read with pdf.

55 New or Supplemental Watershed Plan and Environmental Document Connection

55.1 The Contractor shall use the Final Supplemental or (NEW) Watershed Plan and Environmental Document in conjunction with and in support of the engineering design tasks. The proposed/selected alternative documented in the Final Plan-EA/EIS will be used for generation of a final engineering design based on the specific watershed measure carried forward for Final Design.

56 Landrights Work Maps

56.1 Landrights work maps shall be prepared electronically on a georeferenced aerial photographic base. Maps shall be prepared to be no less accurate than required by nationally recognized map

accuracy standards for 1:4,800 maps (scale of 1 inch to 400 feet). The NRCS shall furnish the information required to determine the physical features necessary to complete the map. The landrights work map(s) shall, at a minimum, show the following features:

- Existing physical features in the project area.
- Proposed project feature locations and or project boundary.
- Major project features.
- Easement limits, including construction campsite or other easement needed for construction.
- Property lines and owners with address.
- Utilities and owners with contact name, phone number and address.
- Section numbers and corners, township and range lines, and benchmark locations.
- Access routes for construction and maintenance.
- Table of easement requirements by property owner.
- Map scale and North arrow.
- Legends and title block.
- Match line between corresponding sheets, if applicable.

56.2 This item shall also consist of preparing drawings and data for any required permits and NEPA documents.

57 Conferences, Review and Approval

57.1 Work shall be reviewed and verified for accuracy by the Contractor's personnel prior to conference meetings and prior to submittals to NRCS.

57.2 Liaison will be maintained by the Contractor with the Sponsor and NRCS to the extent necessary to ensure that NRCS is aware and concurs with the progress of the work, selection of alternatives, and other matters concerning the development of general or specific elements of the supplemental watershed plan.

57.3 NRCS will provide technical oversight on all phases of the planning process from initiating planning to final plan completion. Conferences shall be held whenever requested by the Contractor or the Sponsor and NRCS during which questions relating to the project will be discussed, work previously performed will be reviewed, and decisions made with a view toward expediting the plan of work. Work that in the opinion of NRCS does not require conference discussions may be reviewed and accepted by correspondence or telephone conversations. Where conferences are required, the Contractor shall notify NRCS and the Sponsor in advance of the time of each conference. An agenda for each meeting/conference should be considered.

57.4 The Contractor shall prepare notes summarizing discussions and decisions reached during conferences or in telephone conversations and promptly furnish one copy of the notes to NRCS. Meetings will be held wherever practicable.

58 Ownership of Documents

58.1 The NRCS acknowledges that the supporting data and documents generated by the Contractor are instruments of professional service. However, all documents, including resource inventory data, engineering, and economic model outputs, geologic investigation reports, drawings, maps, estimates, and all other data used in the preparation of the Supplemental Watershed Plan and Environmental Assessment and Final Design are the property of the NRCS.

59 Appendix I. NRCS Reference Material

The following reference materials for use in developing the work products outlined in this agreement are available through NRCS.

NRCS may have additional technical material available for reference. The Contractor should discuss specific needs with the appropriate NRCS discipline representative to determine applicable references and to obtain copies of those references.

Primary References are:

National Watershed Program Manual (NWPM)
https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/wfpo/

National Resources Economics Handbook (NREH)
National Engineering Manual (NEM) https://directives.sc.egov.usda.gov/RollupViewer.aspx?hid=27418
- NEM Part 511 - Design
- NEM Part 512 - Construction
- NEM Part 520 – Soil And Water Resource Development, Subpart C - Dams

National Engineering Handbook (NEH)
National Operation and Maintenance Manual (NO&MM)
Technical Release (TR)-60 - Earth Dams and Reservoirs
"Economic And Environmental Principles And Guidelines For Water And Related Land Resources Implementation Studies" Dated March 10, 1983.

Specific Additional References, listed by discipline, include:

Survey
- NEM Part 540 – Field Surveys
- TR-62 - Engineering Layout, Notes, Staking and Calculations

Economics
- National Resources Economics Handbook (NREH)
- Econ2, Floodwater Damage Computer Program
- Urb1, Urban Economics Damage Computer Program
- Economic & Environmental Principals & Guidelines for Water Related Land Resources (PG)

Hydrology
- NEM Part 530 - Hydrology
- NEH Section 4 - Hydrology
- NEH Part 630 - Hydrology
  - Chapter 1, Introduction
  - Chapter 2, Procedures
  - Chapter 3, Preliminary Investigations
  - Chapter 4, Storm Rainfall Depth

Abbreviations:
DN - Design Notes
GN - Geology Notes
NEH - National Engineering Handbook
NEM - National Engineering Manual
NO&MM - National Operation & Maintenance Manual
NREH - National Resources Economics Handbook
NWSM - National Watershed Manual
SMN - Soil Mechanics Notes
TP - Technical Paper

Chapter 5, Streamflow Data
Chapter 6, Stream Reaches And Hydrologic Units
Chapter 12, Hydrologic Effects Of Land Use And Treatment
Chapter 18, Selected Statistical Methods
NRCS-Utah Standard Rainfall Distributions and Procedure
NEH Part 728.5 - Sites Water Resources Site Analysis Computer Program
TR-20 - Computer Program for Project Formulation (Hydrology)
TR-55 - Urban Hydrology

Hydraulics

NEH Section 5 - Hydraulics
TR-25 - Design of Open Channels
TR-29 - Hydraulics of Two-Way Covered Risers
TR-39 - Hydraulics of Broad-Crested Spillways
TR-66 - Simplified Dam-Breach Routing Procedure
TR-70 - Hydraulic Proportioning of Two-Way Covered Baffle Inlet Riser
TR-49 - Criteria for the Hydraulic Design of Impact Basins Associated with Full Flow in Pipe Conduits
TR-64 - Floodway Determination Computer Program
DN-6 - Armored Scour Hole for Cantilever Outlet
DN-8 - Entrance Head Losses in Drop Inlet Spillways
DN-18 - "Unattached" Engineering Standard Drawings
HRB-108 - Highway Research Board Tentative Design Procedure for Riprap Lined Channels
SCS TP-106 - Hydraulic Design of the Box Inlet Drop Spillway
SCS TP-107 - Tests On Chutes with SAF Stilling Basins
USBR EM-25 - Hydraulic Design of Stilling Basins and Energy Dissipators

Geology

NEM Part 531 - Geology
NEH Section 3 - Sedimentation
NEH Section 8 - Engineering Geology (Chapter 5 Is Void; See Part 531 of the NEM)
NEH Part 628 - Dams
Chapter 51, Earth Spillway Erosion Model
Chapter 52, Field Procedures Guide For The Headcut Erodibility Index
NEH Part 631 - Geology
Chapter 12, Rock Material Field Classification System
TR-17 - Geologic Investigations for Watershed Planning
TR-27 - Laboratory and Field Test Procedures for Control of Density and Moisture of Compacted Earth Embankments
TR-32 - Procedure for Determining Rates of Land Damage, Land Depreciation and Volume of Sediment Produced by Gully Erosion
TR-51 - Procedure for Computing Sheet and Rill Erosion on Project Areas
TR-78 - The Characterization of Rock for Hydraulic Erodibility
GN-3 - Geologic Investigation Process
GN-5 - Soil Sample Size Requirements for Soil Mechanics Laboratory Testing
SMN-6 - Glossary, Symbols, Abbreviations, and Conversion Factors

Soil Mechanics

NEH Part 628 - Dams
- Chapter 50, Earth Spillway Design
- Chapter 51, Earth Spillway Erosion Model

NEH Part 633 - Soils Engineering
- Chapter 26, Gradation Design Of Sand And Gravel Filters

TR-26 - The Use of Soils Containing More Than 5 Percent Rock Larger Than the No. 40 Sieve

TR-27 - Laboratory and Field Test Procedures for Control of Density and Moisture of Compacted Earth Embankments

TR-68 - Seismic Analysis of Risers

SMN-3 - Soil Mechanics Considerations for Embankment Drains

SMN-5 - Flow Net Construction and Use

SMN-6 - Glossary, Symbols, Abbreviations, and Conversion Factors

SMN-7 - The Mechanics of Seepage Analysis

SMN-8 - Soil Mechanics Testing Standards

SMN-9 - Permeability of Selected Cleans Sands and Gravels

SMN-12 - Portable Pinhole Test Apparatus

SMN-13 - Dispersive Clays

DN-24 - Guide for the Use of Geotextiles

Forms

- Form 127 - Soil Permeability
- Form 128 - Consolidation Test
- Form 128A - Log Time Consolidation
- Form 129 - Undisturbed Sample Characteristics
- Form 130 - Grain Size Analysis
- Form 352 - Compaction and Penetration Resistance
- Form 353A - Soil Classification
- Form 354 - Soil Mechanics Laboratory Data
- Form 355A - Triaxial Shear Test
- Form 355B - Triaxial Shear Test with Pore Pressure Measured
- Form 357 - Summary – Slope Stability Analysis
- Form 366 - Direct Shear Test
- Form 372A - Placement of Earth Fill Materials

Drafting

NEM Part 541 - Drafting

TR-73 - Computer Aided Design and Drafting (CADD) Standards

Design

NEM Part 536 - Structural Engineering

NEM Part 542 - Specifications

NEM Part 543 - Materials

NEH Section 6 - Structural Design
NEH Section 11 - Drop Spillways (Hydraulic Portion Only)
NEH Section 14 - Chute Spillways
NEH Section 19 - Construction Inspection
NEH Part 642 - Specifications For Construction Contracts
    Chapter 1, General Contract Specification Procedures
    Chapter 2, National Standard Construction Specifications
    Chapter 3, National Material Specifications
TR-5 - Structural Design of Underground Conduits
TR-18 - Computation of Joint Extensibility Requirements
TR-30 - Structural Design of Standard Covered Risers
TR-31 - Structural Analysis and Design at Low Stage Inlets
TR-37 - Structural Analysis and Design at Base of Riser with Conduit Openings in Both Endwalls
TR-50 - Design of Rectangular Structural Channels
TR-54 - Structural Design of SAF Stilling Basins
TR-63 - Structural Design of Monolithic Straight Drop Spillways
TR-67 - Reinforced Concrete Structural Design
TR-74 - Lateral Earth Pressures
TR-77 - Design and Installation of Flexible Conduits
DN-2 - Required Three-Edge Bearing Strength for Rigid Pipe
Example Construction Drawings
Example Construction Specifications
Example Quality Assurance Plan
Example Construction Pollution Prevention Plan

60 Appendix II. NRCS Surveying Preferences

General - All paper or electronic survey notes and sketches shall follow recognized professional practice and industry standards. Notes, sketches, and other data shall be complete, neat, legible, and reproducible. The work shall be organized to facilitate ease in review and shall allow reproduction or production of hard copies. When survey equipment that requires little or no manual recording of field data is used, the survey data shall include information allowing NRCS to review and interpret the raw data.

Natural Stream Channel - Begin plan and profile stationing at the most upstream extent of the area of interest. The thread of the stream or water line at low water shall be shown on the plan. The profile need not go below the low water surface, except that the streambed shall be profiled through riffles.

Centerline of Dam - Stationing should progress from left to right when looking in a downstream direction. Station 10+00 should be established on the left abutment near the crest of the dam for new dams. Stationing will be as shown on the as-built drawings for existing dams.

Centerline of Principal Spillway - The intersection angle with the centerline of the dam should be 90 degrees. Stationing should increase in a downstream direction. NRCS typically sets the principal spillway centerline station, where it intersects the dam centerline, as station 5+00 for new dams. Stationing will be as shown on the as-built drawings for existing dams.

The natural stream channel downstream of the principal spillway outlet should be cross sectioned at distances approximately 400, 800, 1200, and 1600 feet. These cross sections should be taken perpendicular to bank full stream flow. The cross section would define the channel centerline, bottom width, and top of the bank, and it should extend at least 25 feet beyond the bank. Distances on the cross section should be measured right and left when facing downstream.

Centerline of Auxiliary Spillway - The intersection of this centerline and the dam centerline becomes the point for construction layout of the auxiliary spillway. Therefore, it is necessary to tie the two lines together with stationing and horizontal angle. Stationing should increase in a downstream direction. NRCS typically sets the auxiliary spillway centerline station, where it intersects the dam centerline, as station 10+00. Stationing will be as shown on the as-built drawings for existing dams.

On new dams since the auxiliary spillway is a borrow area, NRCS establishes a 100-foot by 100-foot grid on area of the auxiliary spillway. This provides a system to use for the geologic investigation and for computing quantities. Grid lines are perpendicular to the auxiliary spillway centerline. The Contractor shall designate the grid points by base line stations and distance up or downstream.

Borrow Area(s) - Profiles of borrow area(s) in the reservoir should parallel the dam centerline at 200-foot intervals beginning 200 feet upstream from the dam centerline. If the dam centerline has angle point, use the longest leg as the baseline for layout of borrow grids. Each profile upstream from the dam centerline should be designated alphabetically starting with A. Profile stationing should mimic the stationing on the dam and identified by station and letter (such as 19+00, A). Profile downstream from the dam centerline could be designed alphabetically starting with AA.

Geologic Investigation - Investigation boring holes and excavations should be located horizontally using the above suggested centerlines or grids with a vertical elevation established at each hole.

Valley Cross Sections - The valley downstream of the dam should be cross sectioned at intervals not to exceed 2500 feet starting from the centerline of the dam and extending down to the point of intersection where the breach wave crest and the flood level of the 100-year frequency storm from the uncontrolled drainage area. If development exists downstream from this point and is below the 100-year flood level, valley sections should be extended to include such development or until the depth of the flooding from the breach discharge no longer creates a hazard. Valley sections should be taken more often if the valley cross sectional area changes significantly. Each valley section shall be taken perpendicular to the direction of floodwater flow and shall define the bottom width and centerline of the channel and the tops of bank. The portion of the valley section across the channel shall be perpendicular to stream flow, which may cause the section to be bent. Valley sections should extend vertically to at least six tenths of the planned dam height above the stream channel. Distances should be measured from right and left when facing downstream.

Centerline of Downstream Affected Roads - The crown of all downstream roads within the study area should be profiled to an elevation which is equal to or higher than six tenths the planned height of the dam above the stream channel. Stationing shall progress from left to right when looking in a downstream direction. The centerline of the bridge or culvert shall be located on the road profile. Structure dimensions and skew angle from the road should be measured. Valley sections should be taken upstream and downstream of roads.

Drainage Structures - Structures in the channel should be measured in sufficient detail to permit determination of the hydraulic characteristics of the structure. This may include, but not be limited to, a cross section of the structure, its skew to flow direction, the shape and number of pilings and/or piers, width and or length of the structure, size and angle of wing walls, flow line elevations, and cross sections upstream and downstream of the structure.

Building Elevation Surveys - Threshold elevations of buildings in the potentially inundated area should determined. The project economist should be present or consulted during surveys of building threshold elevations to assure that locations on the buildings are surveyed. Additional vertical dimensions should be recorded to support accurate economic evaluations, particularly related to the elevation of zero damage (e.g. basement windows, et cetera).

Permanent Benchmarks - These must be positioned such that they will not be disturbed or made useless by future construction operations. They should consist of a bronze pin or caps set in concrete or a number 5 reinforcing bar 36 inches long, firmly set and driven flush with the ground. An aluminum or plastic cap should be set on the #5 re-bar with a lath set nearby.

61 Appendix III. NRCS Drafting Preferences

General - All maps, drawings, and notes, whether paper or electronic, shall follow recognized professional practice and industry standards. Notes, sketches, and other data shall be complete, neat, legible, and reproducible. The drafting work shall be organized to facilitate ease in review and allow reproduction or production of hard copies. Where drafting products are delivered as electronic files, NRCS must be able to reproduce the same view, map, drawing, or note. Therefore, AutoCad files must contained named views and layouts and ArcGIS must contain unique view with associated layouts, or the drafting products can be delivered as pdf files or a similar format.

NRCS uses drawing sheets measuring 22 by 34 inches with a one-half inch margin on top, bottom, and right end and a one and one-half inch border on the left end. Plan views should be drawn so that flow is toward the right side or the top of the sheet or with north to the top of the sheet. Profiles representing a view essentially parallel to the direction of stream flow should be drawn so the upstream end is on the left and flow progresses from left to right. Elevations and sections representing views essentially normal to stream flow are to be drawn so that they are viewed from upstream (with the observer looking downstream). A series of sheets should be numbered (example: Sheet 10 of 27).

Map or drawings must, as appropriate, include the following details: north arrow, bar scale, and contour interval. In addition, Map and drawings must, as appropriate, include the following: centerlines, bench mark descriptions, monument descriptions, ties between centerlines and monuments or bench marks, coordinate grid system.

If requested, NRCS will furnish a typical, blank drawing file in the following formats: AutoCad dwg or dxf, ASCII file, or ArcGIS template. This blank drawing will include NRCS title blocks in a 22-inch by 34-inch drawing template.

Topographic Maps and Plan Views - Maps shall contain planimetric features, which are visible or identifiable on the base aerial image, including buildings, ditches, terraces, reservoirs, trails, roads, railroads, quarries, borrow pits, cemeteries, wooded areas, utilities (i.e. telephone, telegraph, electric, underground cables, and pipelines and sewers), fence lines, walls, and similar man-made features. The designation of state and federal numbered highways should be shown. Structures such as bridges, trestles, tunnels, piers, retaining walls, dams, oil, water, other storage tanks, and the like should also be shown. Maps should also show drainage ways which are longer than one inch at map scale, water features (i.e. springs, falls, rapids, ponds, lakes, swamps, marshes, and bogs), rock ledges, cliffs, and other essential topographic features.

Spot elevations should be shown for: water levels, hilltops, saddles, depression bottoms, intersections of important roads and railroads, and along the ridge and channel of terraces. Spot elevations should also be shown where contours are more than three inches apart at map scale.

Each contour should be drawn as a 3D polyline and shown as a solid line, except where it is obscured by an overhanging bluff or ledge, and on maps compiled by photogrammetry where the ground cannot be seen due to dense woods. In such ground-hidden places, the contours should be shown as dashed

(broken) lines. Index contours should be established using every fifth contour, and these index contours should be labeled with its actual elevation.

Horizontal control point used for photogrammetric surveys must be plotted on the finished maps with an accuracy of 1/100 of an inch of its true position as expressed by the plane coordinates calculated for the point. Ninety percent of all planimetric features should be plotted so that their position on maps are accurate to within at least 1/40th of an inch, and no feature should be more than 1/20th of an inch from their true coordinate position. Ninety percent of all spot elevations placed on maps should have an accuracy of at least one-fourth the contour interval and the remaining 10 percent shall be not in error by more than one-half the contour interval.

Profiles of Centerlines - Profiles should typically be plotted so that the ratio of horizon scale to vertical scale is equal to 5 or 10. For example, if the horizontal scale is 1 inch equals 100 feet then the vertical scale would be 1 inch equals 10 or 20 feet. For plan and profile views, NRCS typically uses a horizontal scale of 1 inch equals 100 feet.

Cross Sections – Cross sections should be plotted with the smallest station number in the lower left corner of the drawing and the next station plotted above the first. If space exists, a second or third column of cross sections may by plotted to the right of the first column. By plotting up the sheet in order of increasing stationing, the view shows left on the left and right on the right, and the individual viewing the cross sections can visualize the stream reach. The plot should show the centerline location. The human eye can perceive the actual land form if the plotted ratio between the horizontal scale and vertical scale is 5.

Cross section of drainage structures should be included. Typically, it takes two orthographic sketches of the structure at a scale that facilitates clear dimensioning of the hydraulic characteristics of the structure or one cross section with notes that describe the structure's dimensions, elevations, materials, and condition.

62 Appendix IV. NRCS Geotechnical Terms and Preferences

Terms relating to geology and soil mechanics should be accordance with SCS Soil Mechanics Note 6. Geologic terms not contained in NRCS reference material should conform to "Glossary of Geology and Related Sciences," the American Geological Institute. Soil mechanics definitions not contained in NRCS reference material should conform to ASTM D 653, "Terms and Symbols Relating to Soil and Rock Mechanics."

The following additional definitions should also apply:

- Rough Profile (or Profile Section): A soil or rock profile showing the depths to principal strata and depths to the free groundwater level (in cases where exploration extends below groundwater levels).
- Detailed Profile (or Profile Section): A soil or rock profile showing not only the major strata but also the dip and strike of the strata, thin strata, seams, faults, lenses, shear planes, water bearing strata, piezometric pressure at various depths (when pertinent) and other details critical to the purpose of the investigation.
- Bedrock Profile: A profile showing only surface elevations and depths to rock, or, in some cases, to strata of exceptional bearing capacity such as hardpan, hard clay or very dense sands and gravels.
- Significant Depth: The vertical distance below the ground surface within which: (1) the loads applied to the foundation may be expected to alter the state of stress in the foundation materials enough to produce critical shear strains or to cause significant increments of settlement by compression of the foundation; or, (2) the permeability characteristics of the foundation profile may be expected to influence the stability or functional adequacy of the proposed structure.
- Representative Samples: Samples of soil or rock (either disturbed or undisturbed) selected and recovered in such a manner as to insure that they indicate the true nature of the material in the zone under consideration to the extent required to determine the characteristics and properties pertinent to the purpose of the investigation.

Assumptions and Exclusions

Horrocks Engineers is pleased to submit this statement of work which was provided by NRCS. Several amendments or modifications have been added to the SOW in red text. In order to clarify specific scope items, the following assumptions and exclusions are included a part of this statement of work;

- The engineering hydrology and hydraulic analysis generated during the EA phase will be used as as a starting point for design.
- Contract Management and Administration assumes one hour per week for 48 months for invoicing, billing and project update email.
- It is assumed general project meetings will last one hour on a biweekly basis during design and production portions of the project. These meetings will include Santaquin, NRCS, Horrocks, and Geostrata. Meetings will generally be held at Horrocks Engineers office in Pleasant Grove, with an option to join virtually.
- Construction Management hours assume that the basins will be built sequentially (one at a time). This also assumes each basin will take 3 months to construct. If basins are built at the same time, or take longer to construct, it will impact the staff and hours required.
- No time is included for right-of-way acquisition. This may be added to the contract as an additional service if desired.
- It is assumed that property owners will be favorable in allowing geotechnical investigations on their property and will not cause schedule delays.
- Topographic survey will be gathered for the proposed construction sites. Topographic data required for off-site areas such as for a breach or flood analysis will be obtained from the City or from AGRC.
- Public involvement coordination will cover help in obtaining permission to access sites for geotechnical investigations. It will also cover a notice to residents that live in the immediate vicinity of the project that may be affected by the project. Notices will be provided as mailers or door hanger items, and social media posts.
- As there are no known utilities in the project area, no scope, design fee or schedule has been included for utility relocation, removal, or design
- All rates shown are in 2021 fees; it is assumed that a contract modification will be required in the future to cover increases in engineering service and construction management fees.

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T: (801) 501-0583 ~ info@geostrata-llc.com

May 10, 2021

Horrocks Engineers
c/o Mr. Jacob O'Bryant, P.E.
2162 West Grove Parkway, Suite 400
Pleasant Grove, Utah 84052

Subject: Santaquin Debris Basin Cost Estimate

Jacob,

Attached is our cost estimate for the work we anticipate performing at the site of the proposed debris basin structures. This letter describes some of our assumptions and proposed scope of work for each of the structures. Our work scope is designed to meet the requirements of the NRCS Design Manual and NEM Part 531.

Currently the project will consist of 5 sites with design and constrcuction of debris retention structures. We reviewed the concept designs for the sites that you provided and our scope is based on these concept designs. Basins 1 3A and 5 will consist of below grade structures and uphill slope cuts up to 55 feet upslope. Basins 4E and 6A will be above grade structures with slope cuts of 15 feet and structural embankment heights of approximately 17 feet.

We plan on using a trackhoe and an ODEX drill rig for the majority of the field explorations. We plan on excavating 2 test pits in each of the proposed slope cut areas. The excavations will extend to depths of approximately 10 to 12 feet. The purpose of these test pits will be to define subsurface conditions in the proposed cuts and to provide recommended maximum slope grades for these cuts. We additionally plan on completing 3 to 4 test pits using a trackhoe to depths of 10 to 12 feet in the borrow areas. These test pits will be used to identify the subsurface soils in the borrow areas and, if possible, to identify the amount of borrow materials available. GeoStrata may also complete infilration testing on the exposed soils should our explorations persist to appropriate depths. The drill rig limits the size of the materials that can be collected in the sampler. This limitation in sampling during drilling skews the gradation results. To aquire more accurate gradation data we plan to excavate into the borrow areas using a trackhoe and obtaining bulk samples.

For above grade embankments, we plan on completing 2 borings along the crest of the proposed embankments to depths of 40 feet below existing site grade. Downhole permeability and packer testing will be completed to identify hydraulic properties of the foundation soils for the proposed embankments.

Samples obtained during the explorations will be packaged and transported to our geotechnical laboratory for testing. Tests will include but not be limited to Atterberg limits (ASTM D 423, 424), grain size analysis of soils (ASTM D 422), specific gravity (ASTM 854), compaction (ASTM 698), back pressure permeability (ASTM D 5084), direct shear (ASTM D3080), and triaxial shear (ASTM D4767).

According to Utah Dam Safety, all new dams and embankments located within a fault special study area require a fault study to be completed to assess to location of faults within the footprint of or near proposed dams. Fault trenches will be excavated and logged by a geologist at each of the proposed embankment locations (Basins 4E and 6A) to assess the locations of faults in the vicinity of the proposed embankments. If faults are encountered beneath the proposed locations of the embankments, recommendations for relocation of the proposed embankments and for fault offsets will be provided. Trenching, logging, and assessment of the potential faults will be completed under the direction of a professional geologist.

Other field work will include geologic mapping of each of the sites performed by a geologist from our staff.

Our deliverables will include the following:

> Geologic reports for each site. The reports will contain geologic maps of each area and orientaion of bedding and joint sets. We will identify conditions that may impact on the proposed structures. Bedrock and groundwater contour maps will be presented in the reports. The location of faults near the site and a definition of the seismic conditions that exist at the sites will also be included in the geologic reports.
>
> Engineering reports for each site will include logs of exploratory test holes, a detailed description of surface and subsurface conditions encountered, a summary of laboratory test data, earthwork and site grading recommendations, slope stability assessments for cuts and fills, seepage modeling of the foundatin and proposed embankments etc.

We have included time to meet with both the NRCS and dam safety prior to the completion of field work, during the field work and after completion of our engineering assessments. These meetings will aid in coordinating the work and minimizing any potential additional work that they deem necessary.

Please call me if you have any questions about the scope and the discussion presented in this letter.

Sincerely,
GeoStrata

Hiram Alba, P.E., P.G.
Principal Engineer