Supplemental Watershed Plan No. 1 and Environmental Assessment for Santaquin Flood Prevention

Santaquin Watershed
Utah County, Utah

Sponsoring Local Organization:

Santaquin City

Lead Federal Agency:

U.S. Department of Agriculture
Natural Resources Conservation Service

Cooperating Agency

United States Forest Service

December 2019

Title and Document Status: Supplemental Watershed Plan No. 1 and Environmental Assessment (Plan-EA) for Santaquin Flood Prevention ("Santaquin Watershed – Supplemental Plan-EA #1").

Lead Agency: United States Department of Agriculture Natural Resources Conservation Service (NRCS)

Cooperating Agency: United States Department of Agriculture Forest Service

Sponsoring Local Organization: Santaquin City

Authority: The original watershed work plan was prepared, and works of improvement have been installed, under the authority of the Watershed Protection and Flood Prevention Act of 1954 (Public Law 83-566) as amended.

Abstract: The purpose of the project is to control and prevent stormwater flooding and associated debris flow resulting from erosion off the east bench hillsides that constitute the Santaquin East Bench Watersheds from impacting private properties and public infrastructure. The objective of the project is to provide substantial flood reduction from the 100-year-storm event and to prevent flooding from the 25-year fire-related event and debris flow from the 5-year storm event (i.e., 20% chance storm). The proposed action is needed because currently the study area lacks natural drainage channels to convey stormwater and debris flow away from residential and commercial properties along Santaquin's east bench and critical public infrastructure.

The proposed study area lies along foothills of the east bench of Santaquin on the outskirts of the city. Several subwatersheds drain off the adjacent slopes into the project area and high intensity storms in the East Bench drainage area can create erosive flows, especially subsequent to wildfires or other such events in the hillsides above Santaquin that remove soil-stabilizing vegetation. The influx of large quantities of stormwater then results in the transport of floodwaters and associated sediment and debris off the hillsides and impacts to residential, commercial, and agricultural properties; and public infrastructure.

The Proposed Alternative includes five (5) separate debris basins at strategic locations associated with the drainage areas. Flooding and debris flows would be directed into the debris basins excavated into the hillsides, each with a principal spillway and a 50-foot-wide concrete structural auxiliary spillway to allow for a controlled release of water from the debris basins into existing channels or into the existing flow patterns that would be the drainage corridor absent the basin. These debris basins would be below grade to the extent possible to reduce the risk of failure and to blend in with the natural hillsides to minimize impact on the viewshed, as well as save on the cost of construction and maintenance. The installation cost estimate is **$12,279,633.00**

Comments: NRCS has completed this Plan-EA in accordance with the National Environmental Policy Act (NEPA) and NRCS guidelines and standards. Reviewers provided their comments to NRCS during the allotted Draft Plan-EA review period.

Further information may also be obtained for this project by contacting the following NRCS personnel:

Norm Evenstad – NRCS Utah - Water Resources Coordinator
125 South State Street, Room 4010, Salt Lake City, UT 84138-1100
801-524-4569
norm.evenstad@ut.usda.gov

Non-Discrimination Statement: In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating

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Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

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SANTAQUIN WATERSHED, UTAH
SUPPLEMENTAL WATERSHED WORK PLAN AGREEMENT #1
between

Santaquin City
(Referred to herein as sponsors)

and the

Natural Resources Conservation Service,
U.S. Department of Agriculture
(Referred to herein as NRCS)

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act (Public Law 83-566), as amended, has been assigned by the Secretary of Agriculture to the NRCS; and

Whereas, application has heretofore been made to the Secretary of Agriculture by Santaquin City, Utah for assistance in preparing a plan for works of improvement for the Santaquin Watershed, State of Utah, for the improvements of the Santaquin Watershed under the authority of the Watershed Protection and Flood Prevention Act, as amended (16 U.S.C. Sections 1001 to 1008, 1010, and 1012;

Whereas, a Supplemental Watershed Plan which modifies the watershed plan dated September 27, 1954 for said watershed has been developed through the cooperative efforts of the Sponsors and the NRCS;

Now, therefore, the Secretary of Agriculture through NRCS and the Sponsors hereby agree upon the following modifications of and additions to the terms, conditions, and stipulations of Supplemental Watershed Work Plan Agreement No. 1:

1. **Term.** The term of this agreement is for the installation period and evaluated life of the project (100 years) and does not commit NRCS to assistance of any kind beyond the end of the evaluated life.

2. **Costs.** The costs shown in this plan are preliminary estimates. Final costs to be borne by the parties hereto will be the actual costs incurred in the installation of works of improvement.

3. **Real Property.** The sponsors will acquire such real property as will be needed in connection with the works of improvement. The amounts and percentages of the real property acquisition costs to be borne by the sponsors and NRCS are as shown in the cost-share table in section 5 hereof.

   The sponsors agree that all land acquired for measures, other than land treatment practices, with financial or credit assistance under this agreement will not be sold or otherwise disposed of for the evaluated life of the project except to a public agency that will continue to maintain and operate the development in accordance with the operation and maintenance agreement.

4. **Uniform Relocation Assistance and Real Property Acquisition Policies Act.** The sponsors hereby agree to comply with all of the policies and procedures of the Uniform Relocation Assistance and Real Property Acquisition Policies Act (42 U.S.C. Section 4601 et seq. as

further implemented through regulations in 49 CFR Part 24 and 7 CFR Part 21) when acquiring real property interests for this federally assisted project. If the sponsor is legally unable to comply with the real property acquisition requirements, it agrees that, before any Federal financial assistance is furnished; it will provide a statement to that effect, supported by an opinion of the chief legal officer of the state containing a full discussion of the facts and law involved. This statement may be accepted as constituting compliance.

5. **Cost-Share for Watershed Project Plans.** Table 1-Santaquin Watershed Supplemental Agreement #1 Cost-Share Percentages & Amounts shows the estimated cost-share percentages and amounts for Watershed Project Plan implementation.

Table 1. Santaquin Watershed – Supplemental Agreement #1- Cost-Share Percentages and Amounts

Works of Improvement	**NRCS**		**Sponsors**		**Total**
Cost-Sharable Items	**%**	**Cost**	**%**	**Cost**	**Cost**
Debris Basins for Flood Protection[1/]	100	$7,688,700	0	$0	$7,688,700
Floodplain easements (0 acres)	0	$0	0	$0	$0
Land treatment measure	0	$0	0	$0	$0
Mitigation	0	$0	0	$0	$0
Real Property Acquisition Cost	0	$0	100	$2,770,100	$2,770,100
Real estate appraisal fees, legal fees, survey costs, flowage easements	0	$0	0	$0	$0
Relocation [2/]	0	$0	0	$0	$0
Project Administration	0	$	0	$	$
Subtotal: Cost-Sharable Costs		**$7,688,700**		**$2,770,100**	**$10,458,800**
Non-Cost-Sharable Items [3/]					
NRCS Technical Assistance/Engineering	100	$1,348,700	0	$0	$1,348,700
Project Administration	100	$67,400	0	$0	$67,400
Construction Management	0	$0	100	$404,700	$404,700
Permits	0	$0	0	$	$
Real Property Rights	0	$0	0	$0	$0
Relocation, Beyond Required Decent, Safe, …	0	$0	0	$0	$0
Non-Project Costs	0	$0	0	$0	$0
Subtotal: Non-Cost-Sharable Costs		**$1,416,100**		**$404,700**	**$1,820,800**
Grand Total:		**$9,104,800**		**$3,174,800**	**$12,279,600**

[1] - The cost-share rate is the percentage of the average cost of installing the practice in the selected plan for the evaluation unit. During project implementation, the actual cost-share rate must not exceed the rate of assistance for similar practices and measures under existing national programs.

[2] - Investigation of the watershed project area indicates that no displacements will be involved under present conditions. However, in the event that displacement becomes necessary at a later date, the cost of relocation assistance and payments will be cost-shared in accordance with the percentages shown.

[3] - If actual Non-Cost-Sharable item expenditures vary from these figures, the responsible party will bear the change.

6. **Land Treatment Agreements.** The sponsors will obtain agreements from owners of not less than 50 percent of the land above each multiple-purpose and floodwater-retarding structure. These agreements must provide that the owners will carry out farm or ranch conservation plans on their land. The sponsors will ensure that 50 percent of the land upstream of any retention reservoir site is adequately protected before construction of the dam. The sponsors will provide assistance to landowners and operators to ensure the installation of the land treatment measures shown in the Watershed Project Plan. The sponsors will encourage landowners and operators to continue to operate and maintain the land treatment measures after the long-term contracts expire, for the protection and improvement of the watershed.

7. **Floodplain Management.** Before construction of any project for flood prevention, the sponsors must agree to participate in and comply with applicable Federal floodplain management and flood insurance programs. The community of Santaquin City participates in the flood insurance program and is currently in good standing.

8. **Water and Mineral Rights.** The sponsors will acquire or provide assurance that landowners or resource users have acquired such water, mineral, or other natural resources rights pursuant to State law as may be needed in the installation and operation of the works of improvement.

9. **Permits.** The sponsors will obtain and bear the cost for all necessary Federal, State, and local permits required by law, ordinance, or regulation for installation of the works of improvement.

10. **NRCS Assistance.** This agreement is not a fund-obligating document. Financial and other assistance to be furnished by NRCS in carrying out the plan is contingent upon the fulfillment of applicable laws and regulations and the availability of appropriations for this purpose.

11. **Additional Agreements.** A separate agreement will be entered into between NRCS and the sponsors before either party initiates work involving funds of the other party. Such agreements will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

12. **Amendments.** This plan may be amended or revised only by mutual agreement of the parties hereto, except that NRCS may deauthorize or terminate funding at any time it determines that the sponsors have failed to comply with the conditions of this agreement or when the program funding or authority expires. In this case, NRCS must promptly notify the sponsors in writing of the determination and the reasons for the deauthorization of project funding, together with the effective date. Payments made to the sponsors or recoveries by NRCS must be in accordance with the legal rights and liabilities of the parties when project funding has been deauthorized. An amendment to incorporate changes affecting a specific measure may be made by mutual agreement between NRCS and the sponsors having specific responsibilities for the measure involved.

13. **Prohibitions.** No member of or delegate to Congress, or resident commissioner, may be admitted to any share or part of this plan, or to any benefit that may arise therefrom; but this provision may not be construed to extend to this agreement if made with a corporation for its general benefit.

14. **Operation and Maintenance (O&M).** The sponsors will be responsible for the operation, maintenance, and any needed replacement of the works of improvement by performing the work or arranging for such work, in accordance with an O&M Agreement. An O&M

agreement will be entered into before Federal funds are obligated and will continue for the project life 100 years. Although the sponsor's responsibility to the Federal Government for O&M ends when the O&M agreement expires upon completion of the evaluated life of measures covered by the agreement, the sponsors acknowledge that continued liabilities and responsibilities associated with works of improvement may exist beyond the evaluated life.

15. **Emergency Action Plan.** Prior to construction, the sponsors must prepare an Emergency Action Plan (EAP) for each dam or similar structure where failure may cause loss of life or as required by state and local regulations. The EAP must meet the minimum content specified in NRCS Title 180, National Operation and Maintenance Manual (NOMM), Part 500, Subpart F, Section 500.52, and meet applicable State agency dam safety requirements. The NRCS will determine that an EAP is prepared prior to the execution of fund obligating documents for construction of the structure. EAPs must be reviewed and updated by the sponsors annually.

16. **Nondiscrimination Provisions**. In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

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    By signing this agreement, the recipient assures the USDA that the program or activities provided for under this agreement will be conducted in compliance with all applicable Federal civil rights laws, rules, regulations, and policies.

17. **Certification Regarding Drug-Free Workplace Requirements (7 CFR Part 3021)**. By signing this Watershed Agreement, the sponsors are providing the certification set out below. If it is later determined that the sponsors knowingly rendered a false certification, or otherwise violated the requirements of the Drug-Free Workplace Act, the NRCS, in

addition to any other remedies available to the Federal Government, may take action authorized under the Drug-Free Workplace Act.

Controlled substance means a controlled substance in Schedules I through V of the Controlled Substances Act (21 U.S.C. Section 812) and as further defined by regulation (21 CFR Sections 1308.11 through 1308.15);

Conviction means a finding of guilt (including a plea of nolo contendere) or imposition of sentence, or both, by any judicial body charged with the responsibility to determine violations of the Federal or State criminal drug statutes;

Criminal drug statute means a Federal or non-Federal criminal statute involving the manufacturing, distribution, dispensing, use, or possession of any controlled substance;

Employee means the employee of a grantee directly engaged in the performance of work under a grant, including: (i) all direct charge employees; (ii) all indirect charge employees unless their impact or involvement is insignificant to the performance of the grant; and, (iii) temporary personnel and consultants who are directly engaged in the performance of work under the grant and who are on the grantee's payroll. This definition does not include workers not on the payroll of the grantee (e.g., volunteers, even if used to meet a matching requirement; consultants or independent contractors not on the grantees' payroll; or employees of sub-recipients or sub-contractors in covered workplaces).

Certification:

A. The sponsors certify that they will or will continue to provide a drug-free workplace by:

(1) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition.

(2) Establishing an ongoing drug-free awareness program to inform employees about:
   (a) The danger of drug abuse in the workplace;
   (b) The grantee's policy of maintaining a drug-free workplace;
   (c) Any available drug counseling, rehabilitation, and employee assistance programs; and
   (d) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace.

(3) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (1).

(4) Notifying the employee in the statement required by paragraph (1) that, as a condition of employment under the grant, the employee must:
   (a) Abide by the terms of the statement; and
   (b) Notify the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the workplace no later than five calendar days after such conviction.

(5) Notifying the NRCS in writing, within 10 calendar days after receiving notice under paragraph (4)(b) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to every grant officer or other designee on whose grant activity the convicted employee was working, unless the Federal agency has designated a

central point for the receipt of such notices. Notice must include the identification numbers of each affected grant.

(6) Taking one of the following actions, within 30 calendar days of receiving notice under paragraph (4) (b), with respect to any employee who is so convicted.

(a) Taking appropriate personnel action against such an employee, up to and including termination, consistent with the requirements of the Rehabilitation Act of 1973, as amended; or

(b) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency.

(7) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (1), (2), (3), (4), (5), and (6).

B. The sponsors may provide a list of the sites for the performance of work done in connection with a specific project or other agreement.

C. Agencies must keep the original of all disclosure reports in the official files of the agency.

18. Certification Regarding Lobbying (7 CFR Part 3018) (for projects > $100,000)

A. The sponsors certify to the best of their knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the sponsors, to any person for influencing or attempting to influence an officer or employee of an agency, Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned must complete and submit Standard Form LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The sponsors must require that the language of this certification be included in the award documents for all sub-awards at all tiers (including subcontracts, sub- grants, and contracts under grants, loans, and cooperative agreements) and that all sub-recipients must certify and disclose accordingly.

B. This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by 31 U.S.C., Section 1352. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

19. Certification Regarding Debarment, Suspension, and Other Responsibility Matters - Primary Covered Transactions (7 CFR Part 3017).

A. The sponsors certify to the best of their knowledge and belief, that they and their principals:

(1) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or

agency;

(2) Have not within a 3-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(3) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State, or local) with commission of any of the offenses enumerated in paragraph A(2) of this certification; and

(4) Have not within a 3-year period preceding this application/proposal had one or more public transactions (Federal, State, or local) terminated for cause or default.

B. Where the primary sponsors are unable to certify to any of the statements in this certification, such prospective participant must attach an explanation to this agreement.

20. Clean Air and Water Certification. (Applicable if this agreement exceeds $100,000, or a facility to be used has been subject of a conviction under the Clean Air Act (42 U.S.C. Section 7413(c)) or the Federal Water Pollution Control Act (33 U.S.C. Section 1319(c)) and is listed by EPA, or is not otherwise exempt.)

A. The sponsors signatory to this agreement certify as follows:

(1) Any facility to be utilized in the performance of this proposed agreement is ( ), is not (X) listed on the Environmental Protection Agency List of Violating Facilities.

(2) To promptly notify the NRCS-State administrative officer prior to the signing of this agreement by NRCS, of the receipt of any communication from the Director, Office of Federal Activities, U.S. Environmental Protection Agency, indicating that any facility which is proposed for use under this agreement is under consideration to be listed on the Environmental Protection Agency List of Violating Facilities.

(3) To include substantially this certification, including this subparagraph, in every nonexempt sub-agreement.

B. The project sponsor signatory to this agreement agrees as follows:

(1) To comply with all the requirements of section 114 of the Clean Air Act as amended (42 U.S.C. Section 7414) and section 308 of the Federal Water Pollution Control Act (33 U.S.C. Section 1318), respectively, relating to inspection, monitoring, entry, reports, and information, as well as other requirements specified in section 114 and section 308 of the Air Act and the Water Act, issued there under before the signing of this agreement by NRCS.

(2) That no portion of the work required by this agreement will be performed in facilities listed on the EPA List of Violating Facilities on the date when this agreement was signed by NRCS unless and until the EPA eliminates the name of such facility or facilities from such listing.

(3) To use their best efforts to comply with clean air standards and clean water standards at the facilities in which the agreement is being performed.

(4) To insert the substance of the provisions of this clause in any nonexempt sub-agreement.

C. The terms used in this clause have the following meanings:
   (1) The term "Air Act" means the Clean Air Act, as amended (42 U.S.C. Section 7401 et seq.).
   (2) The term "Water Act" means Federal Water Pollution Control Act, as amended (33 U.S.C. Section 1251 et seq.).
   (3) The term "clean air standards" means any enforceable rules, regulations, guidelines, standards, limitations, orders, controls, prohibitions, or other requirements which are contained in, issued under, or otherwise adopted pursuant to the Air Act or Executive Order 11738, an applicable implementation plan as described in section 110 of the Air Act (42 U.S.C. Section 7414) or an approved implementation procedure under section 112 of the Air Act (42 U.S.C. Section 7412).
   (4) The term "clean water standards" means any enforceable limitation, control, condition, prohibition, standards, or other requirement which is promulgated pursuant to the Water Act or contained in a permit issued to a discharger by the Environmental Protection Agency or by a State under an approved program, as authorized by section 402 of the Water Act (33 U.S.C. Section 1342), or by a local government to assure compliance with pretreatment regulations as required by section 307 of the Water Act (33 U.S.C. Section 1317).
   (5) The term "facility" means any building, plant, installation, structure, mine, vessel, or other floating craft, location or site of operations, owned, leased, or supervised by a sponsor, to be utilized in the performance of an agreement or sub- agreement. Where a location or site of operations contains or includes more than one building, plant, installation, or structure, the entire location will be deemed to be a facility except where the Director, Office of Federal Activities, Environmental Protection Agency, determines that independent facilities are collocated in one geographical area.

21. **Assurances and Compliance**. As a condition of the grant or cooperative agreement, the sponsor assures and certifies that it is in compliance with and will comply in the course of the agreement with all applicable laws, regulations, Executive orders and other generally applicable requirements, including those set out below which are hereby incorporated in this agreement by reference, and such other statutory provisions as a specifically set forth herein.

    State, Local, and Indian Tribal Governments: OMB Circular Nos. A-87, A-102, A-129, and A-133; and 7 CFR Parts 3015, 3016, 3017, 3018, 3021, and 3052.

    Nonprofit Organizations, Hospitals, Institutions of Higher Learning: OMB Circular Nos. A-110, A-122, A-129, and A-133; and 7 CFR Parts 3015, 3017, 3018, 3019, 3021 and 3052.

22. **Examination of Records.** The sponsors must give the NRCS or the Comptroller General, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to this agreement, and retains all records related to this agreement for a period of three years after completion of the terms of this agreement in accordance with the applicable OMB Circular.

23. Signatures

Sponsors: Santaquin City
By: Kirk J. Hunsaker
Title: Mayor
Date: 9-10-2020
Address: 275 W. MAIN ST., SANTAQUIN, UT. Zip Code: 84655

The signing of this plan was authorized by a resolution of the governing body of Santaquin City adopted at a meeting held on December 13, 2017

Attest:
K. Aaron Shirley
Secretary [or other Title] City Recorder
Address 45 W. 100 S.
Date: 9-10-2020

SANTAQUIN CITY
Incorporated
January 4,
1932
STATE OF UTAH

USDA United States Department of Agriculture Natural Resources Conservation Service
Approved By: EMILY FIFE Digitally signed by EMILY FIFE Date: 2020.09.11 10:18:11 -06'00'
EMILY FIFE
Title: NRCS State Conservationist
Date:

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S-1 Title of Proposed Action

Supplemental Watershed Plan and Environmental Assessment (Plan-EA) for Santaquin East Bench Flood Prevention - Santaquin Watershed

S-2 County, State

Utah County, Utah

S-3 Congressional District

Third Congressional District

S-4 Sponsoring Local Organization

Santaquin City

S-5 Authority

The original watershed work plan was prepared, and works of improvement have been installed, under the authority of the Watershed Protection and Flood Prevention Act of 1954 (Public Law 83-566) as amended.

S-6 Cooperating Agency

United States Department of Agriculture Forest Service

S-7 Purpose and Need for Action

The proposed action would install permanent flood damage reduction measures along the Santaquin east bench to protect residents, businesses, and public infrastructure from future damage. The objective of the project is to provide substantial flood reduction from the 100-year-storm event (95%) and to prevent flooding from the 25-year fire-related event and debris flow from the 5-year storm event (i.e., 20% chance storm).

The purpose of the project is to control stormwater flooding and associated debris flow off Santaquin's east bench hillsides and reduce potential damages to private properties and public infrastructure. The proposed action is needed because currently the study area lacks natural drainage channels to convey stormwater and debris flow away from residential and commercial properties along Santaquin's east bench and critical public infrastructure. Currently, due to the lack of natural channels in the area, stormwater and debris flow coming off the east bench results in flooding conditions on the alluvial fan landscape where flows have historically occurred.

S-8 Description of the Preferred Alternative

The Proposed Alternative includes five (5) separate debris basins at strategic locations associated with the drainage areas. The NRCS designed all of the debris basins to channelize flooding and debris flows into debris basins that would be excavated into the hillsides, each with a principal spillway and a 50-foot-wide concrete structural auxiliary spillway to allow for a controlled release of water from the debris basins into existing channels or into the existing flow patterns that would be the drainage corridor absent the basin. These debris basins would be below grade to the extent possible to reduce the risk of failure and to blend in with the natural hillsides to minimize impact on the viewshed, as well as save on the cost of construction and maintenance.

S-9 Resource Information

Table S-1 lists relevant resource information for the Santaquin East Bench project.

TABLE S-1-1. EXISTING RESOURCE INFORMATION

Resource	Description
Elevation and Topography	Project located on the eastern bench of Santaquin at approximately 5000 - 5800 feet mean sea level (msl)
Latitude/Longitude	Subwatershed 1 – 39.9818, -111.7354; Subwatershed 2 – 39.9691, -111.7535; Subwatershed 3 – 39.9716, -111.7564; Subwatershed 4 – 39.9709, -111.7432; Subwatershed 5 – 39.977, -111.7428; Subwatershed 6 – 39.9818, -111.7354
Climate	Annual high temperature – 62.1° F Annual low temperature – 38.8° F (https://www.usclimatedata.com/climate/santaquin/utah/united-states/usut0228)
Average Annual Precipitation/ Snowfall	Rainfall – 18.83 inches Snowfall – 53 inches (https://www.usclimatedata.com/climate/santaquin/utah/united-states/usut0228)
Hydrologic Unit Numbers	HU-816020202
Debris Basin Subwatershed Areas	• Subwatershed 1 – 0.6266 square miles; • Subwatershed 2 – 0.0688 square miles; • Subwatershed 3 – 0.0531 square miles; • Subwatershed 4 – 0.6875 square miles; • Subwatershed 5 – 0.7109 square miles; • Subwatershed 6 – 0.4510 square miles
Land Uses	Open space, agricultural, residential and commercial, public infrastructure
Land Ownership	Public, private
Population and Demographics	The study area is located in Santaquin City, Utah, which had a population of 9,128, based on 2010 U.S. Census data. White: 89.3% Black or African American: 0.4% American Indian/Alaskan Native: 0.8% Asian: 0.1% Native Hawaiian/Other Pacific Islander: 0.1% Some Other Race: 6.1% Two or More Races:1.4% Hispanic or Latino (of any race): 12.0%

S-10 Alternative Plans Considered

Two alternative plans were considered in detail. The alternatives considered included:

- No Action Alternative: consists of no flood prevention improvements in the study area. No construction or permits would be required, nor would there be a need for on-going maintenance of flood prevention facilities; however, Santaquin would need to respond with

real-time mitigation and clean-up actions should a flooding event occur. It does not meet the purpose and need for the project as it would not provide attenuation of flooding events nor prevent debris flow from damaging residential, commercial, and agricultural properties or public infrastructure.

- Debris Basins Alternative (Option B): The Debris Basins Alternative, Option B includes five (5) separate debris basins at strategic locations associated with the drainage areas. Flooding and debris flows would be directed into the debris basins excavated into the hillsides, each a principal spillway, and a 50-foot-wideconcrete structural auxiliary spillway to allow for a controlled release of water from the debris basins into existing channels or into the existing flow patterns that would be the drainage corridor absent the basin. These debris basins would be below grade to the extent possible to reduce the risk of failure and to blend in with the natural hillsides to minimize impact on the viewshed, as well as save on the cost of construction and maintenance.

An alternative to remove or relocate homes in potential flood areas was considered but eliminated early due to both cost and concerns over willing landowners versus eminent domain procedures. Four other structural alternatives were considered during the planning process, but those proposed flood prevention measures that would not meet the purpose and need for the project or that were considered to be not prudent or feasible for other reasons, including unacceptable impacts to environmental resources or high costs of construction or maintenance were eliminated. These included:

- Check Structures Only
- Diversion Berms
- Flow Impediments/Level Spreaders
- Debris Basin with Extensive Downstream Pipe Network (Option A)

S-11 Project Costs and Funding Source

The breakdown of the estimated installation cost for the Debris Basin Alternative is summarized in Table S-2. NRCS design engineering, construction management, and NRCS incurred administration costs are not cost-shared by the sponsor. Any costs incurred for administration and real property acquisition by the sponsor would not be cost-shared by NRCS.

TABLE S-1-2. SUMMARY OF COST DISTRIBUTION FOR THE DEBRIS BASIN ALTERNATIVE

Measure	Construction	Engineering	Real Property Rights	Admin.	Total
Basin 1	$2,643,408	$440,418	$924,000	$22,021	$4,029,847
Basin 3A	$570,133	$95,022	$300,000	$4,751	$969,906
Basin 4	$1,060,079	$176,680	$700,000	$8,834	$1,945,593
Basin 5	$2,554,266	$425,711	$58,100	$21,286	$3,059,363
Basin 6	$1,265,467	$210,911	$788,000	$10,546	$2,274,924
Total	**$8,093,353**	**$1,348,742**	**$2,770,100**	**$67,438**	**$12,279,633**

S-12 Project Benefits

The primary benefits from the project measures come from an anticipated reduction in the estimated average annual damages to residential properties, agricultural production, and municipal infrastructure. Table S-3 shows the estimated average annual damage reduction benefits.

TABLE S-1-3. ESTIMATED AVERAGE ANNUAL DAMAGE REDUCTION BENEFITS

Item	Estimated Average Annual Damage Reduction Benefits		
	No Action	Preferred Alternative	Damage Reduction Benefits
Crops and pasture	$400	$4,900	$4,500
Residential	$34,300	$488,700	$454,400
Other	$800	$3,000	$2,200
Total	$35,500	$496,600	$461,100

S-13 Net Economic Benefits

The Debris Basin Alternative has a benefit cost ratio for the Debris Basin Alternative of 1.16 to 1.

S-14 Period of Analysis

The Debris Basin Alternative was analyzed for a period of 100 years, which includes the implantation period.

S-15 Project Life

The debris basins are anticipated to have a life span of 100 years.

S-16 Environmental Impacts

Table S-4 lists the resources of concern and impacts associated with the Debris Basin Alternative. Resources that would not be impacted by the project are not listed in this table.

TABLE S-4. RELEVANT ENVIRONMENTAL RESOURCES

Resource	Issue	Discussion
Soils		
Soils and Geologic Characteristics	Excavation required for the construction of proposed debris basins and associated features	The project would have an impact on soils in the study area during construction of the debris basin since the debris basins would require extensive excavation, but would not impact soil composition or otherwise impact geologic resources. The potential exists for impacts on the proposed flood prevention measures as a result of seismic activity, although the likelihood for seismic activity is low.
Upland Erosion	Erosion of upland soils impacting properties and infrastructure	The project would have a short-term increase in erosion during construction of the debris basins; however, protection measures would be installed during construction.
Sedimentation	Prevention of debris flow	Debris basins are designed to catch sediment and flood flows during runoff events and reduce flood damage to properties below.
Water Resources		

Resource	Issue	Discussion
Hydrology	Prevention of flooding events from impacting properties and infrastructure	The project would have a minor alteration to the runoff hydrology in the project area in that it would catch flood flows to be safely released through the structures into historic drainage paths.
Floodplain Management	Prevention of flooding events from impacting properties and infrastructure	No FEMA-mapped floodplains are located in the study area. The debris basins would provide flood protection for properties below and are designed with outlets from the debris basins directing drainage into historic drainage paths.
Air		
Air Quality	Fugitive dust issues during construction	Construction activities would have temporary impacts to air quality in the study area.
Vegetation		
Vegetation Communities/Habitat	Disturbing existing vegetation communities	Construction of the Debris Basin Alternative would temporarily impact existing vegetation communities and habitat. Disturbed areas would be reseeded with native vegetation in exposed, disturbed areas. Permanent impacts would result in those areas converted to flood prevention measures.
Invasive Species	Construction activity that would disturb soils and allow for potential spread of invasive species	Due to construction activities, there is the potential to spread invasive species. BMPs would be used during construction to prevent the introduction or spread of invasive species.
Wildlife		
Wildlife Communities	Disturbance to wildlife due to construction activities	There would be temporary impacts to wildlife communities during construction due to noise and other construction-related activities. No wildlife communities would be adversely impacted long-term.
Human Environment		
Land Use	Required land acquisition	The proposed action would require land acquisition for the new drainage features (i.e., debris basins and associated structures), as well as easements for induced flooding concerns. **Any needed land for the proposed debris basins would be acquired by Santaquin without any NRCS involvement, as the PL 83-566 Watershed Program does not authorize funding for land acquisition.**

Resource	Issue	Discussion
Scenic Beauty/ Visual Resources	Anticipated changes to the natural views in the study area due to the inclusion of new flood prevention mitigation measures	The proposed action would introduce new drainage features (i.e., debris basins and associated structures) into the viewshed. The majority of the project improvements would be below grade, with the extent of the visual intrusion into the viewshed dependent upon the height of dam structures, which varies by site.
Public Health and Safety	Prevention of flooding and debris flow events from impacting properties and infrastructure	The proposed action would address public health and safety concerns by reducing the risk of future flooding and debris flows from impacting residential and agricultural properties and public infrastructure.
Socioeconomics	Prevention of flooding and debris flow events from impacting properties and infrastructure	Due to the protection of private lands and public infrastructure with the implementation of flooding protection measures, the proposed action would protect existing and future properties, infrastructure, land uses and provide community peace of mind during flood events.

S-17 Major Conclusions

The Preferred Alternative for the project is the Debris Basin Alternative under Option B and is based on the ability of the elements of the alternative to meet the purpose and need for the project and provide the most beneficial impacts to environmental and social resources (see Chapter 5).

S-18 Areas of Controversy and Issues to be Resolved

There are no anticipated areas of controversy. Issues to be resolved include property acquisition.

S-19 Evidence of Unusual Congressional or Local Interest

There is no evidence of unusual congressional or local interest.

S-20 In Compliance

This report is in compliance with executive orders, public laws, and other statutes governing the formulation of water resource projects.

Chapter 1: Introduction

1.1 Introduction

The U.S. Department of Agriculture, Natural Resources Conservation Service, Utah (USDA-NRCS) and Santaquin City (Santaquin), as the project sponsor, have initiated a Watershed Plan and Environmental Assessment (Plan-EA) to evaluate environmental impacts associated with proposed flood prevention measures within the Santaquin east bench subwatersheds and disclose the potential impacts of the Supplemental Watershed Plan No. 1 and Environmental Assessment (Plan-EA) for the Santaquin East Bench Flood Prevention Project, which is intended to control and prevent impacts from flood and debris flow events in Santaquin. The NRCS is the lead federal agency for this Plan-EA. For this project, the United States Forest Service (USFS) is a cooperating agency for the development of this Plan-EA.

The watershed plan is being prepared under the Watershed Protection and Flood Prevention Program (Public Law [PL] 83-566) which authorizes Federal funding and technical assistance. The PL 83-566 Watershed Program requires the development of a "physically, environmentally, socially, and economically sound improvement plan" to be implemented over a specific period of years. A Watershed Plan-EA will be developed as the first component of the proposed action for the purpose of implementing a range of eligible watershed protection measures to be evaluated during the development of the Plan-EA.

This Plan-EA is being commissioned by the USDA-NRCS to comply with the National Environmental Policy Act (NEPA) of 1969 and its implementing regulations, which are set forth in the following documents: Council on Environmental Quality (CEQ) regulations implementing NEPA at 40 Code of Federal Regulations (CFR) 1500-1508; the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) of 1983; USDA's NEPA regulations (7 CFR Part 650); NRCS Title 190 General Manual Part 410; and the NRCS National Environmental Compliance Handbook Title 190 Part 610 (May 2016). ThePlan-EA also meets the guidelines of the NRCS National Watershed Program Manual (NWPM) Parts 501 through 505 (NRCS 2015) and the NRCS National Watershed Program Handbook Parts 600 through 606 (NRCS 2014).

1.2 Basis for the Preparation of a Supplemental Watershed Program

The original plan for the Santaquin Canyon Watershed was prepared in 1954 to provide flood, erosion, and sediment damage reduction benefits for the watershed. The plan included a combination of land treatment practices and measures used for the conservation of water and watershed lands which contribute directly to flood prevention. In the ensuing years since the implementation of the 1954 Watershed Plan, Santaquin has experienced changes to its land use due to ongoing residential and commercial development and has identified further needs for flood prevention measures beyond the policies and limited infrastructure included in the 1954 Watershed Plan.

The proposed study area for the Supplemental Watershed Plan lies along foothills of the east bench of Santaquin. Several subwatersheds drain off the adjacent slopes into the project area. High intensity storms in the east bench drainage area of the Santaquin east bench subwatersheds can create erosive flows, especially in the event of wildfires or other such events in the hillsides above Santaquin that remove soil-stabilizing vegetation. The influx of large quantities of stormwater in such events then results in the transport of flood waters and the associated sediment and debris off the hillsides and impacts to residential, commercial and agricultural properties, and public infrastructure (including roads, the Strawberry Highline Canal, and other such transportation and utility facilities).

1.3 Decision Matrix

The NRCS must identify the federally assisted alternative with the greatest net benefits, otherwise known as the National Economic Development (NED) plan. The NRCS must also decide if the selected alternative would or would not constitute a major federal action significantly affecting the quality of the environment. If the NRCS State Conservationist (responsible federal official) determines that the selected alternative would not significantly affect the quality of the environment, then the NRCS State Conservationist will prepare and sign a Finding of No Significant Impact (FONSI), and the project may proceed. If the NRCS State Conservationist determines that the selected alternative would significantly affect the quality of the environment, then an EIS and a Record of Decision (ROD) must be prepared and signed before the project can proceed.

1.4 Purpose and Need for the Project

The purpose of the project is to control stormwater flooding and associated debris flow off Santaquin's east bench hillsides and reduce potential damages to private properties and public infrastructure. The objective of the project is to provide substantial flood reduction from the 100-year-storm event (95%) and to prevent flooding and debris flow from the 25-year storm event during post-fire conditions and from the 5-year storm event.

The proposed action is needed because currently the study area lacks natural drainage channels to convey stormwater and debris flow away from residential and commercial properties along Santaquin's east bench and critical public infrastructure. Currently, due to the lack of natural channels in the area, stormwater and debris flow coming off the east bench results in sheet flow conditions on the alluvial fan landscape where flows have historically occurred.

In 2001, the 8000-acre Mollie Fire burned across the steep mountain subwatersheds above Santaquin to the east, denuding the mountainside of all vegetation that stabilized the soils and retarded runoff. Because of the lack of soil-stabilizing vegetation on the east benches of Santaquin, intense storm bursts in 2002 and 2004 created two debris flows that damaged residential homes and property, flowed through agricultural land, and filled in and overtopped the Highline Canal, which is a critical regional irrigation distribution canal. The debris flow event in 2002 was nearly large enough to impact I-15, the major interstate freeway in the area.

VIEW OF THE MOLLIE FIRE 2001

VIEW OF AFTERMATH OF THE MOLLIE FIRE 2001

VIEW OF DAMAGE CAUSED BY DEBRIS FLOW 2002

CLOSE-UP VIEW OF DEBRIS FLOW 2002

Losses due to damage caused in 2002 by the debris flows were calculated by Santaquin City to total nearly $376,000, which included damage to infrastructure and volunteer and equipment usage hours, but not including individual homeowner damages. See the October 29, 2002 Memo from the Santaquin City Manager's office to the Santaquin City Council and the November 13, 2002 letter to residents in Appendix E.

Disaster funds expended by the city after these events allowed temporary flood control countermeasures to be put into place, but these measures are insufficient for long-term protection from future such events. Damages were insufficient in 2002 to qualify for federal or state disaster relief assistance and no federal or state funding was available for mitigation measures to prevent future incidents. The temporary facilities channel runoff and debris flows into an area that has been and will continue to be developed.

Due to the geology and development patterns and practices of the past, the study area lacks natural drainage channels to convey such events away from Santaquin and from critical public infrastructure. The proposed action would install permanent flood prevention measures along the Santaquin east bench to protect residents, businesses, and public infrastructure from future damage.

1.5 Project Overview

Santaquin City is located in the southernmost part of Utah County just south of Utah Lake and is bordered on two sides by portions of the Wasatch Mountain range on the west by West Mountain and Rocky Ridge and on the east by Dry Mountain. The Uinta-Wasatch-Cache National Forest is located east of Santaquin and is managed by the U.S. Forest Service (USFS).

The proposed action lies within the PL-566-authorized Santaquin Canyon Watershed Protection Project in Utah County (dated 1954). Six individual areas were identified where flood prevention measures could be most effective. See Figure 1-1 - Project Location Map.

FIGURE 1-1. PROJECT LOCATION MAP

1.6 Scope of the Plan-EA

The scoping process followed the general procedures contained in the NRCS National Watershed Program Handbook (NRCS 2014) and the NRCS NWPM (NRCS 2015). Both NRCS procedures and NEPA regulations (40 CFR 1500-1508) require that the NRCS use a scoping process early in the planning process to identify issues, concerns, and potential impacts that require detailed analysis.

1.6.1 Scoping Phase

Federal, state, and local agencies and representatives, as well as area non-governmental organizations (NGOs), received an invitation to the early scoping phase of the Plan-EA. A scoping notice announcing the scoping period and the public scoping meeting were placed in the Payson Chronicle, a newspaper of general circulation for the study area. The 30-day formal scoping period for this project began on February 14, 2018 and ended on March 19, 2018.

Tribal consultation was conducted in accordance with the National Historic Preservation Act (NHPA) of 1966 and Executive Order (EO) 13175, Consultation and Coordination with Indian Tribal Governments, to maintain the NRCS' government-to-government relationship. Letters were sent to the following tribes:

- Skull Valley Band of Goshute Indians
- Confederated Tribes of the Goshute Reservation
- Ute Indian Tribe of the Uintah & Ouray Reservation

1.6.2 Public Scoping Meeting

A scoping meeting was held on February 27, 2018 at the Santaquin Senior Citizens Center, 55 West 100 South in Santaquin, Utah from 5:00 PM to 7:00 PM. The meeting was held in an open-house format with members of the project team available to provide information regarding the purpose and need for the project, the proposed action description and maps of the study area, the NEPA process, how to get involved, and the project schedule. Sixteen (16) people attended the meeting. Comments included the following topics/issues of concern:

- Flooding and debris flow issues in 2002 and 2004 were serious and flood prevention measures are needed to prevent future types of events like this.
- Why the delay in looking at implementing flood prevention measures?
- What type of flood prevention measures will be analyzed?
- What is the cost of the proposed infrastructure?
- Will the project include recreational opportunities?
- How will the project affect future development in Santaquin?
- Where is the funding for the project coming from?

To address these comments, this Plan-EA looked at a wide array of flood prevention measures to identify the best options to provide substantial flood reduction from the 100-year-storm event (95%) and to prevent flooding from the 25-year fire-related event and debris flow from the 5-year storm event (i.e., 20% chance storm), including potential costs of said measures. Prior to this Plan-EA, a few other smaller measures were implemented by Santaquin City; with the availability of funding from the NRCS, Santaquin is able to look at broader solutions for the flooding issue. NRCS is providing funding for this Plan-EA. Future development in and around the study area would be affected by the project, either by the acquisition of land for use in the flood prevention measures or by addressing issues that prevented other types of developments from occurring.

1.6.3 Identification of Resource Concerns

Based on initial data gathering and input received during the scoping phase, several environmental and human resource concerns for the study area were identified.

Table 1-1 provides a summary of resource concerns and their relationship to the Debris Basin Alternative. Resource items determined to either not be present or not be relevant to the study area have been eliminated from detailed study while those determined to be relevant have been carried forward for analysis.

TABLE 1-1. SUMMARY OF ENVIRONMENTAL RESOURCE CONCERNS

Resource	Relevant?		Discussion
	Yes	No	
Soils			
Soils and Geologic Characteristics	X		The project would have an impact on soils in the study area during construction of the debris basin since the debris basins would require extensive excavation, but would not impact soil composition or otherwise impact geologic resources. The potential exists for impacts on the proposed flood prevention measures as a result of seismic activity, although the likelihood for seismic activity is low.
Upland Erosion	X		Short-term increase in erosion during construction of the debris basins. Protection measures to be installed during construction.
Stream Bank Erosion		X	No perennial streams were identified.
Sedimentation	X		Debris basins are designed to catch sediment and flood flows during runoff events and reduce flood damage to properties below.
Prime and Unique Farmland		X	The project would have no impact on Prime and Unique Farmlands.
Water Resources			
Surface Water Quality		X	The project would have no impacts to surface water in the study area, as there are no perennial streams or other waterbodies present.
Hydrology	X		The project would have a minor alteration to the runoff hydrology in the project area in that it would catch flood flows to be safely released through the structures into historic drainage paths.
Groundwater		X	The proposed action would have no effect on groundwater levels in the study area.
Floodplain Management	X		Affected areas within the City of Santaquin do not currently have special flood hazard areas nor areas of special mudslide hazard designated by FEMA. The debris basins would provide flood protection for properties below and are designed with outlets from the debris basins directing drainage into historic drainage paths. Therefore, existing historic drainage flow patterns would not be disrupted.

Resource	Relevant?		Discussion
	Yes	No	
Water Rights		X	The proposed action would not involve the transfer of water rights, nor would it otherwise impair existing water rights in the study area.
Wild and Scenic Rivers		X	No wild or scenic rivers exist within or directly adjacent to the study area.
Coastal Zone Management Areas		X	No coastal zones occur within or near the study area.
Air			
Air Quality	X		Construction activities would have temporary impacts to air quality in the study area.
Vegetation			
Vegetation Communities/Habitat	X		Construction of the Debris Basin Alternative would temporarily impact existing vegetation communities and habitat. Disturbed areas would be reseeded with native vegetation in exposed, disturbed areas. Permanent impacts would occur within the footprint of the proposed flood prevention mitigation structures.
Wetlands/ Riparian Areas		X	The project would have no impacts to wetlands.
Special Status Species		X	The project would have **No Effect** on ESA-listed plant species and no impact on other special-status species due to a lack of suitable habitat.
Invasive Species	X		Due to construction activities, there is the potential to spread invasive species. BMPs would be used during construction to prevent the introduction or spread of invasive species.
Wildlife			
Wildlife Communities		X	There would be temporary impacts to wildlife communities during construction due to noise and other construction-related activities. No wildlife communities would be adversely impacted long-term.
Fish		X	No fish species were identified as present in the study area.
Coral Reefs		X	There are no coral reefs present in or near the study area.
Essential Fish Habitat		X	There is no essential fish habitat in the study area.
Special Status Species		X	The project would have **No Effect** on ESA-listed wildlife species and no impact on other special-status species due to a lack of suitable habitat.
Human Environment			
Cultural and Historic Resources		X	The project would have a No Historic Resources Affected determination.

Resource	Relevant?		Discussion
	Yes	No	
Paleontological Resources		X	There are no paleontological localities recorded in the Utah Geological Service (UGS) files for this study area. Quaternary, Tertiary and Recent alluvial and lacustrine deposits and Cambrian and Precambrian bedrock deposits that are exposed here have a low potential for yielding significant fossil localities (PFYC 1 - 2). Unless fossils are discovered as a result of construction activities, this project should have no impact on paleontological resources.
Environmental Justice		X	Executive Order (EO) 12898, Federal Actions to Address Environmental Justice (EJ) in Minority Populations and Low-Income Populations, requires all federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their programs and policies on minorities and low-income populations and communities. No EJ populations were identified in the study area and the project would not have disproportionately high and adverse impacts to any EJ populations.
Land Use	X		The proposed action would require land acquisition for the new drainage features (i.e., debris basins and associated structures), as well as easements for induced flooding concerns. **Any needed land would be acquired by Santaquin without any NRCS involvement, as the PL 83-566 Watershed Program does not authorize funding for land acquisition.**
Recreation		X	The proposed action would not impact existing recreational resources and does not include any new recreational resources.
Scenic Beauty/ Visual Resources	X		The proposed action would introduce new drainage features (i.e., debris basins and associated structures) into the viewshed. The majority of the project improvements would be below grade, with the extent of the visual intrusion into the viewshed dependent upon the height of dam structures, which varies by site.
Public Health and Safety	X		The proposed action would address public health and safety concerns by reducing the risk of future flooding and debris flows from impacting residential and agricultural properties and public infrastructure.
Socioeconomics	X		Due to the protection of private lands and public infrastructure with the implementation of flooding protection measures, the proposed action would protect existing and future properties, infrastructure, land uses and provide community peace of mind during flood events.

Resource	Relevant?		Discussion
	Yes	No	
National Economic Development (NED)	X		An economic cost/benefit analysis is required by the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G). The NED cost/benefit ratio is 1.88.
Other Concerns (Identified by Cooperating Agencies or the Public)			
None			

Chapter 2: Affected Environment

2.1 Soils

2.1.1 Soils and Geologic Features

The study area is located at the base of the foothills that make up the eastern bench of Santaquin, which are part of the Wasatch Front mountain range. Elevation in the study area ranges from approximately 5000 feet to 5800 feet. There are several ravines through the mountain range that direct runoff from the higher slopes down toward Santaquin. Soils in the study area consist mainly of Henefer-Rake association (35 to 70 percent slopes), Kilburn stony sandy loan (3 to 15 percent slopes), Yeates Hollow very stony loam (25 to 40 percent slopes), and Pleasant Grove stony loam (10 to 25 percent slopes, eroded) in the higher reaches of the foothills, with Cleverly gravelly fine sandy loam (3 to 6 percent slopes and 6 to 15 percent slopes) in the lower elevations closer to town (USDA-Web Soil Survey, 2018). See Figure 2-1 - Soils in the Study Area.

Earthquake activity is a known risk in the area due to the close proximity of active segments of the Wasatch Fault zone which trends north-south along the east bench of Santaquin. A rupture of the fault in the area could produce ground motions that would damage properties, structures, roads and other infrastructure in the area.

2.1.2 Upland Erosion

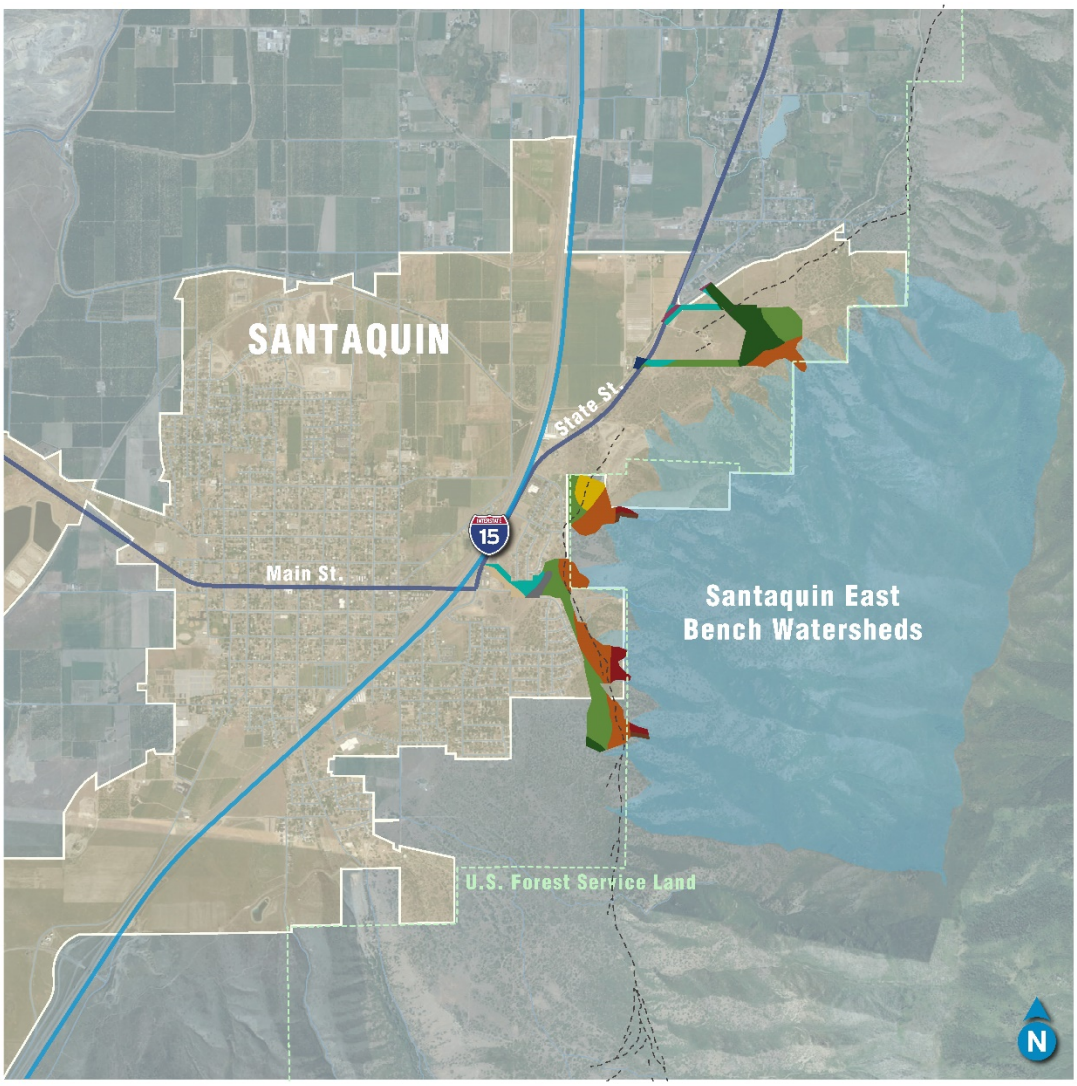
The study area is located at the foothills of the Wasatch Mountain Range at the edge of the Uinta-Wasatch-Cache National Forest, which ranges from 5000 to 5800 feet in elevation and is relatively steep. Storm events on the mountain front can create high runoff and accelerate erosion from these steep slopes. The Uinta-Wasatch-Cache National Forest is under the administration of the U.S. Forest Service; management of the area is in accordance with the Revised Wasatch-Cache National Forest Plan 2003. Several subwatersheds drain into the Santaquin area.

2.1.3 Stream Bank Erosion

No perennial streams were identified in the study area.

2.1.4 Sedimentation

In 2001, the 8000-acre Mollie Fire burned across the steep mountain subwatersheds above Santaquin to the east, denuding the mountainside of all vegetation that stabilized the soils and retarded runoff. Because of the lack of soil-stabilizing vegetation on the east benches of Santaquin, intense storm bursts in 2002 and 2004 created two debris flows that damaged residential homes and property, flowed through agricultural land, and filled in and overtopped the Highline Canal, which is a critical regional irrigation distribution canal. The debris flow event in 2002 was nearly large enough to impact I-15, the major interstate freeway in the area.



LEGEND

---- Fault Line

----- U.S. Forest Service Land

SOIL TYPES

CsC	Cleverly gravelly fine sandy loam, 3 to 6 percent slopes	PD	Pachic Cryoborolls, north slopes
CsD	Cleverly gravelly fine sandy loam, 6 to 15 percent slopes	PmE2	Pleasant Grove stony loam, 10 to 25 percent slopes, eroded
HKG	Henefer-Rake association, 35 to 60 percent slopes	PoC	Pleasant Vale loam, extened season, 3 to 6 percent slopes
HNG	Hillfield-Layton complex, 30 to 60 percent slopes	W	Water
KOD	Kilburn stony sandy loam, 3 to 15 percent slopes	YaE	Yeates Hollow very stony loam, 25 to 40 percent slopes
LcE	Lakewin cobbly fine sandy loam, 15 to 30 percent slopes		

FIGURE 2-1. SOILS IN THE STUDY AREA

2.1.5 Prime and Unique Farmland

Important farmlands, including lands identified with soils that are prime, unique, or statewide or locally important farmland, are subject to the provisions of the Farmland Protection Policy Act (FPPA). The following lands are not covered by the act:

- Lands that receive a combined score of less than 160 points from the LESA criteria
- Lands identified as "urbanized area" (UA) on Census Bureau maps
- Land with a "tint overprint" on the USGS topographical map
- Areas shown as white (not farmland) on USDA Important Farmland Maps
- Areas shown as "urban-built up" on USDA Important Farmland Maps (This is consistent with the guidance of the National Resources Inventory [NRI] for mapping urban built-up areas. Note: Areas 10 acres or larger without structures are not considered urban built-up and are subject to FPPA.)
- Land in water storage, including lands that have been acquired or planned for water storage prior to August 5,1984
- Lands that are used for national defense purposes during a National Emergency
- Private land where no Federal funds or technical assistance is utilized

Most of the land in the study area is undeveloped, but near Basin Site 6, a portion of the land is currently under agricultural production as an orchard. The majority of the study area consists of soils that are not classified as prime and/or unique farmland by the NRCS, although there are a few areas that have been classified as farmland of unique importance or that would be farmland of prime importance if irrigated. See Figure 2-2 - Prime and Unique Farmland in the Study Area.

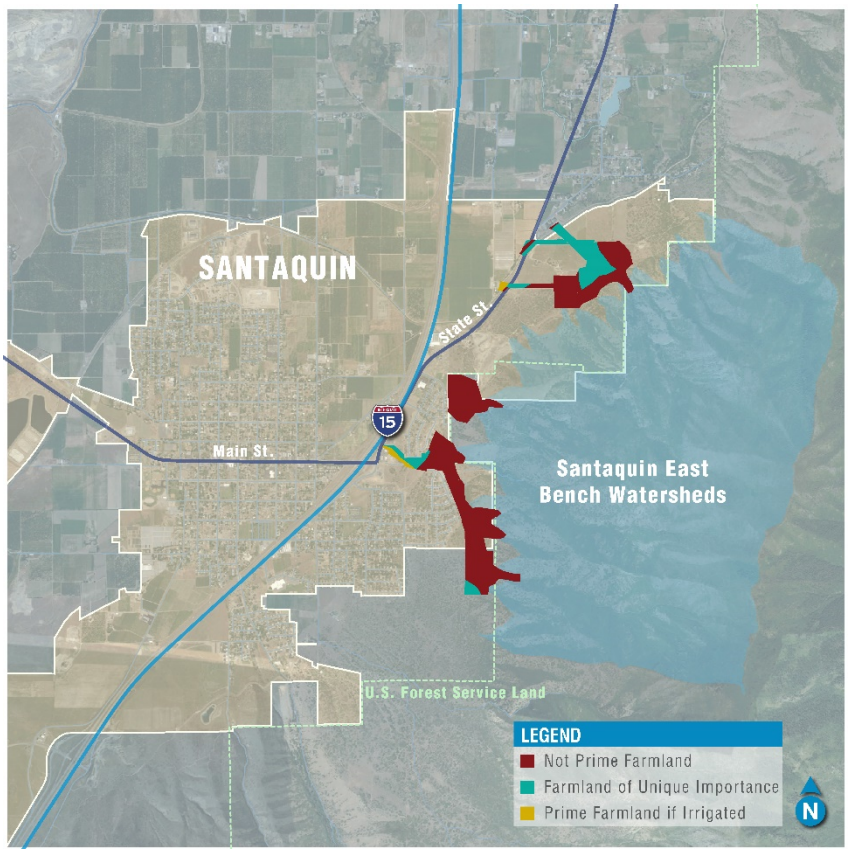


FIGURE 2-2. PRIME AND UNIQUE FARMLAND IN THE STUDY AREA

Due to the nature of this project as providing temporary water storage facilities, the FFPA would not apply to this project. Further, those areas that have soils that are designated as farmland or that would be farmland if irrigated that are located within the Santaquin Urban Cluster Area (as shown on the U.S. Census Bureau 2010 Urban Cluster Reference Map for Santaquin, UT) are not subject to the FFPA. The majority of such designated soils are within the Santaquin Urban Cluster area; the remaining such soils are within Santaquin's city limits.

2.2 Water Resources

2.2.1 Hydrology and Surface Water

This project is located within the Hydrologic Unit Number Jordan River Basin watershed (Unit 16020202). The watershed consists of approximately 3,551 square miles (9,200 km^2) and includes the upper Jordan River, Utah Lake, Provo, and Spanish Fork sub-basins. This project is located within the Spanish Fork Subbasin (HU 1602020201) which is approximately 825 square miles (2,140 km^2).

The subwatersheds that are the subject of this report lie to the east of Santaquin. They are steep, dry canyons located at the base of the Wasatch Front. The subwatersheds drain onto alluvial fans, with no defined outlet channels down through the community. The regionally critical Highline Canal crosses along the base of the alluvial fans. Heavily used highways and arterials, including the regionally critical I-15 freeway, are also located downstream. Over time, development has moved up the alluvial fan, with further development anticipated in a community that is experiencing rapid growth.

Water from the project area drains west/ northwest and eventually into Utah Lake. There are no perennial streams in the project area.

2.2.2 Floodplain Management

Flood hazard areas are designated by the Federal Emergency Management Agency (FEMA) and identified on Flood Insurance Rate Maps (FIRMs). Special flood hazard areas are defined as areas that have a one percent or greater chance of being inundated by a flood event in any given year. The one-percent annual chance flood is also referred to as the base flood or 100-year flood (FEMA 2017).

Affected areas within the City of Santaquin do not currently have special flood hazard areas nor areas of special mudslide hazard designated by FEMA. The project is intended to control flooding events from the subwatersheds associated with the foothills east of Santaquin.

2.2.3 Groundwater

Groundwater in Utah Valley occurs in unconsolidated basin-fill deposits in the valley. The principal groundwater recharge area for the basin-fill deposits is in the eastern part of the valley, along the base of the Wasatch Range. Groundwater occurs in Utah Valley in the alluvium under both water table and artesian conditions. Many of the local municipalities rely on deep groundwater wells as a primary source of municipal drinking water. Each municipality has to develop a Drinking Water Source Protection Plan that identifies groundwater recharge areas and protection zones for each water source.

Santaquin City has a 3.5-million gallon water storage capacity. Water comes from four (4) culinary wells, producing 2,600 gallons per minute, and springs producing 900 gallons per minute. During the summer months, approximately 50% of the water comes from springs and 50% from wells. During the winter months, 90% or more comes from the springs (see Figure 2-3 - Water Resources and Wetlands Identified in the Study Area).

2.2.4 Waters of the U.S.

Waters of the U.S. (WOTUS) are defined in 33 CFR §328.3 as waters currently or previously used for interstate or foreign commerce; all interstate waters; any waters, the destruction of which could affect interstate or foreign commerce; all impoundments; tributaries of the previously mentioned waters; the territorial seas; and wetlands adjacent to waters. A wetland is an area that is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. See 40 CFR §230.3(t) and 33 CFR §328.3.

A field survey to identify WOTUS, including wetlands, was conducted by Horrocks Engineers on June 20, 2018, which included a review of National Wetlands Inventory (NWI) maps and a site visit to identify possible WOTUS based on vegetation type and hydrology. See the Aquatic Resources Inventory, Santaquin Debris Basins Memorandum dated June 25, 2018 in Appendix E. No formal wetland delineation was performed. The inventory identified one canal (the Strawberry Highline Canal) and one potential wetland area located within the study area. See Figure 2-3- Water Resources and Wetlands Identified in the Study Area.

FIGURE 2-3. WATER RESOURCES AND WETLANDS IDENTIFIED IN THE STUDY AREA

Further, the NWI maps identified four intermittent streams draining from the major canyons to the east. Each of these areas was surveyed and none of them included an Ordinary High Water Mark (OHWM); therefore, they do not meet the USACE definition for a WOTUS and would not be considered jurisdictional.

2.3 Air

The Clean Air Act Amendments (CAAA) of 1990 (42 USC 7401 et seq.) established the National Ambient Air Quality Standards (NAAQS) for airborne pollutants. The six criteria pollutants addressed in the NAAQS are:

- carbon monoxide (CO)
- particulate matter with a diameter of 10 micrometers or less (PM_{10})
- particulate matter with a diameter of 2.5 micrometers or less ($PM_{2.5}$)
- ozone (O_3)
- nitrogen dioxide (NO_2)
- lead (Pb)

If the NAAQS levels are exceeded, the area is designated a non-attainment area and the development of a State Implementation Plan (SIP) is required. The SIP sets allowable emissions levels to be met and identifies control strategies to meet the NAAQS for those specific criteria pollutants that experienced exceedances.

The study area is located in Utah County, which is within a nonattainment area for PM_{10} and $PM_{2.5}$. The EPA has recently classified the Wasatch Front (including all or part of Salt Lake, Davis, Weber, Tooele, and Utah counties) and parts of the Uinta Basin (portions of Uintah and Duchesne counties below 6,250 feet) as Marginal Nonattainment Areas for ozone, which is the least stringent classification for a nonattainment area and doesn't require the state to submit a formal SIP. Therefore, the study area is now located in a marginal nonattainment area for ozone. It is not within a nonattainment or maintenance area for any other criteria pollutants.

2.4 Vegetation

2.4.1 Vegetation Communities and Habitat

Vegetation in the study area is predominantly a mixture of native and introduced grasses, shrubs, and upland vegetation found within the Foothill plant community. General vegetation species include gambel oak, cliffrose, juniper spp., sagebrush spp., rabbit brush, and other native shrubs and grasses.

2.4.2 Special Status Species

Threatened and Endangered Species

The Endangered Species Act (ESA) provides protection to federally listed threatened and endangered (T&E) species and their designated critical habitats and is under the jurisdiction of the United States Fish and Wildlife Service (USFWS). On May 9, 2018, an official T&E species list was obtained from the USFWS' Information, Planning, and Conservation (IPaC) service.

Table 2-1 lists the T&E botanical species and their associated habitat that could potentially be present within the study area. No critical habitat was identified by USFWS to exist in the study area for any of the identified species.

TABLE 2-1. THREATENED AND ENDANGERED BOTANICAL SPECIES IN THE STUDY AREA

Species	Status	Habitat	Present?
Ute Ladies'-tresses* *Spiranthes diluvialis*	Threatened	Found in moist to very wet meadows, as well as along streams, abandoned stream meanders, and near springs, lake shores, and spring seeps in sandy or loamy soils with mixed gravel; elevation range is between 4,300 and 7,000 ft. above mean sea level (msl).	Not likely to be present due to lack of suitable habitat/soils; no known instances within 1 mile
Jones Cyclandenia *Cycladenia humilis var. jonesii*	Threatened	Grows in gypsiferous soils that are shallow, fine textured, and intermixed with rock fragments. The species can be found in Eriogonum-Ephedra, mixed desert shrub, and scattered pinyon-juniper communities, at elevations ranging from 4000 to 6800 feet.	Not likely to be present due to lack of suitable habitat/soils

Source, U.S. Fish and Wildlife Service's Information, Planning, and Conservation (IPaC) online services, (https://ecos.fws.gov/ipac/), dated May 9, 2018
**Also identified as a state sensitive plant, according to the Utah Conservation Data Center.*

State Sensitive Species

A review of the botanical plants listed on the Utah Conservation Data Center website as some of the rarest plants in the state indicated the potential for Ute Ladies'-tresses (ULTs) (which is also a federally listed species and is discussed in Table 3.1 above). No other state sensitive plant species were identified as potentially being present in the study area.

Invasive Species

Executive Order 13112 directs federal agencies to expand and coordinate their efforts to combat the introduction and spread of plants and animals not native to the United States. Non-native flora and fauna can cause substantial changes to ecosystems, upset the ecological balance, and cause economic harm to our nation's agricultural and recreational sectors.

Land uses and degrees of development vary throughout the study area. The majority of the land in the study area is undeveloped open space along the east bench of Santaquin. These areas provide the greatest opportunity for movement and the spread of invasive species. Residential, agricultural, and commercial properties lie at the base of the foothills.

2.5 Wildlife

2.5.1 Wildlife Communities

The study area is located along the eastern foothills of Santaquin and consists mostly of open, undeveloped land. Residential, agricultural, and commercial properties lie at the base of the foothills. The majority of the study area is undeveloped; however, regular use from off-highway vehicles is apparent. Other uses within the study area consist of fruit-tree orchards and unofficial campsites. Further, the Santaquin Wildlife Management Area is located south of Santaquin and outside of the study area.

Sufficient habitat exist within the study area to support big game species, other common small mammals, and migratory birds. One mule deer (*Odocoileus hemionus*) and several bird species were observed during the site visit including black-capped chickadee (*Poecile atricapillus*), western kingbird (*Tyrannus verticalis*), American robin, (*Turdus migratorius*), broad-tailed hummingbird (*Selasphorus*

platycercus), lazuli bunting, (*Passerina amoena*), lark sparrow, (*Chondestes grammacus*), Eurasian collared-dove (Streptopelia decaoctoringered), black-billed magpie, (*Pica hudsonia*), American kestrel (*Falco sparverius*), turkey vulture (*Cathartes aura*), and prairie falcon, (*Falco mexicanus*).

2.5.2 Fish/Essential Fish Habitat

There are no perennial streams in the study area, nor are there other bodies of water in the study area sufficient to support aquatic species. Therefore, no fish species were identified as being present in the study area. Further, no essential fish habitat has been identified in the study area.

2.5.3 Special Status Species

Threatened and Endangered Species

Table 2-2 lists the T&E wildlife species and their associated habitat that could potentially be present within the study area. No critical habitat was identified by USFWS to exist in the study area for any of the identified species.

TABLE 2-2. THREATENED AND ENDANGERED WILDLIFE SPECIES IN THE STUDY AREA

Species	Status	Habitat	Present?
Mammals			
Canada Lynx *Lynx Canadensis*	Threatened	Prefers moist, cool boreal/coniferous forests in areas with deep snow and an abundance of snowshoe hare	Not present in the study area due to lack of suitable habitat
Birds			
Yellow-billed Cuckoo *Coccyzus americanus*	Threatened	Riparian obligate that inhabits dense, deciduous riparian forests, preferring tall cottonwoods and willows	Not present in the study area due to lack of suitable habitat
Fish			
June Sucker *Chasmistes liorus*	Endangered	Endemic to Utah Lake and portions of the Provo River	Not present in the study area

**Source, U.S. Fish and Wildlife Service's Information, Planning, and Conservation (IPaC) online services, (https://ecos.fws.gov/ipac/), dated May 9, 2018*

State Sensitive Species

According to the Utah Sensitive Species List, compiled by the Utah Division of Wildlife Resources (UDWR) dated November 1, 2017, Utah County includes several wildlife species of concern. Table 2-3 lists the state sensitive wildlife species and their associated habitat that could potentially be present within the study area.

TABLE 2-3. STATE SENSITIVE WILDLIFE SPECIES

Species	Habitat	Present?
Mammals		
Brown (Grizzly) Bear *Ursus arctos*	Extirpated from Utah	Not present in the study area
Fringed Myotis *Myotis thysanodes*	Commonly roosts in mine tunnels, caves, and buildings; migratory; water courses and lowland riparian areas important	Not likely to be present due to lack of suitable habitat

Species	Habitat	Present?
Kit fox *Vulpes macrotis*	Found exclusively in arid and semi-arid landscapes	Not likely to be present due to lack of suitable habitat
Spotted bat *Euderma maculatum*	Most often found in dry, rough, desert terrain; roosts in rock crevices or under loose rocks or boulders	Not likely to be present due to lack of suitable habitat
Townsend's big-eared bat *Corynorhinus townsendii*	Correlated with availability of caves and abandoned mines below 9,000 feet	Not likely to be present due to lack of suitable habitat
Western red bat *Lasiurus blossevillii*	Dependent on broad-leaf shrubs and trees in lowland (below 5,700 feet) riparian zones; roosts in cottonwood trees; very rare in Utah	Not likely to be present due to lack of suitable habitat
White-tailed prairie dog *Cynomys leucurus*	Inhabit mountain valleys, semi-desert grasslands, agricultural areas, and open shrublands; occur primarily in the Uintah Basin and northern portion of Colorado Plateau	Not likely to be present due to lack of suitable habitat
Fish		
Bluehead sucker *Catostomus discobolus*	Fast flowing water in high gradient reaches of mountain rivers	Not present in the study area
Bonneville cutthroat trout *Oncorhynchus clarkia utah*	Requires a functional stream riparian zone that provides structure, cover, shade and bank stability	Not present in the study area
Colorado River cutthroat trout *Oncorhynchus clarkia pleuriticus*	Prefers cool, clear water of high-elevation streams and lakes	Not present in the study area
Least chub *Iotichthys phlegethontis*	Prefers areas of dense vegetation in slow-moving water	Not present in the study area
Roundtail chub *Gila robusta*	Prefers large rivers; mostly found in murky pools near strong currents in the main-stem Colorado River and its large tributaries	Not present in the study area
Southern leatherside chub *Lepidomeda aliciae*	Occurs in pools and low-velocity runs of creeks and small-to-medium sized rivers; currently limited to tributaries of the Spanish Fork, Provo, and Sevier River drainages	Not present in the study area
Reptiles		
Smooth greensnake *Opheodrys vernalis*	Found in meadows and stream margins associated with moist, grassy areas; rarely observed in Utah	Not likely to be present due to lack of suitable habitat
Amphibians		
Columbia spotted frog *Rana luteiventris*	Prefer isolated springs and seeps with a permanent water source	Not likely to be present due to lack of suitable habitat

Species	Habitat	Present?
Western toad *Bufo anazyrus*	Variety of habitats including slow moving streams, wetlands, desert springs, ponds, lakes, meadows, and woodlands	Not likely to be present due to lack of suitable habitat
Birds		
American three-toed woodpecker *Picoides dorsalis*	Nests in coniferous forests above 8,000 feet	Not likely to be present due to lack of suitable habitat
American white pelican *Pelecanus erythrorhynchos*	Located on small islands with low gradient slopes; Gunnison Island only colonial nesting site in Utah	Not likely to be present due to lack of suitable habitat
Bald eagle *Haliaeetus leucocephalus*	Nests in cottonwood or conifer forests near open water	Not likely to be present due to lack of suitable habitat
Bobolink *Dolichonyx oryzivorus*	Breeding is restricted to wet meadow and flooded pasture habitats	Not likely to be present due to lack of suitable habitat
Burrowing owl *Athene cunicularia*	Nest in ground burrows of prairie dogs or other fossorial mammals	Not likely to be present due to lack of suitable habitat
Ferruginous hawk *Buteo regalis*	Rely on grassland or shrub steppe terrain and require an available prey base	Not likely to be present due to lack of suitable habitat
Greater sage-grouse *Centrocercus urophasianus*	Require sagebrush rangeland	Not likely to be present due to lack of suitable habitat
Lewis's woodpecker *Melanerpes lewis*	Habitat specialist with primary breeding habitat in ponderosa pine and open riparian areas and winter habitat in open woodlands and lowland riparian areas; requires large open pine forests with adequate spacing between trees to allow for foraging	Not likely to be present due to lack of suitable habitat
Long-billed curlew *Numenius americanus*	Nest in dry grasslands where sufficient cover and abundant prey exist	Not likely to be present due to lack of suitable habitat
Northern goshawk *Accipiter gentilis*	Prefers mature mountain forest and riparian zone habitats	Not likely to be present due to lack of suitable habitat
Short-eared owl *Asio flammeus*	Occupies grasslands and tundra; dependent upon abundance of small mammals for prey	Not likely to be present due to lack of suitable habitat
Mollusks		
California floater *Anodonta californiensis*	Occurs in lake and pond habitats and low-gradient streams at middle elevations in Utah	Not likely to be present due to lack of suitable habitat

Species	Habitat	Present?
Eureka mountainsnail *Oreohelix eurokensis*	Endemic to Utah; found in both shrubland and forested habitats, associated with limestone outcrops or soils with high calcium concentration and low-growing vegetation/well-developed layer of plant litter; only 4 populations documented	Not likely to be present due to lack of suitable habitat
Southern Bonneville springsnail *Pyrgulopsis transversa*	Highly endemic; many only in isolated springs; noted in only 6 localities in Utah	Not likely to be present due to lack of suitable habitat
Utah physa *Physella utahensis*	Occur in small pools associated with springs with varying substrates and degree of vegetation	Not likely to be present due to lack of suitable habitat

Source: UDWR Utah Sensitive Species List dated November 1, 2017, https://dwrcdc.nr.utah.gov/ucdc/ViewReports/SSL_Appendices.pdf; Utah Conservation Data Center https://dwrcdc.nr.utah.gov/ucdc/, accessed April 2018.
**The ESA-listed species June sucker is also included as a state species of concern, but it is addressed separately*

Birds of Conservation Concern

The 1988 amendment to the Fish and Wildlife Conservation Act mandates USFWS to "identify species, subspecies, and populations of all migratory nongame birds that, without additional conservation actions, are likely to become candidates for listing under the Endangered Species Act (ESA) of 1973." The overall goal of the **Birds of Conservation Concern** (BCC) is to identify the migratory and non-migratory bird species (beyond those already designated as federally threatened or endangered) that represent the highest conservation priorities. Bird species considered for inclusion on lists in this report include nongame birds, gamebirds without hunting seasons, subsistence-hunted nongame birds in Alaska; and Endangered Species Act candidate, proposed endangered or threatened, and recently delisted species. Birds of Conservation Concern (BCC) birds that may be present in the study area are detailed in Table 2-4.

The **Migratory Bird Treaty Act** with Canada, Mexico, and Japan makes it unlawful at any time, by any means, or in any manner, to pursue, hunt, take, capture, kill, or sell migratory birds. The law grants full protection to any bird parts (such as feathers) and applies to the removal of nests (such as swallow nests on bridges) occupied by migratory birds during the breeding season. Executive Order 13186, signed by President Bill Clinton on January 10, 2001, directs federal agencies whose activities are likely to have a measurable negative effect on migratory birds to undertake actions in support of the Migratory Bird Treaty Act. One of these actions is for federal agencies to ensure that the environmental analyses required by the National Environmental Policy Act (NEPA) evaluate the effects of actions and agency plans on migratory birds, with an emphasis on species of concern.

The **Bald and Golden Eagle Protection Act** prohibits the take, sale, purchase, possession, barter, or transport, or offer to do any of the above, of either the bald eagle (*Haliaeetus leucocephalus*) or golden eagle (*Aquila chrysaetos*) at any time or in any manner.

TABLE 2-4. BIRDS OF CONSERVATION CONCERN FOR THE STUDY AREA

Species	Habitat	Breeding?
Bald Eagle *Haliaeetus leucocephalus*	Nests almost always in tall trees and commonly near bodies of water where fish and waterfowl prey are available	Dec 1 – Aug 31

Species	Habitat	Breeding?
Golden Eagle *Aquila chrysaetos*	Found in open country, especially in mountainous regions; nests constructed on cliffs or in large trees	Dec 1 – Aug 31
Lewis's Woodpecker *Melanerpes lewis*	Major breeding habitat consists of open park-like ponderosa pine forests with a good under-story of grasses and shrubs to support insect prey populations; prefers oak woodlands for wintering	Apr 20 – Sep 30
Olive-sided Flycatcher *Contopus cooperi*	Prefers woodland and forest areas, especially areas where standing dead trees are present; migratory	May 20 – Aug 31

Source: U.S. Fish and Wildlife Service's Information, Planning, and Conservation (IPaC) online services, (https://ecos.fws.gov/ipac/), dated May 9, 2018

2.6 Human Environment

2.6.1 Cultural and Historic Resources

A literature search was conducted by Horrocks Engineers on June 5, 2018, using the Utah Division of State History's (UDSH) online database Preservation Pro to identify previously documented archaeological site or areas of historic importance within the Area of Potential Effect (APE), which identified two archaeological sites. On June 19 and 20, 2018, Horrocks Engineers conducted an intensive-level pedestrian inventory of the study area. See *An Archaeological Inventory for the Santaquin East Bench Flood Prevention Project* prepared in connection with this project.

Table 2-5 lists the archaeological sites identified, as well as a recommendation as to the site's eligibility for the National Register of Historic Places (NRHP). One eligible site (Strawberry Highline Canal) and four ineligible sites were identified, as well as six isolated occurrences (IO) that are also ineligible.

The Strawberry Highline Canal was originally recorded by the Bureau of Reclamation (BOR) in 1981. The overall canal measures 17.5 miles long, but the portion in the project area is 4,400 feet long. The canal originally had earthen and concrete-lined sections and was created to facilitate irrigation of local fields from its origin at Spanish Fork Canyon. The section in the project area is concrete-lined and is U-shaped with an average width of approximately 20 feet and an approximate depth of six feet.

TABLE 2-5. CULTURAL AND HISTORIC RESOURCES WITHIN THE AREA OF POTENTIAL EFFECTS (APE)

No.	Site Name/ Description	Eligibility Recommendation
42UT1322	Historic Trash Scatter	Ineligible
42UT1323	Historic Trash Scatter	Ineligible
42UT1473	**Strawberry Highline Canal**	**Eligible**
42UT2020	Historic Foundation	Ineligible
42UT2021	Historic Trash Scatter	Ineligible
IO-1	Glass Insulators	Ineligible
IO-2	Milk Glass Fragments	Ineligible
IO-3	Amethyst Glass Bottle Fragments	Ineligible
IO-4	Clear Glass Bottle Fragments	Ineligible
IO-5	Chert Flake	Ineligible
IO-6	Historic Soda Bottle	Ineligible

The recommendations of eligibility for all sites contained required consultation with the Utah State Historic Preservation Officer (SHPO). See the correspondence to SHPO requesting concurrence with the eligibility determinations dated April 9, 2019 in Appendix E.

2.6.2 Land Use and Recreation

The study area is located in Santaquin, Utah and the immediate vicinity in Utah County. Land uses in the area consist of undeveloped open space along the east bench of Santaquin. Residential, agricultural, and commercial properties lie at the base of the foothills. While there are no public parks directly in the study area itself, the public parks and other recreational facilities in the vicinity include:

- Orchard Hills Park (268 610 South), Santaquin, UT
- Eastside Park (397 Cherry Lane), Santaquin, UT

The study area contains USFS-administered land within the confines of the Uinta-Wasatch National Forest near Basin Site 5. The National Forest provides public recreational opportunities, although there are no specific USFS-administered recreational sites (i.e., campgrounds/camp sites, trails/trailheads, in the study area.

2.6.3 Scenic Beauty and Visual Resources

The viewshed in the study area consists of mostly open undeveloped land along the foothills of the east bench, with residential, agricultural, and some commercial properties on the outskirts of Santaquin City. The foothills rise above Santaquin City along the eastern bench and contain USFS-administered land within the confines of the Uinta-Wasatch National Forest.

2.6.4 Public Health and Safety

Currently, public health and safety concerns relate to the future potential for flooding and erosion from the East Bench area near Santaquin to impact existing residential, commercial, and agricultural properties, as well as public infrastructure in the area. As indicated previously, in 2002 and 2004 created two debris flows that damaged 20-25 residential homes and property, flowed through agricultural land, and filled in and overtopped the Highline Canal, which is a critical regional irrigation distribution canal. The debris flow event in 2002 was nearly large enough to impact I-15, the major interstate freeway in the area.

2.6.5 Socioeconomics

Santaquin is located in Utah County, about seventy miles south of Salt Lake City. Originally called Summit City because of its location at the summit dividing line between Utah and Juab valleys, it was settled in late 1851 by pioneers who were helping settle Payson, located about six miles to the north. In 1856, it was renamed Santaquin for the son of Guffich, a local native chieftain friendly to the settlers.

Today, Santaquin is a growing city. The median age of residents is 23.3 years (compared to 30.7 for Utah in general), with 63.9% currently married and 88.7% with at least a high school education. The unemployment rate as of September 2015 was 3.0% and the most common occupations in 2016 were construction-related, manufacturing, and retail trade for men and health care and social assistance, educational services, and retail trade for women (http://www.city-data.com/city/Santaquin-Utah.html). Tables 2-6 and 2-7 contain selected populations and economic data for Santaquin City and Utah County (as of the 2010 Census).

TABLE 2-6. SELECTED POPULATION DEMOGRAPHICS (2010 CENSUS)

Criteria		Santaquin		Utah County	
		Number	Percent	Number	Percent
Total Population		9,128	--	516,564	--
Age	Under 18	3,886	42.6%	181,977	35.2%
	Over 65	465	5.1%	33,457	6.5%
	Median	23.9	--	24.6	--
Race	White	8,155	89.3%	461,775	97.3%
	Black or African American	38	0.4%	2,799	0.5%
	American Indian/Alaskan Native	72	0.8%	3,074	0.6%
	Asian	13	0.1%	7,032	1.4%
	Native Hawaiian/Other Pacific Islander	10	0.1%	3,905	0.8%
	Some Other Race	294	6.1%	23,943	4.6%
	Two or More Races	66	1.4%	14,036	2.7%
Hispanic or Latino (of any race)		1,098	12.0%	55,793	10.8%

Source: U.S. Census Bureau, American FactFinder website (https://factfinder.census.gov), accessed April 23 and July 11, 2018

TABLE 2-7. SELECTED ECONOMIC CHARACTERISTICS (2010 CENSUS)

Criteria		Santaquin		Utah County	
		Estimate	Percent	Estimate	Percent
Population in labor force (16 years+)		4,520	71.0%	263,756	68.2%
Median Household Income (dollars)		$65,959	--	$64,321	--
Percent Below Poverty Level		--	8.9%	--	12.5%
Industry	Agriculture, forestry, fishing, mining	327	7.5%	2,345	0.9%
	Construction	577	13.3%	16,062	6.4%
	Manufacturing	542	12.5%	24,104	9.6%
	Wholesale trade	117	2.7%	6,718	2.7%
	Retail trade	534	12.3%	31,030	12.4%
	Transportation, utilities	198	4.6%	6,985	2.8%
	Information	168	3.9%	7,683	3.1%
	Finance, real estate, leasing	189	4.4%	13,750	5.5%
	Professional, scientific, management, administrative, waste management	253	5.5%	35,516	14.2%
	Educational services, health care, social assistance	855	19.7%	67,475	26.9%
	Arts/ entertainment, recreation, accommodation, food	274	6.3%	19,843	7.9%
	Public administration	159	3.7%	7,688	3.1%
	Other services	144	3.3%	11,259	4.5%

Source: U.S. Census Bureau, American FactFinder website, 2012-2016 American Community Survey 5-year Estimates (https://factfinder.census.gov, accessed April 23 and July 11, 2018

Chapter 3: Alternatives

3.1 Alternatives Development

The process of formulating alternatives for the project followed the procedures outlined in the USDA-NRCS NWPM (NRCS 2015) Parts 500 through 506, USDA-NRCS National Watershed Program Handbook (NRCS 2014) Parts 600 through 606, and other USDA-NRCS watershed planning policies. Proposed flood prevention measures were presented to the public and interested agencies at a public scoping meeting and the comments received were incorporated into the formulation process for the alternatives development.

3.1.1 Alternatives Development

Development of the alternatives began at a basic level to look at general alternatives that could potentially meet the purpose and need for the project, including alternatives that would not require the installation of new structures).

Further, a hydrological analysis was conducted to determine the most effective flood prevention measures to meet the purpose and need for the project. Further, all of the proposed flood prevention measures were analyzed for the following environmental screening criteria:

- Would the proposed flood prevention measures result in adverse impacts to environmental resources?
- What are the costs versus the economic benefits of the proposed flood prevention measures?

Alternatives were eliminated that would either not provide adequate levels of flood prevention to meet the purpose and need for the project in that they would not fully contain the 50-year flood event or reduce the 100-year flood event by 95% or they would have other impacts that would make them not prudent or feasible, including unacceptable impacts to environmental resources or high costs of construction and maintenance.

Two alternatives were eventually selected by USDA-NRCS to be analyzed in this Plan-EA; the Debris Basin Alternative, Option B, which entails the expenditures of NRCS funds towards the flood prevention improvements, and the No Action Alternative. Details of the Debris Basin Alternative Option B are set forth in Section 3.1.2.5.

3.1.2 Alternatives Considered but Eliminated from Detailed Study

3.1.2.1 Planning, Regulatory and Land Use Development Restrictions

This alternative included implementing planning, regulatory, and land use development restrictions (i.e., restrictions on building, providing assistance for floodproofing retrofits for residences in the area, etc.). While this alternative would not meet the purpose and need for the project in that building restrictions and other policy considerations would not address the flooding issues alone, they would be incorporated into the Preferred Alternative.

3.1.2.2. Removal or Relocation of Residences in Flood-Prone Areas

An alternative to remove or relocate homes in potential flood areas was considered but eliminated early due to both cost and concerns over willing landowners versus eminent domain procedures. Under the 50-year flood, at least 30 homes would experience some level of flooding. Using a median home value of $331,500 (obtained from Zillow for the purposes of an estimate for this analysis), this alternative would cost an estimated $9,945,000 (not included relocation assistance costs) and would not address damages to other infrastructure that may be damaged by flood events (i.e., roads,

utilities). Under the 100-year flood, the number of homes that would experience flooding rises to 52, which in turn increases the potential cost to $17,238,000, with the same limitations as before. This cost is also based upon willing sellers; without that, the addition of the costs of the eminent domain process would be in addition to the costs of land acquisition. Further, PL 83-566 Watershed Program does not authorize funding for land acquisition, so this cost would need to be borne by the project sponsor alone.

3.1.2.3 Check Structures Only

This alternative consists of utilizing various types of check structures, such as stone check dams, debris nets, wooden piles, debris racks or concrete structures, with no other types of improvements, both within the canyons along the east bench that constitute the subwatersheds and just below the mouth of the canyons. See Figure 3-1.

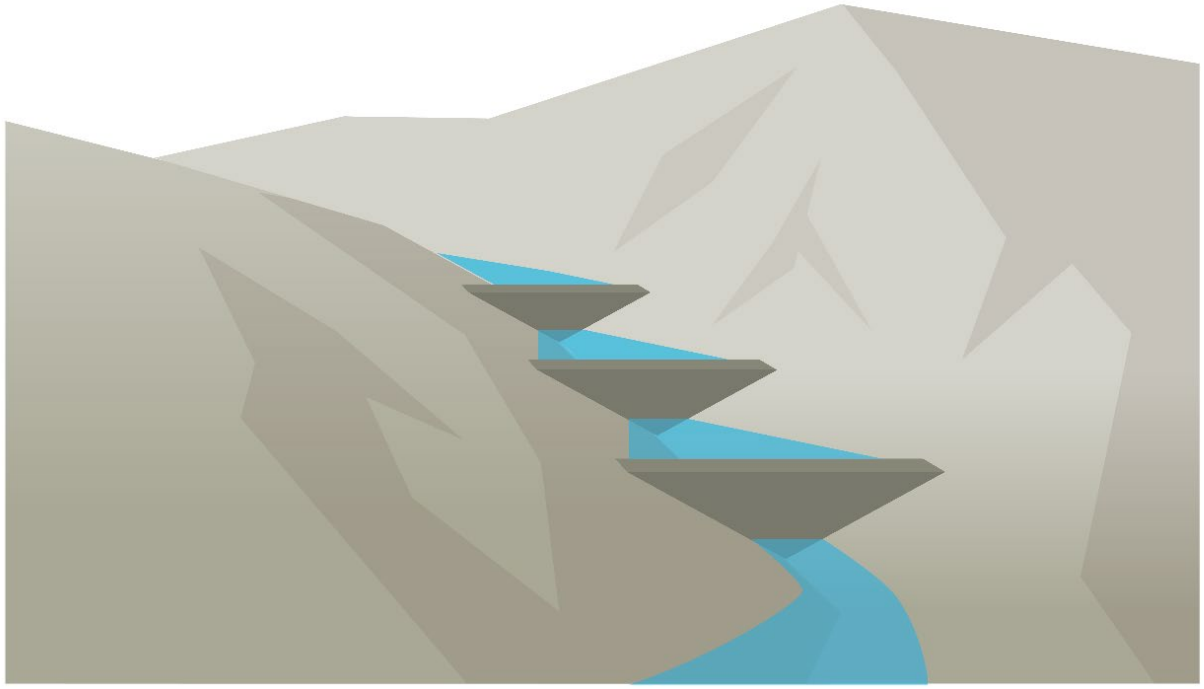


FIGURE 3-1. CHECK DAM ILLUSTRATION

This alternative would offer some protection by reducing flows and arresting large debris elements that come out of the watershed canyons during flood events and has smaller individual footprints for the proposed improvements and lower engineering costs than debris basins while reducing sediment loads and reducing the peak flows of major events. However, this alternative would require a large number of check dams within the very steep gradient of the canyons with difficult access for maintenance purposes. One concern is that due to the lack of access for maintenance, over time the check dams would fill up with debris from smaller storm events, rendering them unable to function properly during a flood event.

This alternative was eliminated because it failed to meet the purpose and need for the project because it would not provide sufficient reduction of flooding events as defined. It also requires routine maintenance to prevent failure that would be extremely difficult to do because of the location of the structures in remote, somewhat inaccessible areas that would require access across Forest Service lands and larger peak flows that would not be contained by these smaller structures still would have to be somehow accommodated downstream.

3.1.2.4. Diversion Berms

This alternative involves constructing earthen diversion berms in various locations near the outlets of the subwatersheds to direct flooding and debris flows away from developed lands and public infrastructure to undeveloped areas where they would cause minimal damage, but not including debris basins to contain either floodwater or debris. See Figure 3-2. This alternative would be potentially feasible for only one of the subwatersheds (Subwatershed 1) where there was undeveloped lands in the downstream vicinity.

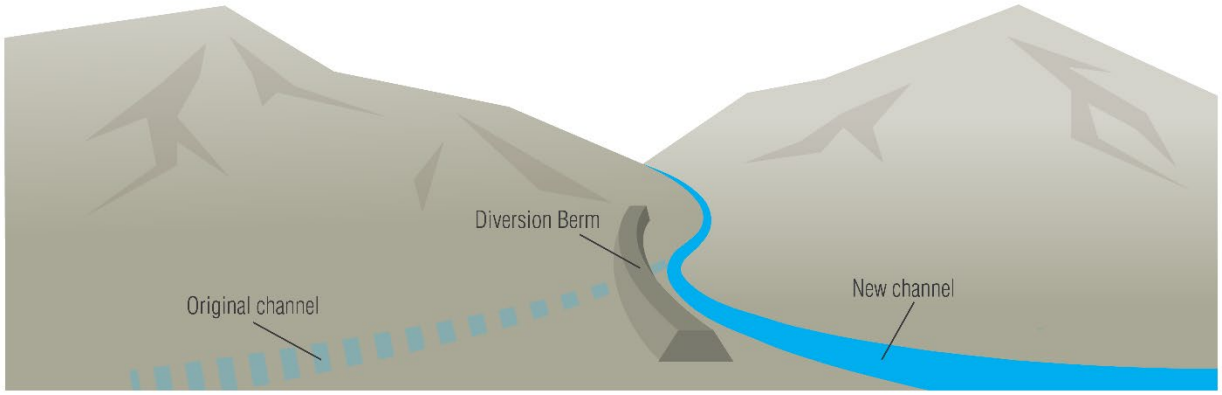


FIGURE 3-2. DIVERSION BERM ILLUSTRATION

This alternative addressed immediate threats to developed lands and public infrastructure by diverting such flows away from sensitive land uses. It benefits from reduced regulatory and engineering analysis and review and would potentially have a smaller footprint of disturbance than debris basins.

However, this alternative requires additional downstream storm flow conveyance due to the lack of debris basins and does not provide sufficient flood reduction as defined. It also introduces the likelihood of flooding in new areas that previously would not have been flooded (approximated at up to 92 acres on the east side of I-15 alone plus additional acreage across the freeway) and would threaten flood damage to approximately 200 structures. Further, this alternative would involve having to acquire additional lands Therefore, it was eliminated from further consideration because it does not meet the purpose and need for the project and would likely result in additional environmental impacts due to the potential for induced flooding in areas that previously would not have experienced it.

3.1.2.5. Flow Impediments/Level Spreaders

This alternative involves using various debris control methods within the flood channel for the various subwatersheds but does not involve debris basins. It does include a combined basin downstream to capture the floodwater from the various subwatersheds after the bulk of the sediment was removed from the flow using the settling ponds. See Figures 3-3 through 3-5.

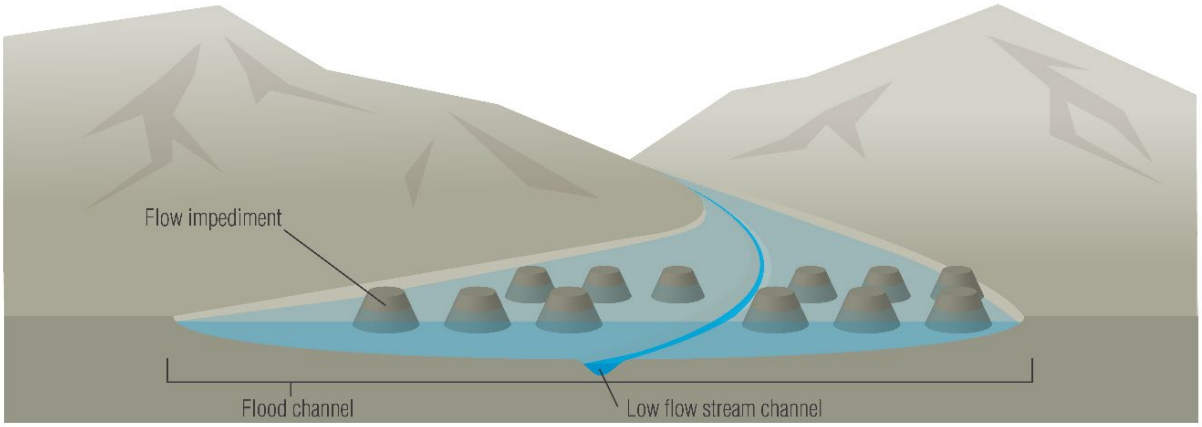


FIGURE 3-3. FLOW IMPEDIMENT ILLUSTRATION

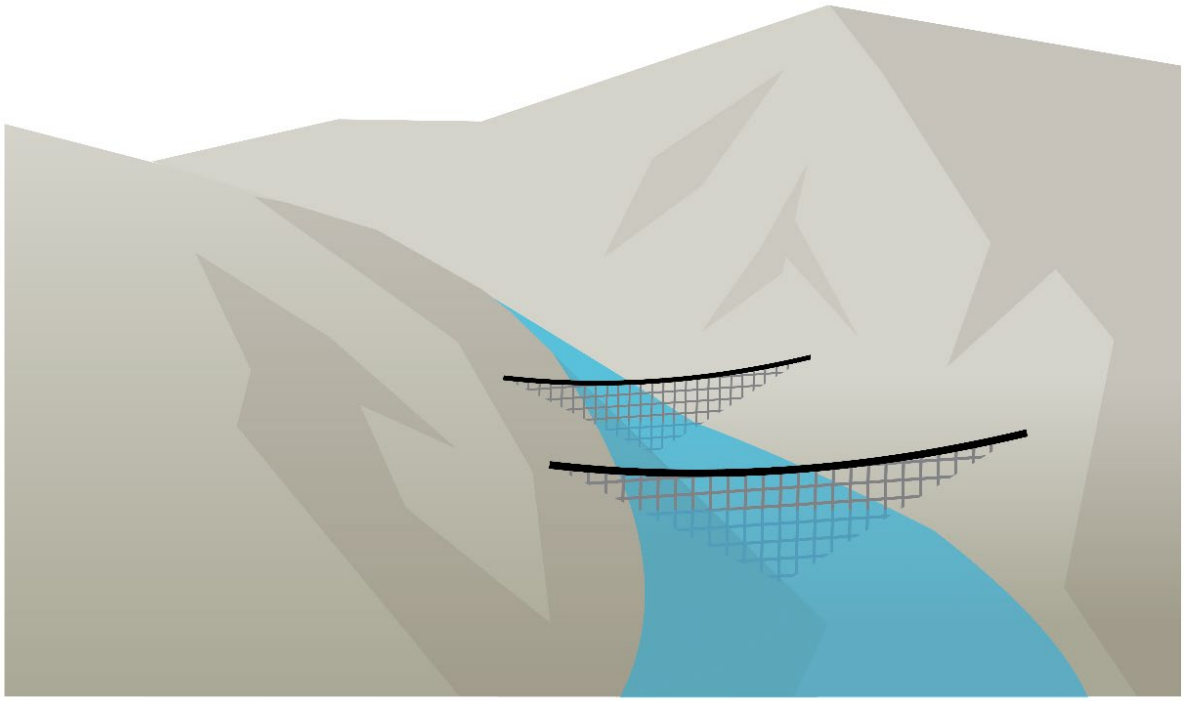


FIGURE 3-4. DEBRIS NETS ILLUSTRATION

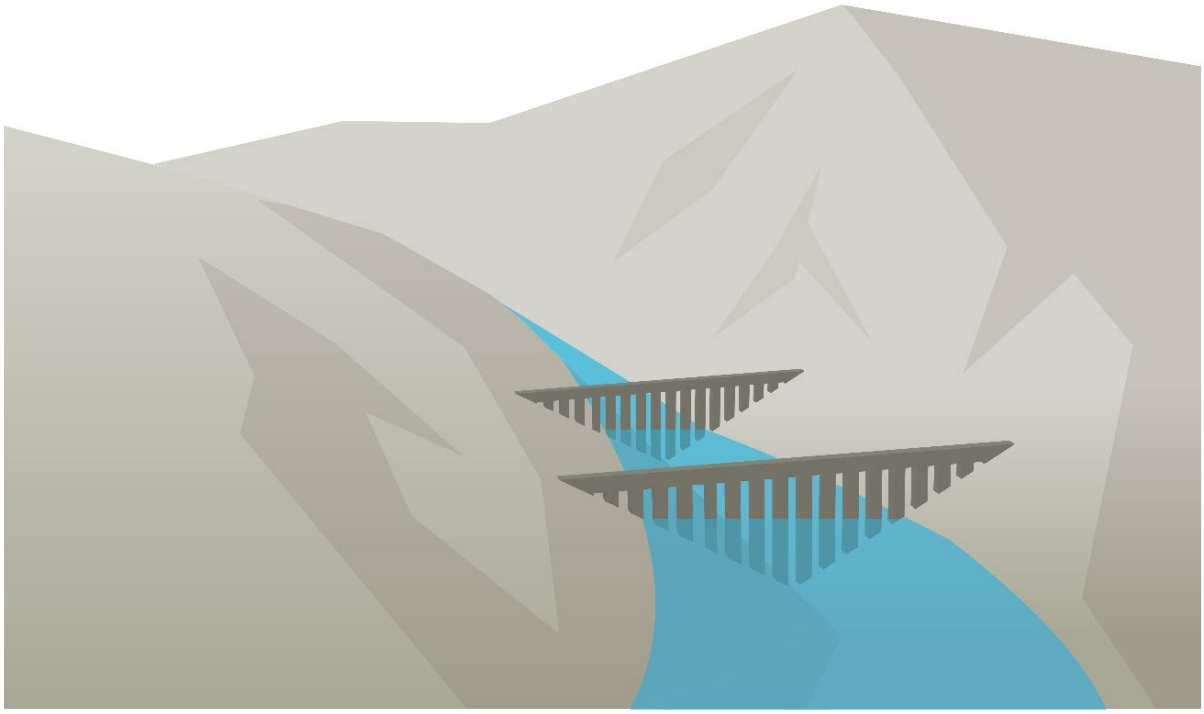


FIGURE 3-5. DEBRIS RACKS ILLUSTRATION

This alternative would reduce the peak flow and large sediment loads to a degree and would potentially involve less regulatory and engineering analysis and review. This alternative was eliminated from further consideration since it would not meet the purpose and need for the project because, while it would help remove sedimentation, it would not provide sufficient flood protection since flood volumes would not be contained at the site due to the nature of flow impediment structures. Flow impediment structures function by slowing down the flow and causing large debris elements to settle out of the flow. While offering some protection, these types of structures do not capture or contain the floods. It would require maintenance to address ongoing sedimentation after flood events and the size of the basin needed to contain the flood volumes may be prohibitive.

3.1.3 Alternatives Considered for Detailed Study

There are two alternatives for the project that were carried forward for further study in this Plan-EA: the Debris Basin Alternative and the No Action Alternative.

3.1.3.1 No Action Alternative

The No Action Alternative consists of no flood prevention improvements in the study area. No construction or permits would be required, nor would there be a need for on-going maintenance of flood prevention facilities; however, Santaquin would need to respond with real-time mitigation and clean-up actions should a flooding event occur, as was the case with the 2002 flooding. Santaquin has been developing a stormwater management plan and would continue to engage in planning activities to address potential flooding, including seeking coordination with FEMA and NRCS regarding watershed management.

The No Action Alternative does not meet the purpose and need for the project as it would not provide attenuation of flooding events nor prevent debris flow from damaging residential, commercial, and agricultural properties or public infrastructure.

While the No Action Alternative would not meet the purpose and need for the project, it is required under NEPA to be included in an environmental analysis as a baseline for which to compare impacts with the Proposed Alternative.

3.1.3.2. Debris Basins

This alternative analyzed constructing debris basins in six (6) different locations along the base of the eastern bench intended to contain the design flood and debris flows on-site and prevent damage to residential, commercial, and agricultural properties and public infrastructure See Figures 3-6 through 3-7.

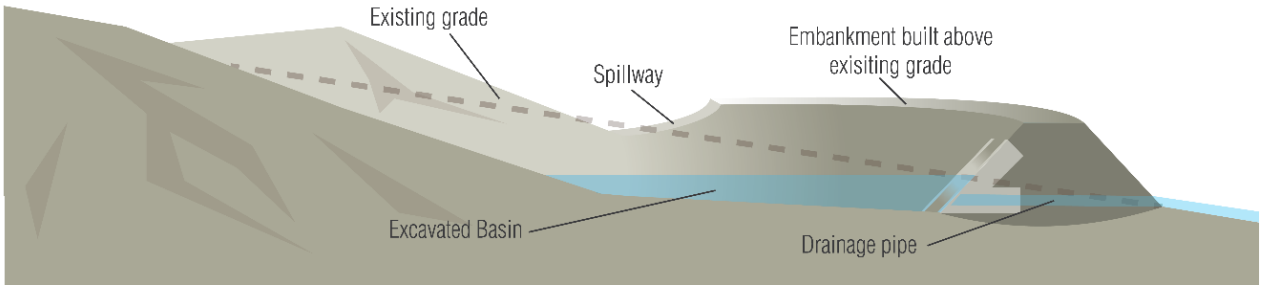


FIGURE 3-6. DEBRIS BASIN ILLUSTRATION

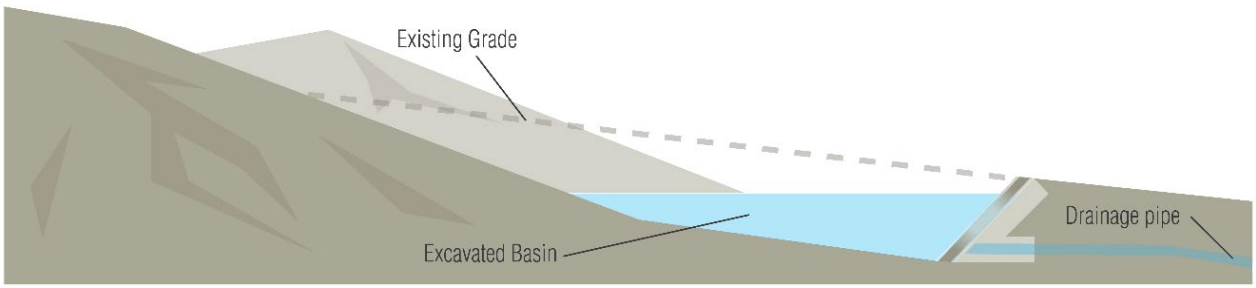


FIGURE 3-7. EXCAVATED DEBRIS BASIN ILLUSTRATION

The Debris Basin Alternative initially consisted of six (6) locations where debris basins were originally proposed. See Figure 3-8. Each site was analyzed for the best location, size and design for a debris basin. In order to do so, hydrologic modeling was completed to evaluate if the proposed action meets the purpose and need of the project. All hydrologic and hydraulic analysis was conducted in accordance with NRCS requirements and standards. Close coordination was ongoing during the technical development of the alternatives. For Sites 2 and 3, the proposed basins were combined into one debris basin that would contain the flooding/debris flows from both of those subwatersheds.

The Debris Basin Alternative includes five (5) separate debris basins at strategic locations associated with the drainage areas. All of the debris basins were designed to catch runoff and debris from flooding and debris flows from the drainages into debris basins that would be excavated into the hillsides. The debris basins would all have a principal spillway that would allow for a controlled release of water from the debris basins. All of the debris basins were designed with a 50-foot-wide concrete structural auxiliary spillway to allow excess water that is unable to be contained in the basin to spill into existing channels or into the normal floodplains that would be the pathway absent the basin. All of the basin would have an internal depth of 16.5 feet. Additional capacity for anticipated sediment volume up to a 25-year sediment life was included in the design. Sediment transport into reservoirs and debris basins is a major design consideration, since the volume displaced by the sediment reduces the capacity and design life of the basin, and its ability to control flood flows. Additional volume must be provided for sediment so that throughout its design life the basin will function as intended. To determine the required basin capacity, the sediment yield must be calculated.

These debris basins were designed to be below grade to the extent possible considering the terrain in order to reduce the risk of failure (which is higher with aboveground structures) and to blend in as much as possible with the existing hillsides to minimize impact on the natural landscape views. This design would also save on the cost of construction and maintenance.

This alternative was carried through the alternatives screening for detailed analysis since it would meet the purpose and need for the project since it would be able to contain the 50-year flood event and reduce the 100-year flood by 95%. See Appendix D for further information.

Two options were developed for the Debris Basin Alternative. The differences between Option A and B were related to the size and design of the debris basins, as well as the inclusion of an extensive pipe network. Both Option A and Option B met the technical requirements and goals of NRCS.

- Option A consisted of five debris basins for the six subwatersheds, with a new and extensive large-diameter pipe network extending several miles downstream. Water and debris would fill the debris basins and flow out into the new pipe network. Under Option A, the debris basins would completely hold the 25-year storm and would convey the 100-year storm through an extensive large diameter pipe network downstream of the debris basins. Flows in excess of the 1% chance storm would fill up the debris basins and then spill over the debris basins and flow in historic drainage paths. The pipe network would extend north through private property to a point approximately 10,500 feet (two miles) north of the Strawberry-Highline Canal, where a natural low channel exists.
- Option B consisted of five larger debris basins for the six subwatersheds designed to hold the 50-year storm, without a downstream pipe network. Once the volume of the each of the debris basins was exceeded, flooding and debris flows that could not be contained by the debris basins to spill into historic drainage paths via an outlet pipe.

City Council

The two options were presented to the Santaquin City Council and the Mayor on November 12, 2018. Both Option A and B would provide a benefit for Santaquin City; however, Option B provides a greater benefit for the cost. Moreover, the large diameter pipe network associated with Option A would require extensive maintenance efforts, right-of-way purchasing/coordination (for which Santaquin would be solely responsible), and potential downstream flood inundation problems. Santaquin expressed a preference for Option B since it provides a higher benefit to cost ratio, has less maintenance, and can store a larger volume of floodwater/debris in a centralized location.

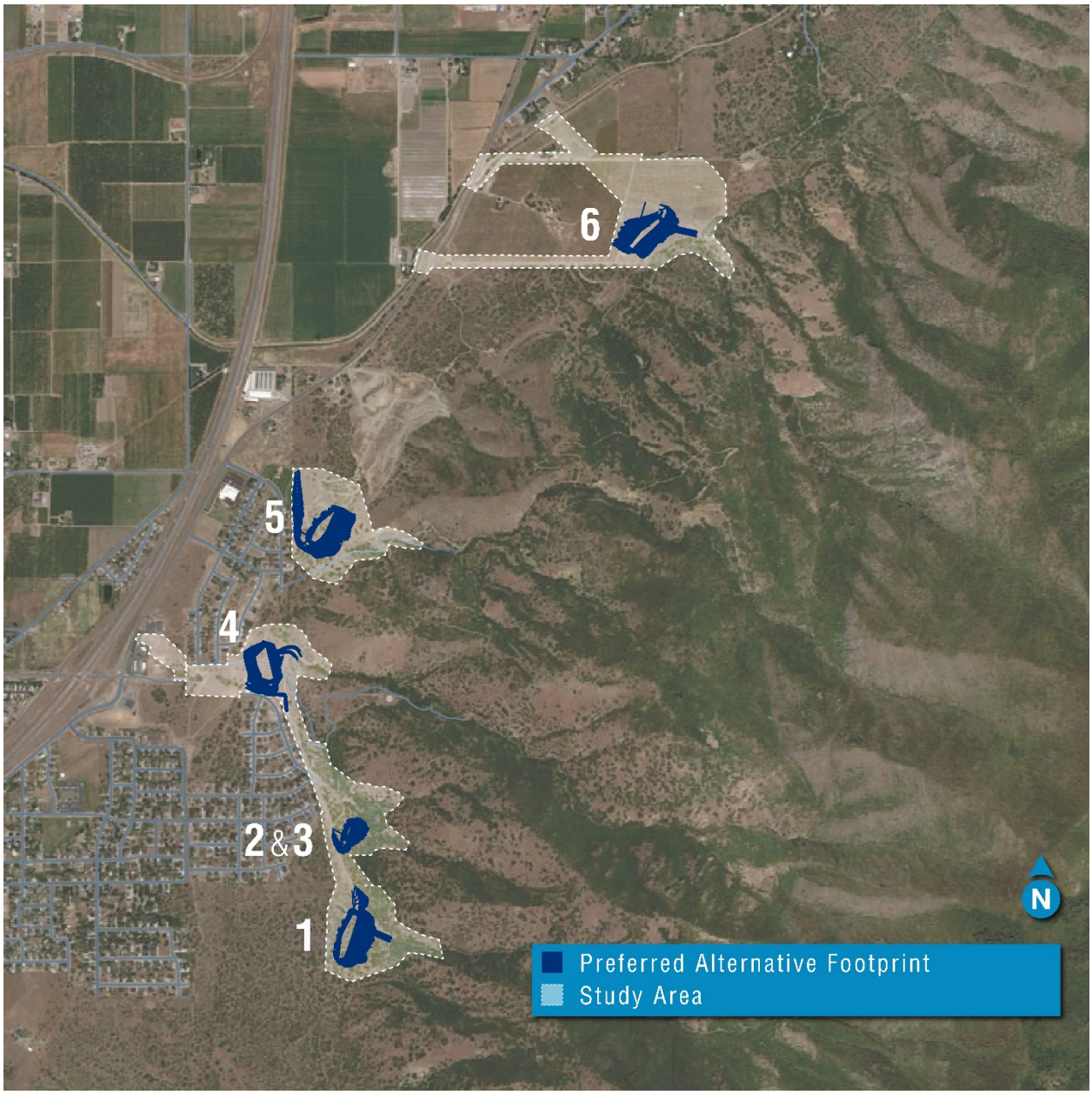


FIGURE 3-8. DEBRIS BASIN ALTERNATIVE OPTION B

Site 1

Site 1 consists of a below-grade debris basin with a concrete spillway that would direct excess water flows back to the existing channel. Floodwaters and debris flows from the drainage would be directed into the debris basin, with potential debris control structures on the input channel to limit debris entering the debris basin. The debris basin would be approximately 0.06 acres in size when complete and have a total volume of 27.15 acre-feet. See Figure 3-9.

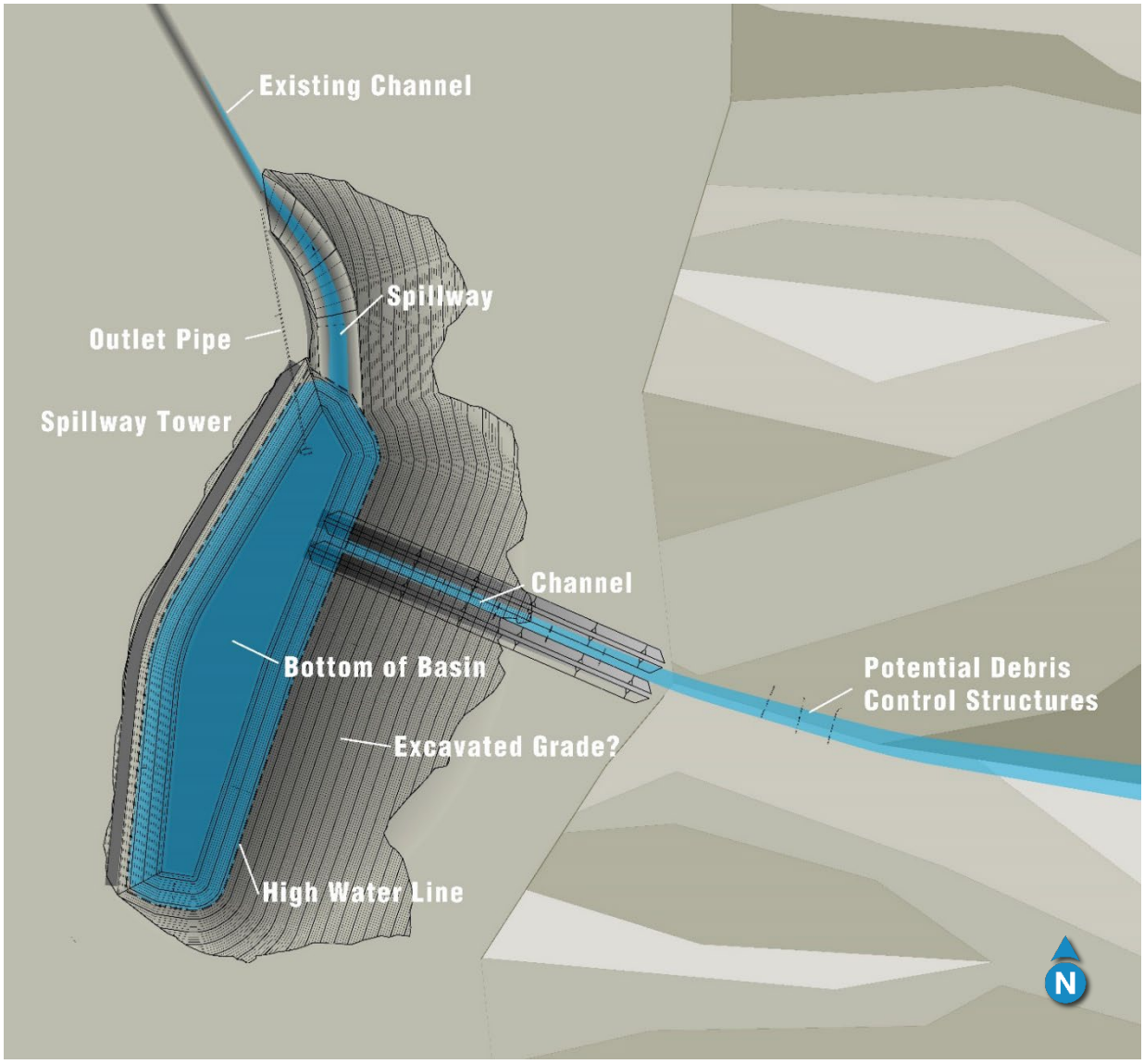


FIGURE 3-9. BASIN SITE 1

Sites 2 and 3

The debris basin for the combined Sites 2 and 3 consists of a below-grade debris basin with two channels from each of the two drainages to funnel flows into the debris basin and a concrete spillway that would allow excess water flows to exit the debris basin into the existing channel. The debris basin would be approximately 0.72 acres in size when complete and have a total volume of 4.25 acre-feet. See Figure 3-10.

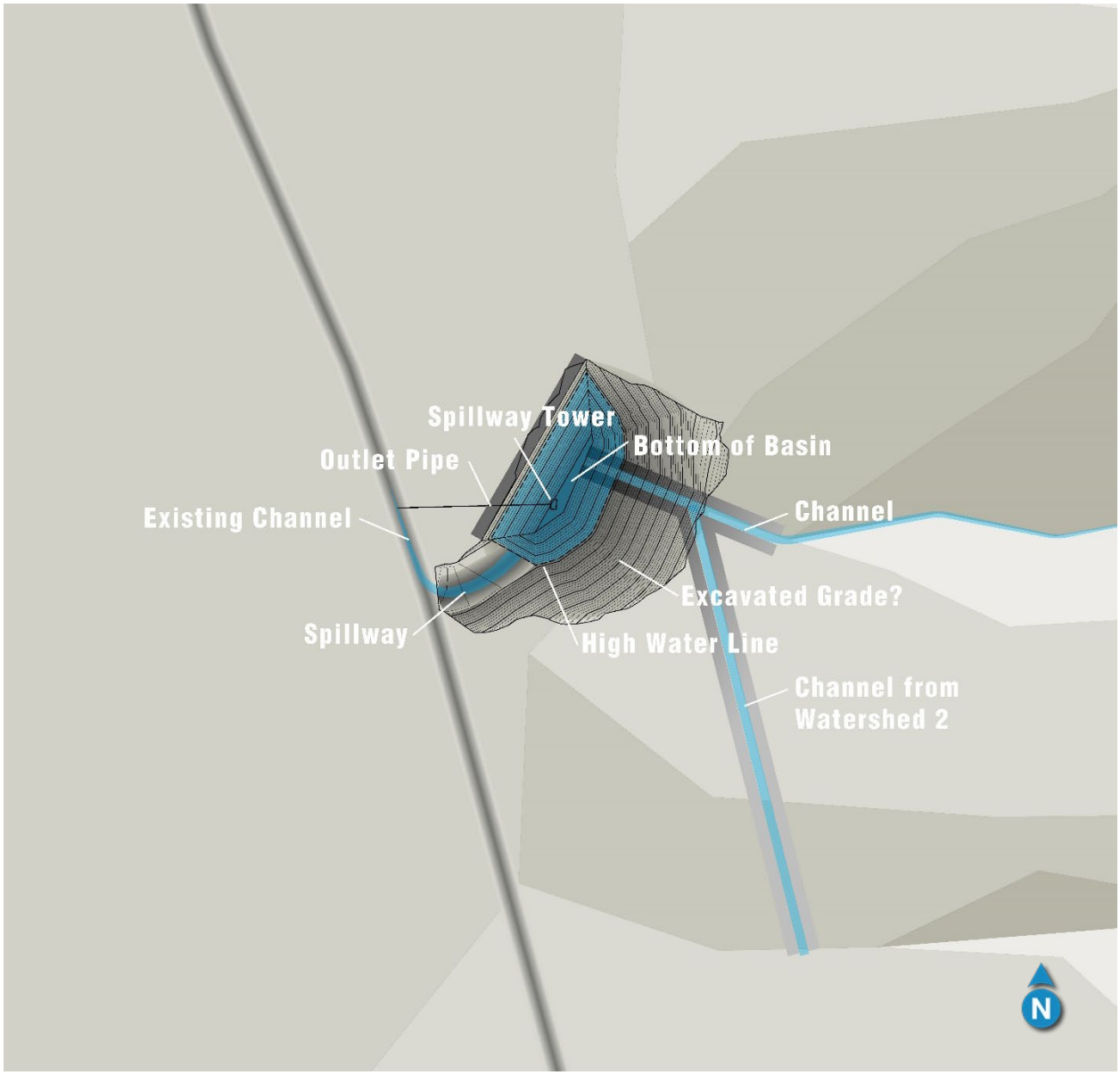


FIGURE 3-10. BASIN SITE 2 AND 3

Site 4

Site 4 consists of a debris basin that would be constructed mostly above-grade with a 20-foot embankment that would be built above the existing grade. It would direct flooding/debris flow from the drainage into the debris basin and would conduct excess flows to the existing channel via a concrete spillway. The debris basin would be approximately 2.88 acres in size when complete and have a total volume of 25.9 acre-feet. It would also have a maximum height of 19 feet above the existing grade. See Figure 3-11.

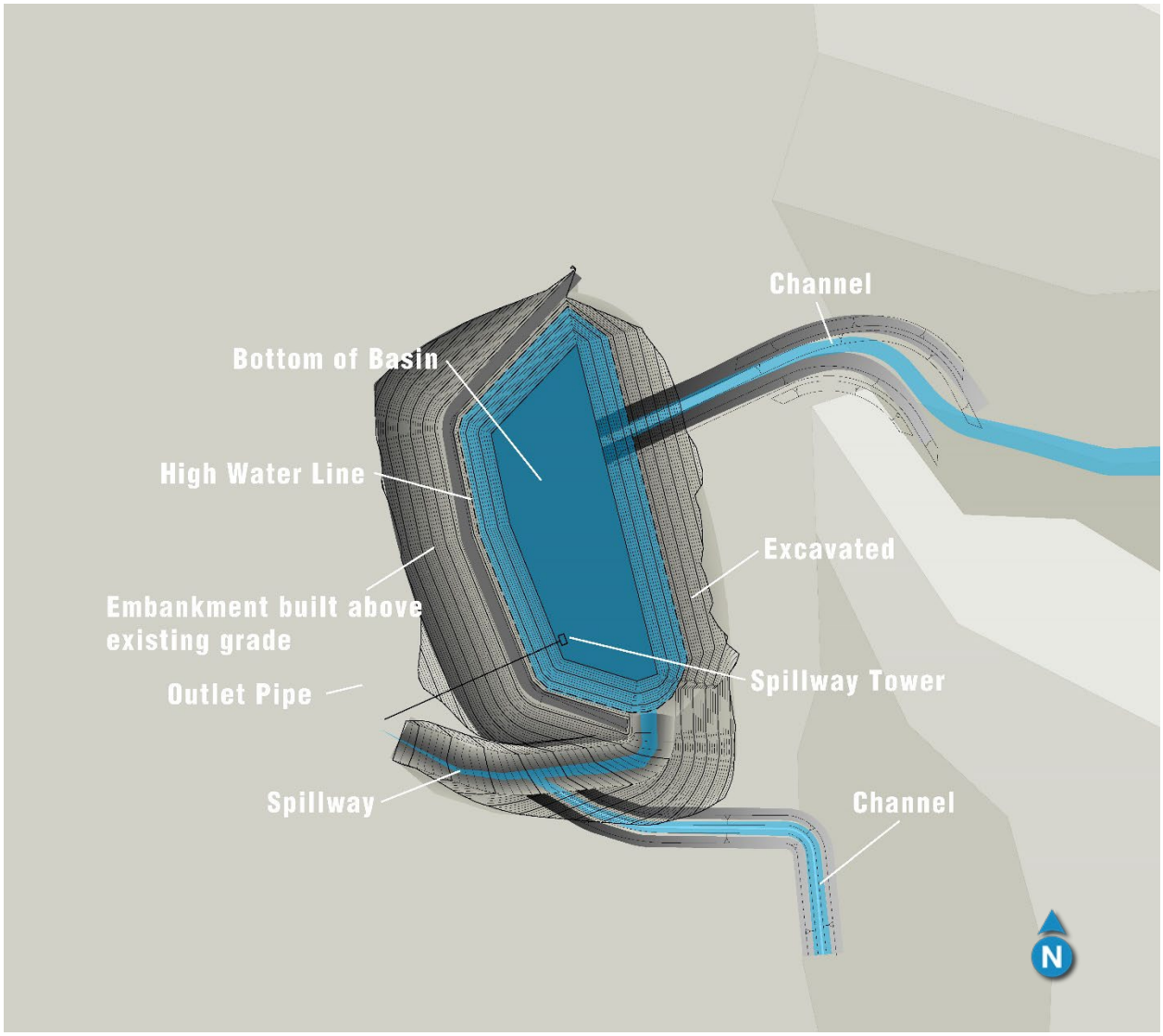


FIGURE 3-11. BASIN SITE 4

Site 5

Site 5 consists of a debris basin that would be constructed mostly below-grade. It would direct flooding/debris flow from the drainage into the debris basin and would conduct excess flows to the existing channel via a concrete spillway. The debris basin would be approximately 2.4 acres in size when complete and have a total volume of 20.8 acre-feet. See Figure 3-12.

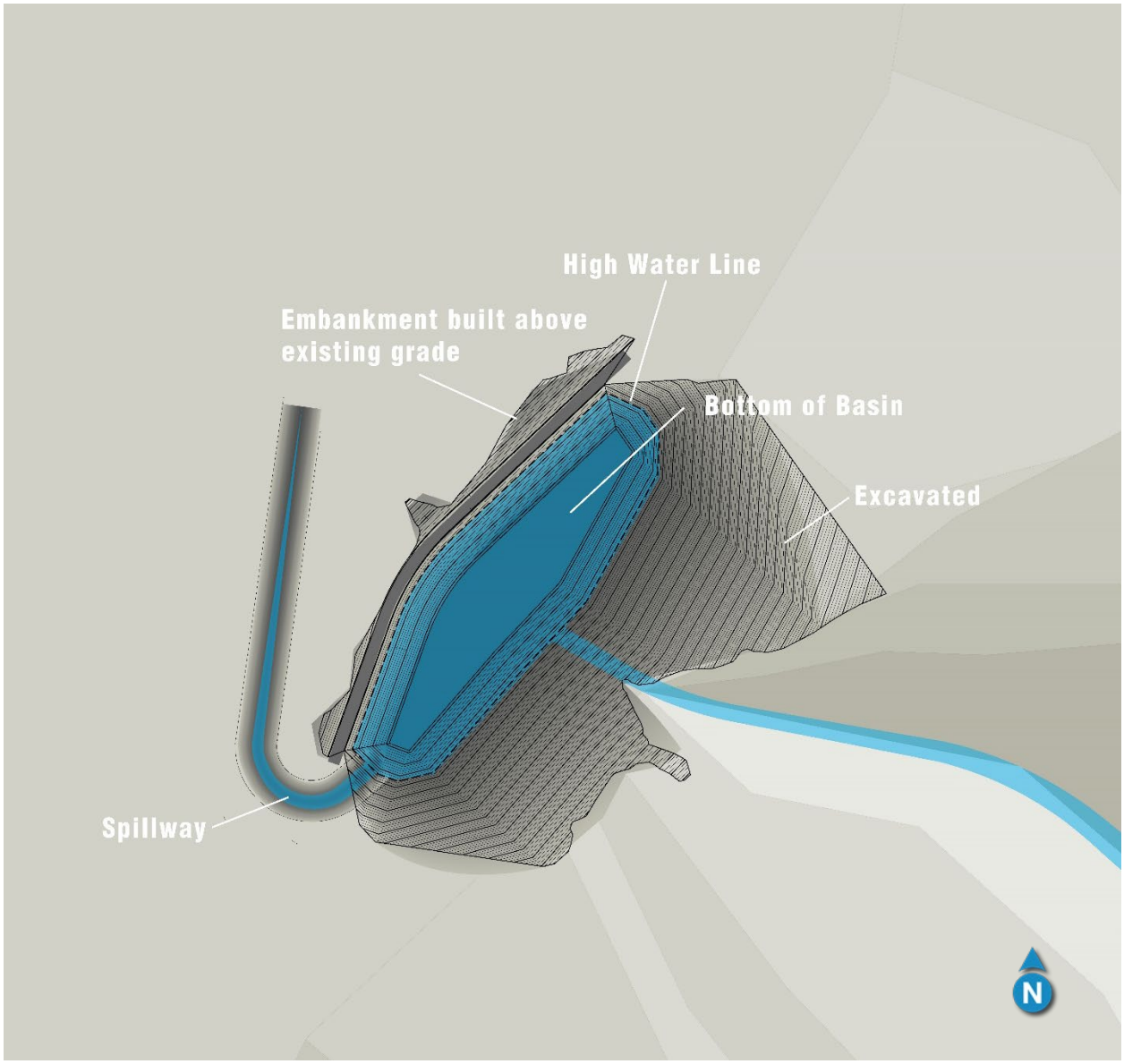


FIGURE 3-12. BASIN SITE 5

Site 6

Site 6 consists of a debris basin that would be constructed mostly above-grade with an 18-foot embankment that would be built above the existing grade. It would direct flooding/debris flow from the drainage into the debris basin and would conduct excess flows to the existing channel via a concrete spillway. The debris basin would be approximately 2.37 acres in size when complete and have a total volume of 18.6 acre-feet. It would also have a height of 23 feet above the existing grade. See Figure 3-13.

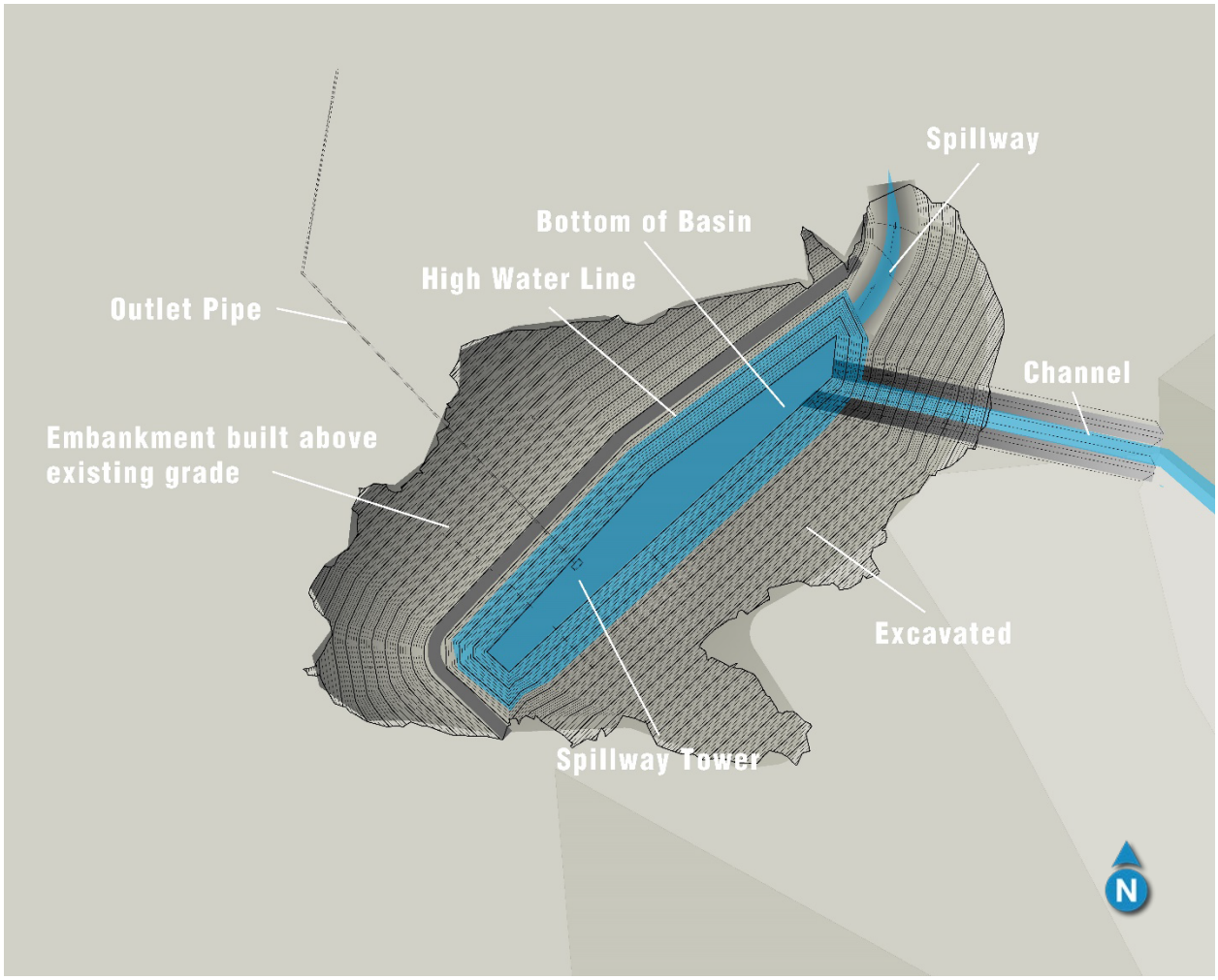


FIGURE 3-13. BASIN SITE 6

3.2 Summary and Comparison of Alternative Plans

The alternative proposed for consideration and analyzed in detail in this Plan-EA have been compared against each other to discern the merits and disadvantages of each alternative. This comparison of environmental, social, and economic effects is summarized in Table 3-1.

TABLE 3-1. SUMMARY AND COMPARISON OF ALTERNATIVES

Resource Concern/Item	No Action	Debris Basin Alternative Option B
Soils		
Soils and Geologic Characteristics	No impacts to soils or geologic characteristics.	Proposed debris basins would require extensive excavation since they would be mostly below grade. Temporary impacts to soils due to construction activities.
Upland Erosion	Runoff from storm events will naturally continue to erode upland materials with a risk of transporting those materials downstream.	Debris Basin Alternative Option B addresses impacts from upland erosion events on Santaquin by providing measures to mitigate fire-related and storm-related erosion events.
Sedimentation	Existing conditions regarding sedimentation would remain unaltered.	The Debris Basin Alternative Option B would contain floodwater and debris runoff in the proposed debris basins, which would result in an increase in sedimentation in the new debris basins (to be addressed with ongoing O&M activities).
Water Resources		
Hydrology and Surface Water	Existing hydrologic conditions and trends in the study area would continue unaltered.	Storm water runoff from the drainages above the debris basins would be captured in the debris basins and safely released. Minor, long-term impacts to existing hydrologic conditions and trends due to seepage.

Resource Concern/Item	No Action	Debris Basin Alternative Option B
Floodplain Management	Affected areas within the City of Santaquin do not currently have special flood hazard areas nor areas of special mudslide hazard designated by FEMA and Santaquin is not currently involved in on-going studies regarding potential for designation of future areas of special flood hazard and mudslide hazards. However, Santaquin would continue to engage in planning activities to address potential flooding, including seeking coordination with FEMA and NRCS regarding watershed management.	Proposed debris basins would be constructed for flood prevention purposes. Modeling performed for the 50-year, the 100-year and the 500-year storm events shows that the project would protect 321 acres, 257 acres, and 184 acres, respectively.
Wetlands/Riparian Areas	No impacts.	Debris Basin Alternative Option B would have no impacts to WOTUS in the study area
Air		
Air Quality	No changes to existing air quality in the study area. Maintenance activities would result in temporary impacts, including vehicle and equipment emissions and dust entrainment.	Construction activities would generate emissions and fugitive dust during construction. These impacts to air quality would be temporary in nature and localized to the construction area. Maintenance activities would result in temporary impacts, including vehicle and equipment emissions and dust entrainment.
Vegetation		
Vegetation Communities/Habitat	Existing conditions and trends would continue as they currently exist.	Debris Basin Alternative Option B would require temporary ground disturbance within the study area and the removal of vegetation due to the excavation for the debris basins and the construction of the earthen dams, concrete spillways, and other associated features.
Special Status Species	No impact.	The Debris Basin Alternative Option B would have No Effect on federally listed species.
Invasive Species	No impact.	Potential for introduction and spread of invasive species during construction.
Wildlife		

Resource Concern/Item	No Action	Debris Basin Alternative Option B
Wildlife Communities	Existing conditions and trends would continue unaffected.	The Debris Basin Alternative Option B would have temporary impacts to wildlife and their habitats as a result of higher than usual noise levels, proximity of construction equipment, and other construction related activities.
Special Status Species	Existing conditions and trends would continue unaffected.	The Debris Basin Alternative Option B would have No Effect on federally listed wildlife species in the study area.
Human Environment		
Cultural and Historic Resources	No impact.	NRCS has made a No Historic Properties Affected determination for the project since the Debris Basin Alternative Option B would have no impact on eligible cultural resources.
Land Use	No land acquisition required.	The Debris Basin Alternative Option B would require land acquisition by Santaquin.
Scenic Beauty/Visual Resources	No impact.	The Debris Basin Alternative Option B would introduce new features into the landscape, as well as having temporary impacts during construction due to construction-related activities.
Public Health and Safety	The potential for future flooding and debris flow events would continue to exist unmitigated, including the risk of damage to residential, agricultural, and commercial properties and to public infrastructure.	The Debris Basin Alternative Option B would greatly reduce potential flooding and debris flows from the east bench and would provide a substantial reduction in the risk of damage to people and properties. Further, it will allow for the development and protection of certain real property that would otherwise have been at risk of damage due to flooding events and debris flows off the east bench, which would contribute to the growth of Santaquin.

Resource Concern/Item	No Action	Debris Basin Alternative Option B
Socioeconomics	Existing socioeconomic conditions in the study area would continue into the future. The potential for future flooding events and debris flow from off the east bench would continue to exist unmitigated, including the risk of damage to residential, agricultural, and commercial properties and to public infrastructure.	The Debris Basin Alternative Option B would greatly reduce potential flooding and debris flows from the east bench and would provide a substantial reduction in the risk of damage to people and properties. Further, it will allow for the development and protection of certain real property that would otherwise have been at risk of damage due to flooding events and debris flows off the east bench, which would contribute to the growth of Santaquin.
NED		
Installation Costs	$0	$12,279,633
Annual Costs	$0	$397,000
Average Annual Damage Reduction Benefits	$0	$745,300

Chapter 4: Environmental Consequences

4.1 Soils

4.1.1 Soils and Geologic Characteristics

No Action Alternative

Under the No Action Alternative, there would be no construction activities and therefore there would be no impacts to soil composition or consistency or other geologic resources in the study area. Soil erosion potential would continue to be influenced by the presence or absence of vegetation due to USFS-management decisions for the upland areas along Santaquin's east bench.

Debris Basin Alternative Option B

The Debris Basin Alternative Option B would have an impact on soils in the study area during construction of the debris basins since they would be mostly below grade and would require extensive excavation. The project would not impact soil composition or otherwise impact geologic resources in the study area. The potential exists for impacts on the proposed flood prevention measures as a result of seismic activity from the fault lines in the proposed area, although the likelihood for seismic activity is low.

Mitigation

Best Management Practices (BMPs) would be implemented to reduce and mitigate impacts to soils during construction, including but not limited to:

- During construction, topsoil would be saved and then redistributed after completion of construction activities.
- Straw wattles, silt curtains, cofferdams, dikes, straw bales, or other suitable erosion control measures would be used to minimize soil erosion and prevent soil erosion from entering water bodies during construction.
- Disturbed areas would be smoothed, shaped, contoured and reseeded to as near their pre-project conditions as practicable.
- For project-specific components that would disturb an acre of soil or more, the contractor would submit a Stormwater Pollution Prevention Plan (SWPPP) to the Utah Division of Water Quality (UDWQ) for approval to reduce potential impacts of sedimentation on water bodies.
- Contractors would be required to follow standard BMP and compliance measures to quickly contain any leaks or spills occurring from construction vehicles or activities and a spill response plan would be prepared in advance of construction by the contractors for areas of work where spilled contaminants could flow into water bodies.

Cumulative Impacts

Additional construction and development of currently undeveloped land in the vicinity of the study area would contribute to impacts to soils as a result of the Debris Basin Alternative Option B. Such impacts would need to be considered in the planning and design stages of future construction projects in the area.

Under the No Action Alternative, there would be no construction activities and therefore, the project would not contribute to cumulative impacts on soils in the study area.

4.1.2 Upland Erosion

No Action Alternative

Under the No Action Alternative, there would be no construction activities and therefore there would be no impacts related to upland erosion in the study area and no temporary impacts related to

construction activities. Runoff from storm events will naturally continue to erode upland materials with a risk of transporting those materials downstream.

Debris Basin Alternative Option B

The proposed action is intended to address upland erosion issues during identified storm events. While the proposed action would not directly address existing or future upland erosion conditions (which would be the subject of USFS-management activities on the Uinta-Wasatch National Forest), it would address impacts from upland erosion events on Santaquin by providing measures to address fire-related and storm-related erosion events.

Mitigation

No mitigation measures required due to a lack of impacts on upland erosion conditions.

Cumulative Impacts

For the Debris Basin Alternative Option B, USFS-management activities on the Uinta-Wasatch National Forest would contribute to cumulative effects on existing and future upland erosion conditions in the vicinity of the study area due to fire-related and wildlife management prescriptions for the National Forest.

Under the No Action Alternative, there would be no construction activities and therefore, the project would not contribute to cumulative impacts for upland erosion in the study area.

4.1.3 Sedimentation

No Action Alternative

Under the No Action Alternative, there would be no construction activities and therefore there would be no temporary impacts related to construction activities. Existing conditions regarding sedimentation would remain unaltered.

Debris Basin Alternative Option B

The Debris Basin Alternative Option B would contain floodwater and debris runoff in the proposed debris basins, which would result in an increase in sedimentation in the new debris basins that would need to be addressed with ongoing operation and maintenance (O&M) activities (estimated at approximately $11,090 per year and assuming that the basins would be cleaned out once every five years at a unit cost of $7 per cubic yard for excavation and disposal).

Mitigation

Best Management Practices (BMPs) would be implemented to reduce and mitigate impacts of sedimentation during construction, including but not limited to:

- During construction, topsoil would be saved and then redistributed after completion of construction activities.
- Straw wattles, silt curtains, cofferdams, dikes, straw bales, or other suitable erosion control measures would be used to minimize soil erosion and prevent soil erosion from entering water bodies during construction.
- Disturbed areas would be smoothed, shaped, contoured and reseeded to as near their pre-project conditions as practicable.
- For project-specific components that would disturb an acre of soil or more, the contractor would submit a Stormwater Pollution Prevention Plan (SWPPP) to the Utah Division of Water Quality (UDWQ) for approval to reduce potential impacts of sedimentation on water bodies.

Cumulative Impacts

For the Debris Basin Alternative Option B, USFS-management activities on the Uinta-Wasatch National Forest would contribute to cumulative effects on existing and future upland erosion conditions in the vicinity of the study area due to fire-related and wildlife management prescriptions for the National Forest.

Under the No Action Alternative, there would be no construction activities and therefore, the project would not contribute to cumulative impacts for sedimentation in the study area.

4.1.4 Prime and Unique Farmland

No Action Alternative

Under the No Action Alternative, there would be no construction activities and therefore there would be no impacts related to prime and unique farmland. Existing conditions would remain unaltered.

Debris Basin Alternative Option B

The Debris Basin Alternative Option B would have no impacts on Prime or Unique Farmland due to the nature of the project as providing temporary water storage facilities. Further, all of the soils designated as farmland are either within the Santaquin Urban Cluster area or within Santaquin's city limits. The project would require approximately 8.7 acres of land that is currently used for agricultural production from an existing orchard for the construction of Basin 6A.

Mitigation

Mitigation for impacts to agricultural land will include the following:

- Needed land acquisition will be acquired in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended.
- Access to and use of the farmland in question will be maintained during construction.
- Any potential effects of the project to water delivery or irrigation systems associated with agricultural areas will be mitigated. These facilities will be relocated and reconstructed to maintain the continuity and use of the existing systems.

Cumulative Impacts

For the Debris Basin Alternative Option B, the project would protect the existing orchard from flooding and debris events, thereby making conditions better for existing and future agricultural activities on the farmland in question.

Under the No Action Alternative, there would be no construction activities and therefore, the project would not contribute to cumulative impacts on prime and unique farmlands in the study area.

4.2 Water Resources

4.2.1 Hydrology and Surface Waters

No Action Alternative

Under the No Action Alternative, existing hydrologic conditions and trends in the study area would continue unaltered.

Debris Basin Alternative Option B

During construction, there is the potential for temporary impacts to water quality due to sedimentation. However, BMPs would be implemented during construction to protect surface water from the effects of erosion. These measures would be outlined in a Storm Water Pollution Protection Plan (SWPPP). Minimal and temporary impacts to surface water quality are expected, if any.

In the long-term, the proposed action would have minor, beneficial impacts on the hydrology of the study area due to the seepage of floodwaters into the ground at the various debris basin locations. The level of this impact would be dependent on the severity and frequency of flooding events. Storm water runoff from the drainages above the debris basins for the 50-year flood (with a 95% containment of the 100-year flood) will be captured in the debris basins and safely released.

Mitigation

BMPs would be implemented to protect surface water quality from sedimentation and pollutants entering the waterways during construction, including but not limited to:

- For project-specific components that would disturb an acre of soil or more, the contractor would submit a SWPPP to UDWQ for approval to reduce potential impacts of sedimentation on water bodies.
- Straw wattles, silt curtains, cofferdams, dikes, straw bales, or other suitable erosion control measures would be used to minimize soil erosion and prevent soil erosion from entering water bodies during construction.
- Fuel, oil, hydraulic fluid, lubricants, and other petrochemicals will not be stored within 200 feet of waterway areas and will have a secondary containment system to prevent spills. Appropriate spill clean-up materials, such as booms and absorbent pads, will be available on-site at all times during construction.
- Work crews would carry spill cleanup kits, and in times of burn bans or wildfire concerns, each crew would have a fire suppression kit.
- Equipment that leaks while working on the Project will not be allowed to continue operating until the leak is fixed. Refueling will occur a minimum of 100 feet from any wetland and riparian areas.
- Concrete clean-up operations (if needed) will utilize a dedicated concrete wash-out pit in an upland location. The concrete remnants in the wash-out pit will be fully removed and legally disposed of off-site upon completion of all concrete operations, or as needed for maintenance.

Cumulative Impacts

Through the use of BMPs during construction, the Debris Basin Alternative Option B is not expected to contribute significantly to water quality issues in the study area. Additional water conservation measures that may be implemented in connection with other future water projects in the area would contribute to the overall conservation of water resources.

Under the No Action Alternative, there would be no construction activities and therefore, the project would not contribute to cumulative impacts on water resources in the study area.

4.2.2 Floodplain Management

No Action Alternative

Under the No Action Alternative, there would be no construction activities and therefore, no changes to the existing floodplains in the study area. Santaquin is not mapped for Federal Emergency Management Agency (FEMA) flood insurance. Affected areas within the City of Santaquin do not currently have special flood hazard areas nor areas of special mudslide hazard designated by FEMA and Santaquin is not currently involved in on-going studies regarding potential for designation of future areas of special flood hazard and mudslide hazards. However, Santaquin has been developing a stormwater management plan and would continue to engage in planning activities to address potential flooding, including seeking coordination with FEMA and NRCS regarding watershed management.

Debris Basin Alternative Option B

The debris basins would be constructed for flood prevention purposes. Modeling performed for the 50-year, the 100-year and the 500-year storm events shows that the project would protect 321 acres, 257 acres, and 184 acres, respectively. The potential effects of induced flooding have been adequately analyzed and incorporated into the design of the debris basins.

Mitigation

No compensatory mitigation is required.

Cumulative Impacts

Under the Debris Basin Alternative Option B, the inclusion of the debris basins and ongoing O&M for those debris basins, would contribute to flood prevention in the area. The spillways for the debris basins would conduct excess flows into the same floodplains and historic drainage paths that currently exist and would not result in induced flooding into areas that did not previously experience flooding events. Therefore, there would be no adverse cumulative impacts to floodplains in the study area.

Under the No Action Alternative, there would be no construction activities and therefore, the project would not contribute to cumulative impacts to floodplains in the study area.

4.2.3 Groundwater

No Action Alternative

Under the No Action Alternative, existing conditions and trends in the study area in relation to groundwater resources would continue unaltered.

Debris Basin Alternative Option B

No groundwater resources would be extracted or consumptively used as part of this project. A portion of the ponded water in the debris basins after storm events will percolate into the upper soil profile and some percentage may go deeper until accumulated sediment effectively seals percolation seams in the debris basins.

Mitigation

No mitigation measures are required for the minor impacts to groundwater.

Cumulative Impacts

Under the Debris Basin Alternative Option B, water contained in the debris basins as a result of storm events and other such water collection would seep into the ground below and around the debris basins and would contribute to groundwater resources in the project area. The immediate project area is not necessarily a groundwater recharge area, but it may provide additional water resources.

Under the No Action Alternative, there would be no construction activities and therefore, the project would not contribute to cumulative impacts on groundwater in the study area.

4.2.4 Waters of the U.S.

No Action Alternative

Under the No Action Alternative, there would be no construction activities and therefore, no impacts to waters of the U.S. (WOTUS) in the study area.

Debris Basin Alternative Option B

The Debris Basin Alternative Option B would have no impacts to WOTUS in the study area. The project would avoid impacts to the wetland area that was identified during the wetlands survey conducted as part of this project (referenced in Chapter 2) and would not impact any wetlands associated with the Strawberry Highline Canal. See Section 2.2.4 and Figure 4-1.

FIGURE 4-1 THE DEBRIS BASIN ALTERNATIVE OPTION B AND WETLAND RESOURCES IN THE PROJECT AREA.

Cumulative Impacts

Additional water conservation measures that may be implemented in connection with other future water projects in the area would contribute to the overall efficient use of water resources.

Under the No Action Alternative, there would be no construction activities and therefore, the project would not contribute to cumulative impacts to WOTUS in the study area.

4.3 Air

No Action Alternative

The No Action Alternative would result in no changes to existing air quality in the study area. Maintenance activities would continue to result in temporary impacts, including vehicle and equipment emissions and dust entrainment.

Debris Basin Alternative Option B

The Debris Basin Alternative Option B would require the use of vehicles and heavy equipment that would generate emissions and fugitive dust during construction. These impacts to air quality would be temporary in nature and would be localized to the construction area. The project's construction emissions would be relatively low and of a short duration. On any given day of construction, the estimated PM_{10} and $PM_{2.5}$ emissions would not exceed the general conformity applicability threshold of 100 tons per year; therefore, the general conformity regulation does not apply to this project and no additional air quality analysis is required.

In regards to operation and maintenance (O&M), such activities would be isolated events with minimal, if any, impact on air quality.

Mitigation

Due to the potential for fugitive dust emissions during construction, the contractor would prepare and comply with a fugitive dust plan.

Cumulative Impacts

Cumulative effects to regional or local air quality may result from future construction associated with increased development. Emissions associated with proposed construction activities could have short-term adverse, cumulative impacts if they occur at the same time and in the same area as the Debris Basin Alternative Option B. However, construction activities would be localized and short-term. In addition, BMPs would be implemented to reduce construction emissions. There could be short-term, minor impacts on local and regional air quality.

Under the No Action Alternative, there would be no construction activities and therefore, the project would not contribute to cumulative impacts on air quality in the study area.

4.4 Vegetation

4.4.1 Vegetation Communities and Habitat

No Action Alternative

Under the No Action Alternative, there would be no construction activities and therefore there would be no impacts to vegetation in the study area. Conditions and trends would continue as they currently exist.

Debris Basin Alternative Option B

Effects on vegetation communities and habitat resulting from implementation of the proposed improvements would be both direct and indirect, and occur in both the short- and long-term. The Debris Basin Alternative Option B would require temporary ground disturbance within the study area and the removal of vegetation due to the excavation for the debris basins and the construction of the earthen dams, concrete spillways, and other associated features. Avoidance and minimization measures will be implemented to reduce impacts to vegetation.

Mitigation

To mitigate for vegetation impacts, the following BMPs would be implemented to reduce negative consequences on vegetation communities and habitat:

- Ground disturbances shall be limited to only those areas necessary to safely implement the Debris Basin Alternative Option B.
- Vegetation removal shall be confined to the smallest portion of the Debris Basin Alternative Option B area necessary for completion of the work.
- Construction limits shall be clearly flagged onsite to avoid unnecessary plant loss or ground disturbance.
- Prior to construction, vegetative material shall be removed by mowing or chopping, and either hauled to a proposed staging area to be burned or chipped, or chipped and mulched onsite. Stumps shall be grubbed and hauled to a proposed staging area to be burned.
- Topsoil shall be stockpiled and then redistributed after completion of construction activities.
- Straw wattles, silt curtains, cofferdams, dikes, straw bales, or other suitable erosion control measures shall be used at the edges of ground disturbance to minimize soil erosion and prevent soil erosion from entering water bodies during construction.
- Following construction, all disturbed areas shall be smoothed, shaped, contoured and reseeded to as near to their pre-project conditions as practicable.
- Seeding shall occur at appropriate times with weed-free seed mixes per NRCS specifications, as appropriate.
- Weed control shall be implemented by the project proponent to county standards (at a minimum).

Cumulative Impacts

In the long term, the construction of the debris basins would allow for future development of properties below the proposed locations of the debris basins that were previously not feasible due to the risk of damage from flooding and debris flows, which in turn could impact vegetation communities on land that is currently undeveloped.

Under the No Action Alternative, there would be no construction activities and therefore, no contribution to cumulative impacts on vegetation communities in the study area.

4.4.2 Special Status Species

No Action Alternative

Under the No Action Alternative, no construction activities would occur. Existing conditions in the study area would continue to occur unaffected. The No Action Alternative would have no effect on federally listed T&E species.

Debris Basin Alternative Option B

Threatened and Endangered Species

The Debris Basin Alternative Option B would have **No Effect** on either Ute Ladies'-tresses or Jones cycladenia because there is no suitable habitat, they are not known to occur, and they are not expected to be present in the study area.

State Sensitive Species

As discussed above, the Debris Basin Alternative Option B would not have an impact on Ute Ladies'-tresses because there is no suitable habitat, they are not known to occur, and they are not expected to be present in the study area. No other state-sensitive plant species were identified as potentially being present in the study area.

Mitigation

The following BMPs would be implemented to reduce negative consequences on special status plants:

- Ground disturbances shall be limited to only those areas necessary to safely implement the Debris Basin Alternative Option B.
- Vegetation removal shall be confined to the smallest portion of the study area necessary for completion of the work.
- Construction limits shall be flagged onsite to avoid disturbing ground outside areas that have received special status plant clearance.
- If special status plants are identified in pre-construction surveys in or near the construction corridor, weed management strategies shall prioritize the protection of special status plants.
- Ensure that project staff and contractors working on site are aware of and can identify special status plant species with potential to occur in the project footprint and stop work if a special status plant species is discovered in the project footprint and notify the project manager.

Cumulative Impacts

The Debris Basin Alternative Option B is not anticipated to result in a substantial contribution to cumulative area-wide impacts on population trends of special status plants. Surveys would be conducted for special status plants in appropriate habitat within and near the footprint of planned ground disturbances. Any anticipated negative impacts to special status plants would be eliminated by design features, regulatory compliance measures, and BMPs described throughout this Plan-EA.

Under the No Action Alternative, there would be no construction activities and, therefore, no contribution to the cumulative impact on special status plants in the study area.

4.4.3 Invasive Species

No Action Alternative

Under the No Action Alternative, there would be no construction activities and therefore there would be less opportunity for the introduction and/or spread of invasive species in the study area.

Debris Basin Alternative Option B

The Debris Basin Alternative Option B would put the study area at risk for future invasion of noxious weeds and invasive plants due to construction activities. BMPs would be implemented to minimize the short-term impacts associated with construction activities.

Mitigation

To mitigate for vegetation impacts, reseeding and revegetation utilizing native species will be performed as a part of the Debris Basin Alternative Option B. Best Management Practices would be implemented during construction to protect the integrity of the plant communities in the area and to help prevent introduction of noxious and invasive plant species, which would include:

- Ground disturbances shall be limited to only those areas necessary to safely implement the Debris Basin Alternative Option B.
- Construction limits shall be clearly flagged onsite to avoid unnecessary ground disturbance.
- All equipment shall be cleaned before it is brought to the construction area, to minimize transport of new weed species to the construction area.
- All equipment shall be cleaned before it is transported to another job site, to avoid introducing weed species from the construction area to another job site.
- Straw wattles, straw bales, offsite mulch and other erosion control materials shall be free of weeds and weed seed.
- Revegetation of construction sites shall occur as soon as practicable following construction.
- Seed mixes used for revegetation shall be certified noxious weed-free seed mixes approved by NRCS.

- Weed control measures shall be implemented to county standards (at a minimum).

Cumulative Impacts

Through the use of BMPs and continued weed management programs of the project proponents, the Debris Basin Alternative Option B is not expected to contribute significantly to the cumulative spread of invasive species in the study area.

Under the No Action Alternative, there would be no construction activities and therefore, no contribution to cumulative impacts on invasive species in the in the study area.

4.5 Wildlife

4.5.1 Wildlife Communities

No Action Alternative

Under the No Action Alternative, there would be no construction activities and therefore there would be no impacts to wildlife that may be present in the study area. Existing conditions in the study area would continue to occur unaffected. In the event of future flooding and debris flow events, there would be temporary impacts to wildlife habitat due to soil erosion and vegetation loss.

Debris Basin Alternative Option B

During construction, there may be temporary impacts to wildlife and their habitats as a result of higher than usual noise levels, proximity of construction equipment, and other construction related activities. Direct impacts to small animals, especially burrowing mammals, amphibians, and reptiles, could include mortality or displacement during construction activities, and stress from human presence and construction noise. Small animal species may experience localized reduced populations in direct proportion to the amount of habitat disturbed. Restricting ground disturbance to the smallest practical footprint for individual project components would reduce the direct loss of small burrowing animals and temporal loss of their habitat. Once construction of the Debris Basin Alternative Option B is finished, the habitat conditions in the study area would be very similar to existing conditions and would not diminish the ability of wildlife species to frequent the study area.

Short-term direct impacts to migratory birds would include disturbance and displacement during construction activities. Wintering or migrating birds are not expected to be measurably affected by construction disturbance or displacement because they have the flexibility to move away from disturbances to other suitable areas.

Mitigation

The following BMPs would be implemented to reduce negative consequences on wildlife:

- Ground disturbances shall be limited to only those areas necessary to safely implement the Debris Basin Alternative Option B.
- For project activities involving vegetation disturbance that would occur during the nesting season, surveys for nesting birds would be conducted before vegetation-disturbing activities could begin, to the extent practicable. Nesting raptor surveys would be conducted as necessary to provide clearance for construction during raptor nesting season.

Cumulative Impacts

The Debris Basin Alternative Option B would not be expected to contribute to cumulative impacts on wildlife. Impacts from the Debris Basin Alternative Option B on wildlife would be negligible to minor.

Under the No Action Alternative, there would be no construction activities and therefore, no contribution to the cumulative impact on wildlife communities in the in the study area.

4.5.2 Special Status Species

No Action Alternative

Under the No Action Alternative, there would be no construction activities and therefore there would be no impacts to special status species that may be present in the study area.

Debris Basin Alternative Option B

Threatened and Endangered Species

The Debris Basin Alternative Option B would have No Effect on the Canada lynx, the yellow-billed cuckoo, or the June sucker or on any critical habitat for said species because there is no suitable habitat and they are not known to occur, nor are they expected to be present in the study area.

State Sensitive Species

Table 4-1 lists the potential impacts on state sensitive wildlife species.

TABLE 4-1. IMPACTS ON STATE SENSITIVE WILDLIFE SPECIES

Species	Impact
Mammals	
Brown (Grizzly) Bear *Ursus arctos*	The project would have **no impact** on this species due to it having been extirpated from Utah.
Fringed Myotis *Myotis thysanodes*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area.
Kit fox *Vulpes macrotis*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area.
Spotted bat *Euderma maculatum*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area.
Townsend's big-eared bat *Corynorhinus townsendii*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area.
Western red bat *Lasiurus blossevillii*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area (very rare in Utah).
White-tailed prairie dog *Cynomys leucurus*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area (occur primarily in the Uintah Basin and northern portion of Colorado Plateau).
Fish	
Bluehead sucker *Catostomus discobolus*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area.
Bonneville cutthroat trout *Oncorhynchus clarkia utah*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area.
Colorado River cutthroat trout *Oncorhynchus clarkia pleuriticus*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area.
Least chub *Iotichthys phlegethontis*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area.
Roundtail chub *Gila robusta*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area.
Southern leatherside chub *Lepidomeda aliciae*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area.
Reptiles	
Smooth greensnake *Opheodrys vernalis*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area (rarely observed in Utah).

Species	Impact
Amphibians	
Columbia spotted frog *Rana luteiventris*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area.
Western toad *Bufo anazyrus*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area.
Birds	
American three-toed woodpecker *Picoides dorsalis*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area.
American white pelican *Pelecanus erythrorhynchos*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area (Gunnison Island only colonial nesting site in Utah)
Bald eagle *Haliaeetus leucocephalus*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area.
Bobolink *Dolichonyx oryzivorus*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area.
Burrowing owl *Athene cunicularia*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area.
Ferruginous hawk *Buteo regalis*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area.
Greater sage-grouse *Centrocercus urophasianus*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area.
Lewis's woodpecker *Melanerpes lewis*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area.
Long-billed curlew *Numenius americanus*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area.
Northern goshawk *Accipiter gentilis*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area.
Short-eared owl *Asio flammeus*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area.
Mollusks	
California floater *Anodonta californiensis*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area.
Eureka mountainsnail *Oreohelix eurokensis*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area (only 4 populations documented)
Southern Bonneville springsnail *Pyrgulopsis transversa*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area (only 6 Utah localities noted)
Utah physa *Physella utahensis*	The project would have **no impact** on this species due to a lack of suitable habitat in the study area.

Migratory Birds/Bald and Golden Eagles

The Debris Basin Alternative Option B has the potential to affect BCC protected under the MBTA due to construction activities. No permanent impacts are anticipated.

Mitigation

Mitigation measures include:

- To prevent undue harm to migratory birds, avian nest surveys for bird species listed under the MBTA would be conducted in accordance with the USFWS' Nationwide Standard Conservation Measures prior to construction to determine if there are any migratory species present in the study area at that time. If nests are encountered within the study area, mitigation measures would be required, as set forth below.
- Ensure that project staff and contractors working on site are aware of and can identify special status wildlife species with potential to occur in the project footprint and stop work if a federally protected special status wildlife species is discovered in the project footprint and notify the project manager.

Cumulative Impacts

The Debris Basin Alternative Option B would have no effect on federally listed species, no impacts on state sensitive species, and only negligible and minor impacts on BCC; therefore, it is not expected to result in a substantial contribution to cumulative area-wide impacts on population trends of special status wildlife. Impacts would be mitigated by design features, compliance measures, and BMPs described throughout this Plan-EA.

Under the No Action Alternative, there would be no construction activities and therefore, no contribution to the cumulative impact on special status wildlife species in the study area.

4.6 Human Environment

4.6.1 Cultural and Historic Resources

No Action Alternative

Under the No Action alternative, there would be no impacts to cultural resources. If the "No Action" Alternative were selected, there would be no requirement for consideration of cultural resources within the study area.

Debris Basin Alternative Option B

Pursuant to 36 CFR Part 800 of the NHPA (1966, as amended in 2000), and the regulations of the Advisory Council on Historic Preservation (ACHP) implementing Section 106 of the NHPA (54 U.S.C. 306108), federal agencies must take into account the potential effect of an undertaking on "historic properties," which refers to cultural resources listed in, or eligible for listing in the NRHP.

As indicated in Section 4-2, there is only one cultural resource in the project area that is eligible for the NRHP; the Strawberry Highline Canal (see Table 4-2).

TABLE 4-2. IMPACTS TO CULTURAL AND HISTORIC RESOURCES IN THE AREA OF POTENTIAL EFFECTS

No.	Site Name/ Description	Eligibility Recommendation	Potential Effect from the Debris Basin Alternative Option B
42UT1322	Historic Trash Scatter	Ineligible	No Historic Properties Affected
42UT1323	Historic Trash Scatter	Ineligible	No Historic Properties Affected
42UT1473	Strawberry Highline Canal	Eligible	No Historic Properties Affected
42UT2020	Historic Foundation	Ineligible	No Historic Properties Affected
42UT2021	Historic Trash Scatter	Ineligible	No Historic Properties Affected
IO-1	Glass Insulators	Ineligible	No Historic Properties Affected
IO-2	Milk Glass Fragments	Ineligible	No Historic Properties Affected
IO-3	Amethyst Glass Bottle Fragments	Ineligible	No Historic Properties Affected

No.	Site Name/ Description	Eligibility Recommendation	Potential Effect from the Debris Basin Alternative Option B
IO-4	Clear Glass Bottle Fragments	Ineligible	No Historic Properties Affected
IO-5	Chert Flake	Ineligible	No Historic Properties Affected
IO-6	Historic Soda Bottle	Ineligible	No Historic Properties Affected

The Debris Basin Alternative Option B would impact the historic trash scatter, 42UT1322, due to the spillway of the basin; however, the site is not significant and not eligible for the NRHP. No other potential impacts to cultural resources were identified. Therefore, the project would have no impacts to historic resources.

Based upon the foregoing analysis, the NRCS has made a No Historic Properties Affected determination for the project. The NRCS consulted with the Utah State Historic Preservation Office (SHPO) in regards to the cultural resources identified in the APE, including both the eligibility and effect determinations. See the correspondence to SHPO requesting concurrence dated April 9, 2019 in Appendix E.

Mitigation

During construction activities, SHPO will be notified if there are any inadvertent historic discoveries, in accordance with applicable guidance and law. Should construction unearth previously undiscovered cultural resources, work would be stopped in the area of the discovery and the NRCS would consult with the Utah SHPO and ACHP, as necessary. In the unlikely event that human remains are discovered during construction, the provisions outlined in the Native American Graves Protection and Repatriation Act of 1990 would be followed.

Cumulative Impacts

Since the proposed action would have no direct effects on cultural resources, it would not directly contribute to cumulative impacts. However, due to both the nature of the cultural resources either known to be within the study area or predicted to be within the study area, it is assumed that adverse cumulative effects to historic properties would be related to the indirect effects associated with the construction of the project in allowing for future development of other properties that may result in impacts to cultural resources.

Under the No Action Alternative, there would be no construction activities and therefore, the project would not contribute to cumulative impacts on cultural resources in the area.

4.6.2 Recreation

No Action Alternative

Under the No-Action Alternative, existing conditions would continue as at present and there would be no impacts to recreational resources.

Debris Basin Alternative Option B

There are no known recreational uses of the private or USFS-administered lands in the project area. Therefore, under the Debris Basin Alternative Option B, there would be no impacts to recreational activities, either from construction or operational activities.

Cumulative Impacts

The Debris Basin Alternative Option B would not be expected to contribute to cumulative impacts on recreational resources. Impacts from the Debris Basin Alternative Option B would be negligible to minor.

Under the No Action Alternative, there would be no construction activities and therefore, the project would not contribute to cumulative impacts on recreation in the study area.

4.6.3 Scenic Beauty and Visual Resources

No Action Alternative

Under the No-Action alternative, there would be no construction activities and no additional visual elements introduced into the viewshed. The No-Action Alternative would not impact visual resources.

Debris Basin Alternative Option B

Under the Debris Basin Alternative Option B, several debris basins would be constructed in the area, which would introduce new permanent features into the viewshed. Although the majority of the debris basins would be constructed below grade, which would minimize impacts to the natural landscape views, earthen embankments of approximately 18 to 20 feet in height would be required for a couple of the debris basins, as well as spillways, access roads, etc. Further, the study area would experience temporary impacts during construction due to construction-related activities, such as earth moving, construction equipment, and staging areas.

Mitigation

Impacts on scenic quality and visual resources can be minimized through implementation of construction-related and visual resource-specific BMPs. Construction-related BMPs include minimization of ground disturbance; restoration and revegetation of disturbed surfaces; dust control/abatement; and control of invasive or non-native plants.

Cumulative Impacts

The Debris Basin Alternative Option B would not be expected to contribute to cumulative impacts on scenic beauty and visual resources. Impacts from the Debris Basin Alternative Option B would be negligible to minor and would be related to the potential impacts to vegetation.

Under the No Action Alternative, there would be no contribution to the cumulative visual impacts.

4.6.4 Public Health and Safety

No Action Alternative

Under the No-Action Alternative, existing conditions in the study area would continue into the future. The potential for future flooding and debris flow events would continue to exist unmitigated, including the risk of damage to residential, agricultural, and commercial properties and to public infrastructure. With a severe enough storm event, there could even be life-threatening impacts for residents, visitors, and first responders.

According to the modeling for this project, the No Action Alternative could result in up to 30 houses to experience some flooding in both the 25- and 50-year storm event, up to 20 houses with one-to-three feet of floodwater, and with at least one house having three (3) or more feet of floodwater. See Appendix D for more information.

Debris Basin Alternative Option B

Under the Debris Basin Alternative Option B, the potential flooding and debris flows from the east bench would be greatly reduced by the implementation of the debris basins that would be designed and constructed to provide substantial flood reduction from the 100-year-storm event (95%)and to prevent flooding from the 25-year fire-related event and debris flow from the 5-year storm event (i.e., 20% chance storm). By so doing, the Debris Basin Alternative Option B would include a substantial reduction in the risk of damage to people and properties. The Debris Basin Alternative Option B is anticipated to result in no houses being inundated with floodwaters under the 25 and 50-year storms;

in comparison, under existing conditions, at least 30 houses would likely experience at least ½ to a foot of water, 20 houses would likely experience one to three feet of water, and one house would likely experience up to three feet of water. The Debris Basin Alternative Option B would also eliminate impacts to roadways and cropland inundated under the 25 and 50-year storm events and substantially reduce the impacts from the 100-year storm events. Under existing conditions, the 25-year flood event would impact approximately 100 acres of cropland and the 50-year event would impact approximately 200 acres. See Appendix D for more information.

Also, the flood prevention measures would be designed and constructed according to industry standards and would be properly maintained by Santaquin City through an Operation and Maintenance Agreement with the NRCS to ensure their designed function. No mitigation is required.

Cumulative Impacts

The Debris Basin Alternative Option B is anticipated to contribute to a positive cumulative effect on public health and safety in the study area. The Santaquin City Storm Drain Master Plan and ongoing management of USFS lands along the east bench would provide cumulative public health and safety benefits toward providing flood/debris damage reduction in the study area.

Under the No Action Alternative, there would be no contribution to the cumulative impact on public health and safety concerns in the study area. Existing issues and concerns would continue as currently constituted.

4.6.5 Socioeconomics

No Action Alternative

Under the No-Action Alternative, none of the proposed improvements would be implemented and existing socioeconomic conditions in the study area would continue into the future. The potential for future flooding events and debris flow from off the east bench would continue to exist unmitigated, including the risk of damage to residential, agricultural, and commercial properties and to public infrastructure. With a severe enough storm event, there could even be life threatening impacts for residents, visitors, and first responders.

Debris Basin Alternative Option B

Under the Debris Basin Alternative Option B, the potential flooding and debris flows from the east bench would be greatly reduced by the implementation of the debris basins that would be designed and constructed to provide substantial flood reduction from the 100-year-storm event (95%) and to prevent flooding from the 25-year fire-related event and debris flow from the 5-year storm event (i.e., 20% chance storm). These measures would provide a substantial reduction in the risk of damage to people and properties. Further, it will allow for the development and protection of certain real property that would otherwise have been at risk of damage due to flooding events and debris flows off the east bench, which would contribute to the growth of Santaquin. No mitigation is required.

Cumulative Impacts

The Debris Basin Alternative Option B is anticipated to contribute to a cumulative effect on the socioeconomic makeup of the population or demographics in the study area due to the potential for future development of the areas that would previously have been flooded by storm events. Property values downstream of the debris basins may be enhanced or stabilized into the future.

Under the No Action Alternative, there would be no contribution to the cumulative impact on socioeconomic conditions in the study area. Existing conditions and trends would continue to exist.

Chapter 5: Consultation, Coordination, and Public Participation

5.1 Public Participation

The 30-day scoping period for this project began on February 14, 2018 and ended on March 19, 2018.The scoping meeting was held on February 27, 2018 at the Santaquin Senior Citizens Center, 55 West 100 South in Santaquin, Utah from 5:00 PM to 7:00 PM. Sixteen (16) people attended the meeting. No written comments were received during the scoping period; however, general oral comments made to the project team were noted during the public open house. One public comment was received after the scoping period expired. The scoping process and scoping comments are summarized in Section 2.1

On September 26, 2019, a public open house meeting was held to explain the Draft Environmental Assessment results, present the Preferred Alternative, and gather public input. The meeting was held at the C.S. Lewis Academy, 364 North Hwy. 298, Santaquin, Utah from 5:00 PM to 7:00 PM. Three public comments were received during the comment period that began on September 11, 2019 and ended on October 16, 2019. One comment expressed support for the project, one comment was related to issues with Santaquin's stormwater management plan efforts, and one comment expressed the desire for further mitigation measures for additional areas. A summary of the public open house is included in Appendix A.

5.2 Agency Coordination

Invitations to participate as a cooperating agency were sent by NRCS to the U.S. Army Corps of Engineers (USACE), the Bureau of Land Management (BLM), the U.S. Fish and Wildlife Service (USFWS), and the U.S. Forest Service (USFS) in February of 2018. The USFS agreed to become a cooperating agency and a Memorandum of Understanding (MOU) was prepared and signed (see Appendix A). No other responses or comments were received.

Additionally, notice of the project was provided to the Utah State Clearinghouse RDCC for any state agencies with particular interest in or jurisdiction over the project. Coordination or consultation has been undertaken with the following agencies:

- USFS
- Utah County

5.3 Tribal Coordination

In accordance with EO 13175, NRCS is responsible for assessing the impacts of activities, considering tribal interests, and assuring that tribal interests are considered in conjunction with federal activities and undertakings. NRCS recognizes that tribal governments are sovereign nations located within and dependent upon the United States. NRCS has a responsibility to help fulfill the U.S. government's responsibilities toward tribes when considering actions that may affect tribal rights, resources, and assets.

Tribal consultation was conducted in accordance with the NHPA of 1966 and EO 13175 to maintain the NRCS's government-to-government relationship between Native villages and tribes. Letters were sent requesting input and notifying them of the scoping process to the following Indian tribes:

- Skull Valley Band of Goshute Indians
- Confederated Tribes of the Goshute Reservation
- Ute Indian Tribe of the Uintah & Ouray Reservation

Chapter 6: The Preferred Alternative

6.1 Selection of the Preferred Alternative

The Preferred Alternative for the project is the Debris Basin Alternative as described in Chapter 3 and is based on the ability of the elements of the alternative to meet the purpose and need for the project and provide the most beneficial impacts to environmental and social resources, as detailed in Chapter 4 of this Plan-EA.

6.2 Rationale for the Preferred Alternative

The project would reduce flood and debris damage to the downstream community and meet the identified purpose and need of the project.

The landscape in the populated study area is comprised of alluvial fan deposits that make controlling runoff difficult due to the typical undefined channel network. The project would provide five debris basins placed in strategic locations for the various drainages that would act to provide substantial flood reduction from the 100-year-storm event (95%) and to prevent flooding from the 25-year fire-related event and debris flow from the 5-year storm event (i.e., 20% chance storm) . It is economically feasible and would allow for continued growth and development in Santaquin in areas that were previously restricted due to high risks of damage from flooding events.

6.3 Measures to be Installed under the Preferred Alternative

6.3.1 Project Components

The Proposed Alternative includes five (5) separate debris basins at strategic locations associated with the drainage areas. All of the debris basins were designed to direct flooding and debris flows from the drainages into debris basins that would be excavated into the hillsides with an internal depth of 16.5 feet. The debris basins would all have a principal spillway that would allow for a controlled release of water from the debris basins, including a 50-foot-wide concrete structural auxiliary spillway to allow excess water that is unable to be contained in the basin to outfall into existing channels or into the normal floodplains that would be the pathway absent the basin.

These debris basins were designed to be below grade to the extent possible considering the terrain in order to reduce the risk of failure (which is higher with aboveground structures) and to blend in as much as possible with the existing hillsides to minimize intrusion into the viewshed. This design would also save on the cost of construction and maintenance.

6.3.2 Avoidance, Minimization, and Mitigation Measures

Soils

Best Management Practices (BMPs) would be implemented to reduce and mitigate impacts to soils during construction, including but not limited to:

- During construction, topsoil would be saved and then redistributed after completion of construction activities.
- Straw wattles, silt curtains, cofferdams, dikes, straw bales, or other suitable erosion control measures would be used to minimize soil erosion and prevent soil erosion from entering water bodies during construction.
- Disturbed areas would be smoothed, shaped, contoured and reseeded to as near their pre-project conditions as practicable.

- For project-specific components that would disturb an acre of soil or more, the contractor would submit a Stormwater Pollution Prevention Plan (SWPPP) to the Utah Division of Water Quality (UDWQ) for approval to reduce potential impacts of sedimentation on water bodies.
- Contractors would be required to follow standard BMP and compliance measures to quickly contain any leaks or spills occurring from construction vehicles or activities and a spill response plan would be prepared in advance of construction by the contractors for areas of work where spilled contaminants could flow into water bodies.
- During construction, topsoil would be saved and then redistributed after completion of construction activities.

Sedimentation

- Straw wattles, silt curtains, cofferdams, dikes, straw bales, or other suitable erosion control measures would be used to minimize soil erosion and prevent soil erosion from entering water bodies during construction.
- Disturbed areas would be smoothed, shaped, contoured and reseeded to as near their pre-project conditions as practicable.
- For project-specific components that would disturb an acre of soil or more, the contractor would submit a Stormwater Pollution Prevention Plan (SWPPP) to the Utah Division of Water Quality (UDWQ) for approval to reduce potential impacts of sedimentation on water bodies.

Prime and Unique Farmlands

Mitigation for impacts to farmlands will include the following:

- Needed land acquisition will be acquired in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended.
- Access to and use of the farmland in question will be maintained during construction.
- Any potential effects of the project to water delivery or irrigation systems associated with agricultural areas will be mitigated. These facilities will be relocated and reconstructed to maintain the continuity and use of the existing systems.

Water Resources

BMPs would be implemented during construction to prevent loose soils from entering into the American Fork River. Measures to protect surface water quality from the effects of erosion during construction would be taken. These measures would be outlined in a Storm Water Pollution Protection Plan (SWPPP).

BMPs would be implemented to protect surface water quality from sedimentation and pollutants entering the waterways during construction, including but not limited to:

- For project-specific components that would disturb an acre of soil or more, the contractor would submit a SWPPP to UDWQ for approval to reduce potential impacts of sedimentation on water bodies.
- Straw wattles, silt curtains, cofferdams, dikes, straw bales, or other suitable erosion control measures would be used to minimize soil erosion and prevent soil erosion from entering water bodies during construction.
- Fuel, oil, hydraulic fluid, lubricants, and other petrochemicals will not be stored within 200 feet of waterway areas and will have a secondary containment system to prevent spills. Appropriate spill clean-up materials, such as booms and absorbent pads, will be available on-site at all times during construction.

- Work crews would carry spill cleanup kits, and in times of burn bans or wildfire concerns, each crew would have a fire suppression kit.
- Equipment that leaks while working on the Project will not be allowed to continue operating until the leak is fixed. Refueling will occur a minimum of 100 feet from any wetland and riparian areas.
- Concrete clean-up operations (if needed) will utilize a dedicated concrete wash-out pit in an upland location. The concrete remnants in the wash-out pit will be fully removed and legally disposed of off-site upon completion of all concrete operations, or as needed for maintenance.

Air

Due to the potential for fugitive dust emissions during construction, the contractor would prepare and comply with a fugitive dust plan.

Vegetation

To mitigate for vegetation impacts, the following BMPs would be implemented to reduce negative consequences on vegetation communities and habitat:

- Ground disturbances shall be limited to only those areas necessary to safely implement the Preferred Alternative.
- Vegetation removal shall be confined to the smallest portion of the Preferred Alternative area necessary for completion of the work.
- Construction limits shall be clearly flagged onsite to avoid unnecessary plant loss or ground disturbance.
- Prior to construction, vegetative material shall be removed by mowing or chopping, and either hauled to a proposed staging area to be burned or chipped, or chipped and mulched onsite. Stumps shall be grubbed and hauled to a proposed staging area to be burned.
- Topsoil shall be stockpiled and then redistributed after completion of construction activities.
- Straw wattles, silt curtains, cofferdams, dikes, straw bales, or other suitable erosion control measures shall be used at the edges of ground disturbance to minimize soil erosion and prevent soil erosion from entering water bodies during construction.
- Following construction, all disturbed areas shall be smoothed, shaped, contoured and reseeded to as near to their pre-project conditions as practicable.
- Seeding shall occur at appropriate times with weed-free seed mixes per NRCS specifications, as appropriate.
- Weed control shall be implemented by the project proponent to county standards (at a minimum).

Wildlife

The following BMPs would be implemented to reduce negative consequences on wildlife:

- Ground disturbances shall be limited to only those areas necessary to safely implement the Preferred Alternative.
- For project activities involving vegetation disturbance that would occur during the nesting season, surveys for nesting birds would be conducted before vegetation-disturbing activities could begin, to the extent practicable. Nesting raptor surveys would be conducted as necessary to provide clearance for construction during raptor nesting season.
- To prevent undue harm to migratory birds, avian nest surveys for bird species listed under the MBTA would be conducted in accordance with the USFWS' Nationwide Standard Conservation Measures prior to construction to determine if there are any migratory species present in the

study area at that time. If nests are encountered within the study area, mitigation measures would be required, as set forth below.

- Ensure that project staff and contractors working on site are aware of and can identify special status wildlife species with potential to occur in the project footprint and stop work if a federally protected special status wildlife species is discovered in the project footprint and notify the project manager.

Cultural Resources

During construction activities, SHPO will be notified if there are any inadvertent historic discoveries during construction, in accordance with applicable guidance and law. Should construction unearth previously undiscovered cultural resources, work would be stopped in the area of the discovery and the NRCS would consult with the Utah SHPO and ACHP, as necessary. In the unlikely event that human remains are discovered during construction, the provisions outlined in the Native American Graves Protection and Repatriation Act of 1990 would be followed.

Scenic Beauty and Visual Resources

Impacts on scenic quality and visual resources can be minimized through implementation of construction-related and visual resource-specific BMPs. Construction-related BMPs include minimization of ground disturbance; restoration of disturbed surfaces; dust control/abatement; and control of invasive or non-native plants.

6.3.3 Permits and Compliance

Permits or authorizations that may be required prior to construction of the proposed action components include:

- **Stream Alteration Permit**: Section 73-3-29 of the Utah Code requires any person, governmental agency, or other organization wishing to alter the bed or banks of a natural stream to obtain written authorization from the State Engineer prior to beginning work.
- **Utah Pollutant Discharge Elimination System (UPDES)**: Construction activities that disturb more than one acre of land require a Storm Water Pollution Prevention Plan (SWPPP) to comply with the Utah Pollutant Discharge Elimination System permit (UPDES). The SWPPP may include such measures as using silt fences, fiber rolls, check-dams, or other techniques to minimize impacts to receiving waters. The project would be constructed in compliance with the District's typical specifications for drainage, sediment control, and environmental. BMPs would be in place to prevent sedimentation or other impacts to water quality in the study area.

The project sponsor is responsible for complying with all BMPs and impact minimization efforts described in Chapter 5, and for obtaining and complying with any permits, should they be required.

6.4 Economic and Structural Information

The NRCS National Watershed Manual was used as a reference for the economic analysis along with the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) (U.S. Water Resources Council 1983). P&G was developed to define a consistent set of project formulation and evaluation instructions for federal agencies that carry out water and related land resource implementation studies.

The objective of P&G is to determine whether or not benefits from proposed actions exceed project costs for federally funded projects. P&G also requires that the "National Economic Development" or

NED Alternative, which maximizes monetary net benefits, is selected for implementation unless there is an overriding reason for selecting another alternative based on federal, state, local, or international concerns related to the social and environmental accounts. Damage reduction benefits from floodwater and debris flow were analyzed for this project according to the P&G and the Manual.

The total installation cost that was estimated for the preferred alternative (Option B) is $12,279,633 as detailed in Table 6-1. Table 6-2 includes the structural data related to the proposed debris basins. Table 6-3 documents land status upon which the project structures reside, as well as federal and non-federal funding sources, respectively. Table 6-4 documents the estimated cost distribution for the installation costs. Table 6-5 documents the estimated average annual NED costs.

TABLE 6-1. SUMMARY OF INSTALLATION COSTS FOR THE PREFERRED ALTERNATIVE

Measure	Construction	Engineering	Real Property Rights	Admin.	Total
Basin 1	$2,643,408	$440,418	$924,000	$22,021	$4,029,847
Basin 3A	$570,133	$95,022	$300,000	$4,751	$969,906
Basin 4	$1,060,079	$176,680	$700,000	$8,834	$1,945,593
Basin 5	$2,554,266	$425,711	$58,100	$21,286	$3,059,363
Basin 6	$1,265,467	$210,911	$788,000	$10,546	$2,274,924
Total	$8,093,353	$1,348,742	$2,770,100	$67,438	$12,279,633

TABLE 6-2. STRUCTURAL DATA

Item	Unit	Basin 1	Basin 3	Basin 4	Basin 5	Basin 6
Dam Number	--	N/A	N/A	N/A	N/A	N/A
Hazard Class of Structure	--	Low Hazard	Low Hazard	High Hazard (TR-60)	Low Hazard	High Hazard (TR-60)
Seismic Zone	--	3	3	3	3	3
Total Drainage Area	sq. mi	0.63	0.12	0.69	0.71	0.45
Runoff curve No. (1-day)	N/A	71.8	69.2	70.9	67.3	72.1
Time of concentration (Tc)	hr	0.54	0.21	0.53	0.68	0.45
Elevation top dam	ft	5,370.00	5,280.00	5,056.00	4,960.00	5,000.00
Elevation crest auxiliary spillway	ft	5,367.00	5,277.00	5,053.00	4,957.00	4,997.00
Elevation crest high stage inlet	ft	5,336.00	5,276.00	5,052.00	4,956.00	4,996.00
Elevation crest low stage inlet	ft	5,357.00	5,267.00	5,043.00	4,947.00	4,987.00
Auxiliary spillway type	--	Concrete Channel	Concrete Channel	Concrete Channel	Concrete Channel	Concrete Channel
Auxiliary spillway bottom width	ft	50	50	50	50	50
Auxiliary spillway exit slope	%	TBD	TBD	TBD	TBD	TBD
Maximum height of dam	ft	16	16	16	16	16
Total capacity at auxiliary spillway crest	ac-ft	17	4.25	25.9	208	18.6
Sediment pool	ac-ft	3.75	0.55	2.5	2	2.5
Sediment submerged	ac-ft	0	0	0	0	0
Sediment aerated	ac-ft	3.75	0.55	2.5	2	2.5
Beneficial use pool (irrigation, recreation)	ac-ft	0	0	0	0	0
Principal spillway hydrograph (10-day,100-year)						
Rainfall Volume	in	4.17	4.75	5.81	4.74	5.78

Item	Unit	Basin 1	Basin 3	Basin 4	Basin 5	Basin 6
Peak Runoff	cfs	50.72	10.08	73.83	56.56	49.52
Dimension of Conduit (low-level outlet)	in	30	30	30	30	30
Type of Conduit (low-level outlet)	N/A	Reinforced Concrete Pipe	Reinforced Concrete Pipe	Reinforced Concrete Pipe	Reinforced Concrete Pipe	Reinforced Concrete Pipe
Frequency of Operation Auxiliary Spillway (spillway)	% chance	<2.0	<2.0	<2.0	<2.0	<2.0
Stability Design Hydrograph (SDH) Not Applicable for Structural Spillway						
Inflow Design Hydrograph (IDF)/Freeboard Hydrograph (FBH)						
Rainfall Volume	in	5.04	5.37	5.1	5.1	5.23
Peak Runoff	cfs	221	49.5	582.7	157.5	494.6
IDF/FBH Storm Duration	hrs	6	6	6	6	6
Velocity of flow (Vc)	ft/s	TBD	TBD	TBD	TBD	TBD
Maximum Combined Spillway Discharge	cfs	TBD	TBD	TBD	TBD	TBD
Maximum Reservoir Water Surface Elevation	ft	5,368.85	5,278.79	5,054.85	4,958.79	4,998.79

TABLE 6-3. ESTIMATED INSTALLATION COST

Works of Improvement	Number of Parcels		Estimated Costs (Dollars)*			
			PL 83-566**		Other Funds	
	Federal Land	Non-Federal Land	Federal Land	Non-Federal Land	Federal Land	Non-Federal Land
Debris Basins	1	4	$0	$9,104,800	$404,700	$2,770,100
Totals	5		$9,104,900		$3,174,800	
			$12,279,700			

**Price base October 2018 (dollars)*

***NRCS is the responsible federal agency participating in installation of works of improvement*

TABLE 6-4. ESTIMATED COST DISTRIBUTION – WATER RESOURCE PROJECT MEASURES

Works of Improvement	Installation Cost – PL 83-566 Funds			Installation Costs – Other Funds				Total
	Construction	Engineering	Project Admin	Construction	Engineering	Real Property Rights	Permits	
Debris Basins	$7,688,700	$1,348,700	$67,400	$404,700	$0	$2,770,100	$0	$12,279,600
Totals	$9,104,800			$3,174,800				

**Price base October 2018 (dollars)*

TABLE 6-5. ESTIMATED AVERAGE ANNUAL NED COSTS

Works of Improvement	Project Outlays Amortization of Installation Costs**	Project Outlays, Operation, Maintenance, and Replacement Costs	Total
Debris Basins	$375,100	$21,900	**$397,000**

**Price base October 2018 (dollars)*
***Amortized at 2.875% annually for 100 years*

Damage reduction benefits were assessed based on the equivalent annual damage reduction expected through implementation of the preferred alternative compared to the no action/existing alternative baseline. The life of the measures proposed in the preferred alternative are estimated at 100 years. The period of analysis is therefore 100 years, with all costs and benefits calculated at the Fiscal Year 2018 Federal Water Resources Discount Rate of 2.875%.

The sum of damages accrued due to the 2, 5, 10, 25, 50, 100, 200 and 500 year storm events were compared between all three alternatives. These damages are estimated by developing inundation extents of each of the storm events using a hydraulic model, overlaying the boundaries of the various events onto aerial maps, determining the structures that intersect the storm event extents, and estimating the damages based on the severity of exposure for each structure.

The primary benefits from the project measures come from an anticipated reduction in the estimated average annual damages to residential properties, agricultural production, and municipal infrastructure. Tables 6-6 and 6-7 below summarizes the results of the flood damage reduction analysis conducted for this project. See also Appendix D for additional information.

TABLE 6-6. ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Item	Estimated Average Annual Damages Reduction Benefits		
	No Action	Preferred Alternative	Damage Reduction
Crops and pasture	$400	$4,900	$4,500
Residential	$34,300	$488,700	$454,400
Other	$800	$3,000	$2,200
Total	**$35,500**	**$496,600**	**$461,100**

**Price base October 2018 (dollars) calculated using FY 2019 Water Resources Discount Rate (2.875%) and 100 year period of analysis.*

TABLE 6-7. ESTIMATED AVERAGE ANNUAL WATERSHED PROTECTION DAMAGE REDUCTION BENEFITS

Item	Estimated Average Annual Damages Reduction Benefits		
	Agriculture-related	Nonagricultural-related	Total
Public	$461,100	$0	$461,100

**Price base October 2018 (dollars) calculated using FY 2019 Water Resources Discount Rate (2.875%) and 100 year period of analysis.*

6.5 NED Alternative

The NED Alternative is the alternative or combination of alternatives that reasonably maximized the net economic benefit of the project consistent with protecting the nation's environment. The net

economic benefit is the benefit minus the cost. For this project, the Preferred Alternative is also the NED Alternative, with a benefit cost ratio of 1.16 to 1. See Table 6-7.

TABLE 6-8. COMPARISON OF NED BENEFITS AND COSTS

Evaluation Unit	Average Annual Cost	Average Annual Benefit	Benefit Cost Ratio
Debris Basins	$397,000	$461,100	1.16

**Price base October 2018 (dollars) calculated using FY 2019 Water Resources Discount Rate (2.875%) and 100 year period of analysis*

Chapter 7: References

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Chapter 8: List of Preparers

This Plan-EA was prepared by Horrocks Engineers, including its subcontractors, under the direction of the NRCS and its cooperating agencies. Table 8-1 lists the staff responsible for the production of the Plan-EA.

TABLE 8-1. LIST OF PREPARERS

Name	Role	Education	Experience
Horrocks Engineers			
Jacob O'Bryant	Project Lead/ Design Manager	B.S. Civil Engineering	12
Stan Jorgensen	Environmental Project Manager	B.S., Civil Engineering M.S., Civil Engineering	25
Aaron Spencer	Design Engineer	B.S., Civil Engineering	13
Judy Imlay	Environmental Lead/ Environmental Analysis	B.A., Political Science J.D., Law	14
Peter Steele	Environmental Analysis/ Archaeology	B.A., Anthropology (Archaeology) M.A., Anthropology (Archaeology)	9
Aaron Woods	Environmental Analysis/ Archaeology	B.A., Anthropology (Archaeology) M.A., Anthropology (Archaeology)	3
Ryan Pitts	Environmental Analysis/ Hydrology	B.S., Horticulture M.L.A., Landscape Architecture	12
Nathan Clarke	Environmental Analysis/ Hydrology and Vegetation	B.S., Landscape Architecture and Environmental Planning	2
Craig Bown	Environmental Analysis/Wildlife	B.S., Environmental Studies	10
Mendy Magistro	Public Involvement	B.S., Music Therapy M.S.W, Social Work LCSW, Licensed Clinical Social Worker	3
Lisa Jimenez	CADD	B.S., Industrial Design	30
Mickey Navidomskis	Design EIT	B.S., Civil Engineering M.S., Civil Engineering (in progress)	1
Sarah Allen	Graphics	B.A., Art	1
Natural Resources Conservation Service			
Norm Evenstad	Water Resources Coordinator	B.S., Geology	25
Cianna Wyshnytzky	Geologist	PhD, Geology	3
Nathaniel Todea	Hydraulic Engineer	M.S., Hydrology	16
City of Santaquin			
Norm Beagley	City Engineer	B.S., Civil and Environmental Engineering	11
GeoStrata			
Sofia Agopian	Staff Geologist		
Daniel J. Brown	Senior Geotechnical Engineer		
Timothy Thompson	Principal Geologist		
Long Watershed Planning Economics, LLC			
John Long	NED Analysis	B.S. Agricultural Economics and Rural Sociology	23

Chapter 9: Distribution List

A Notice of Availability for the Draft Plan-EA was distributed to the following: Federal, state, and local agencies; community representatives; and area NGOs. The agency, representative, and organizational contacts included on the mailing list are as follows:

Agencies

- Bureau of Land Management – BLM
- Bureau of Reclamation – BOR
- Department of Natural Resources – DNR
    - Santaquin Wildlife Management Area
- Division of Water Resources – DWR
- Highline Canal Company
- Resource Development Coordinating Committee – RDCC
- Santaquin City – City Water Tank
- U.S. Army Corps of Engineers – USACE
- U.S. Fish and Wildlife Service
- U.S. Forest Service
- UDOT Region Three – Teri Newell
- Utah County / Spring Lake
- Utah Division of Water Rights - Dam Safety
- Utah Division of Wildlife Resources – UDWR
- Utah Geologic Survey
- Utah School and Institutional Trust Lands Administration – SITLA
- Local Grazing Association

Tribes

- Skull Valley Band of Goshute Indians
- Confederated Tribes of the Goshute Reservation
- Ute Indian Tribe of the Uintah & Ouray Reservation

Businesses

- Charter School
- Dairy Queen
- Maverick
- Stringham's Ace Hardware
- Apex Storage
- Tire Trax

Property Owners and Residents

- Property owners and residents within and surrounding the study area. (The names of private stakeholders and members of the public who received notice of the Draft Plan-EA are not included in this section for privacy reasons.)

Chapter 10: Acronyms, Abbreviations, and Short-Forms

ACHP	Advisory Council on Historic Preservation
af	acre foot
APE	Area of Potential Effects
BCC	Birds of Conservation Concern
BMPs	Best Management Practices
CAAA	Clean Air Act Amendments of 1990
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
CO	carbon monoxide
DERR	Division of Environmental Response and Remediation
EE	Environmental Evaluation
EO	Executive Order
ESA	Endangered Species Act
HDPE	High-density polyethylene
IPaC	Information, Planning, and Conservation
msl	mean sea level
MOA	Memorandum of Agreement
NAAQS	National Ambient Air Quality Standards
NED	National Economic Development
NEPA	National Environmental Policy Act
NGO	non-governmental organization
NHPA	National Historic Preservation Act of 1966
NNIS	non-native invasive species
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NWI	National Wetlands Inventory
NWPM	National Watershed Program Manual
NO2	nitrogen dioxide
O3	ozone
P&G	Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies
Pb	lead
Plan-EA	Watershed Plan and Environmental Assessment
PG	Pleasant Grove City
PL	Public Law
PM_{10}	particulate matter with a diameter of 10 micrometers or less
$PM_{2.5}$	particulate matter with a diameter of 2.5 micrometers or less
RDCC	Resource Development Coordinating Committee
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SWPPP	Stormwater Pollution Prevention Plan
T&E	threatened and endangered
UDEQ	Utah Department of Environmental Quality

ULT	Ute Ladies'-tresses
UPDES	Utah Pollution Discharge Elimination System
USACE	United States Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	United States Fish and Wildlife Service
WOTUS	Waters of the U.S

Chapter 11: Index

APPENDIX A

COMMENTS AND RESPONSES

Supplemental Watershed Plan No. 1 and Environmental Assessment for Santaquin Flood Prevention

Santaquin Watershed
Utah County, Utah

October 2019

United States Department of Agriculture

Public Involvement Plan

Santaquin East Bench Debris Basins
Environmental Assessment
February 14, 2018

Project Overview

The United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), in partnership with Santaquin City as the project sponsor, is considering proposed improvements within the Santaquin east bench watersheds. The proposed improvements include the construction of up to six (6) storm water debris basins and associated facilities along the eastern foothills in Santaquin. Improvements under consideration may be partially funded through the Watershed Protection and Flood Prevention Act of 1954 (PL83-566) and will address flood prevention and control, water conservation, and public safety risks while supporting existing agricultural and municipal land use.

The proposed project is located in Utah County along the east bench of Santaquin. The National Environmental Policy Act (NEPA) and the Council on Environmental Quality's regulations at 40 CFR Parts 1500-1508 require an evaluation of potential environmental impacts associated with federal projects and actions with input from the public.

Project Contacts

Santaquin City		
City Engineer Norm Beagley 801-754-1011 nbeagley@santaquin.org		
NRCS		
Water Resource Coordinator Norm Evenstad 801-557-7068 norm.evenstad@ut.usda.gov	Geologist Cianna Wyshnytzky 801-386-1097 cianna.wyshnytzky@ut.usda.gov	Hydraulic Engineer Nathaniel Todea 801-524-4573 nathaniel.todea@ut.usda.gov
HORROCKS ENGINEERS		
Project Manager Jacob O'Bryant 801-763-5185 jacobo@horrocks.com	NRCS/NEPA Manager Ryan Pitts 801-763-5184 ryanp@horrocks.com	NEPA Lead Judy Imlay 801-763-5173 judyi@horrocks.com
HORROCKS ENGINEERS		
Environmental Manager Stan Jorgensen 801-763-5160 stan@horrocks.com	Project Engineer Aaron Spencer 801-763-5164 aarons@horrocks.com	PI Lead Mendy Magistro 801-763-5256 mendym@horrocks.com

Project Milestones

TASK	DATE
Kick-off Meeting	Feb. 1, 2018
Public/Agency Scoping Meetings	Feb. 27, 2018
Alternative Refinement	March through May 2018
Draft EA	June 2018
Public Hearing	Summer 2018
Final EA	Summer 2018

Goals

- Work in conjunction with project team to identify key stakeholders.
- Conduct effective stakeholder outreach to communicate the environmental process, purpose and need and background/history of the area leading up to this study.
- Inform key stakeholders of public meetings and opportunities to provide comments.

Key Messages

- A solution is needed due to the potential for impacts to residential properties and public infrastructure that results from erosion and debris flow off the hillsides during storm events.
- The study team will follow the NEPA environmental process to determine the best solutions.

Possible Stakeholder Concerns

- Safety and unintentional flooding
- Change to landscape – revegetation timeline
- More desirable land for development
- Wildlife impacts
- Recreation impacts

Stakeholder Identification

The groups listed below have been identified as key stakeholders for this project (See Appendix A for a more detailed list of key stakeholders):

- Santaquin City
- Property owners and residents within and adjacent to the study area
- Businesses within and adjacent to the study area
- Utah State government – various agencies
- U.S. government – various agencies

Public involvement efforts will focus on compiling and tracking concerns and contact information from stakeholders throughout the project. Project updates will be available through the following resources:

- Santaquin City website and social media outlets
- NRCS website
- Public notices in The Payson Chronicle

Public Involvement Strategies and Tactics

DEVELOP PUBLIC INVOLVEMENT PLAN			
TACTIC	**TARGET GROUP**	**OBJECTIVE**	**COMPLETION DATE**
Determine project name and branding	General public	Establish a consistent look and feel for all outreach materials	February 2018
Draft initial PI plan	Project team	Establish and guide PI efforts	February 2018
Draft study messaging	General public and project team	Provide key messages and talking points to be used in all outreach and communications	February 2018
Develop and populate stakeholder database	Key stakeholders and project team	Provide database for tracking interaction with key stakeholders and gathering comments	February – Summer 2018
IMPLEMENT PUBLIC INVOLVEMENT PLAN			
TACTIC	**TARGET GROUP**	**OBJECTIVE**	**TIMEFRAME**
Identify key stakeholders	Project team	Develop list of key stakeholders and document in stakeholder database	February 2018
Develop and provide scoping notice to NRCS for website	General public	Provide notice of the public scoping meeting and comment period in The Payson Chronicle	February 2018
Develop and release public scoping notice	General public	Provide notice of the public of scoping meeting and comment period	Feb. 14 and 21, 2018
Develop and distribute study information mailer	Nearby residents and property owners	Invite broader community to each public open house/hearing	Feb. 16, 2018
Develop and distribute social media content	Santaquin City followers	Provide social media content to Santaquin City for existing Facebook and Twitter accounts	Approx. 14, 7, and 1 day(s) prior to scoping meeting
Develop and distribute project information for city website	Visitors of Santaquin City website	Provide study information and open house details to Santaquin City for the city website	Two weeks prior to scoping meeting
Monitor and document media coverage	Project team	Review media coverage	Ongoing throughout study

Prepare for and execute public/agency scoping open house	**General public**	**Inform community and agencies about study and gather input**	**Feb. 27, 2018**
Complete summary of scoping meeting and compile and summarize public comments	Project team	Provide insight to project team on public feedback and comment themes	March 2018
Update PI plan	Project team	Update PI plan to include updated schedule for public hearing and outreach activities	April – May 2018
Develop and provide public hearing notice for NRCS for website	General public	Provide notice of the public hearing and comment period in The Payson Chronicle	Summer 2018
Develop and release public scoping notice	General public	Provide notice of the public hearing and comment period	14 and 7 days prior to public hearing
Develop and distribute information mailer to announce public hearing	Nearby residents and property owners	Invite broader community to each public open house/hearing	10 days prior to public hearing
Develop and distribute social media content	Santaquin City followers	Provide social media content to Santaquin City for existing Facebook and Twitter accounts	Approx. 14, 7, and 1 day(s) prior to public hearing
Develop and distribute project information for city website	Visitors of Santaquin City website	Provide study information and public hearing details to Santaquin City for the city website	Two weeks prior to public hearing
Prepare for and execute public hearing	**General Public**	**Provide information and gather public input on the Draft EA**	**Summer 2018**
Complete summary of public hearing and compile and summarize public comments	Project team	Provide insight to project team on public feedback and comment themes	Summer 2018
Prepare and submit PI report	Project team	Compile all outreach and documentation for team review	Summer 2018
Develop and distribute notice of Final PLAN-EA	General Public	Provide notice of the Final PLAN-EA in The Payson Chronicle	Fall 2018
Develop and distribute notice of Decision Document	General Public	Provide notice of the Decision Document in The Payson Chronicle	Fall 2018

Appendix A

Santaquin East Bench Debris Basins EA
Key Stakeholders

Agencies

- Bureau of Land Management – BLM
- Bureau of Reclamation – BOR
- Department of Natural Resources – DNR
    - Santaquin Wildlife Management Area
- Division of Water Resources – DWR
- Highline Canal Company
- Resource Development Coordinating Committee – RDCC
- Santaquin City – City Water Tank
- U.S. Army Corps of Engineers – USACE
- U.S. Fish and Wildlife Service
- U.S. Forest Service
- UDOT Region Three – Teri Newell
- Utah County / Spring Lake
- Utah Division of Water Rights - Dam Safety
- Utah Division of Wildlife Resources – UDWR
- Utah Geologic Survey
- Utah School and Institutional Trust Lands Administration – SITLA
- Local Grazing Association

Businesses

- Charter School
- Dairy Queen
- Maverick
- Stringham's Ace Hardware
- Apex Storage
- Tire Trax

Property Owners and Residents

- Property owners and residents within and surrounding the study area

Special Interest Groups

- Recreationalists
    - Jeep and ATV
    - Hunters (deer & elk)

United States Department of Agriculture

Natural Resources
Conservation Service

Utah State Office

125 South State Street
Room 4010
Salt Lake City, UT 84138

Ph: 801-524-4550
Fax: 844-715-4928
www.ut.nrcs.usda.gov

Date: February 12, 2018

Mr. Jason Gipson
Chief - Nevada-Utah Regulatory Branch
U.S. Army Corps of Engineers
533 West 2600 South, Suite 150
Bountiful, Utah 84010

RE: Formal request to be a Cooperating Agency in the development of several watershed Environmental Assessments (EA) in Utah.

Dear Mr. Gipson:

In accordance with the Council on Environmental Quality regulations implementing the National Environmental Policy Act (NEPA) at 40 CFR Part 1501.6, Natural Resources Conservation Service (NRCS) is formally requesting that U.S. Army Corps of Engineers (ACOE) become a cooperating agency in the planning and development of several Watershed EA efforts in Utah. The names and locations of these proposed projects are listed in Attachment-1.

This request is made since your agency is identified as having special expertise or jurisdiction by law related to this project. The EAs are being prepared to fulfill the NRCS NEPA compliance responsibilities pertaining to our Federal financial assistance through the Watershed Protection and Flood Prevention Program (Public Law 83-566) for these projects. As your agency may also have NEPA compliance responsibilities concerning these projects, preparation of the EAs should also assist in fulfilling environmental review requirements for your agency or other federal agencies and meet NEPA's intent of reducing duplication and delay between agencies.

Upon acceptance of this invitation, roles can be defined in an informal agreement or a formal MOU can be established. If your agency is unable to participate as a cooperating agency please return a written explanation why your agency cannot participate. The NRCS shall accept designation as the lead Federal agency to act on behalf of the ACOE for purposes of compliance with the Section 7 of the Endangered Species Act and Section 106 of the National Historic Preservation Act.

Please send a letter confirming your decision by **March 15, 2018 to:** Timothy Wilson, State Conservationist, USDA-NRCS, Wallace F Bennett Federal Building, 125 South State Street, Room 4010, Salt Lake City, Utah 84138-1100.

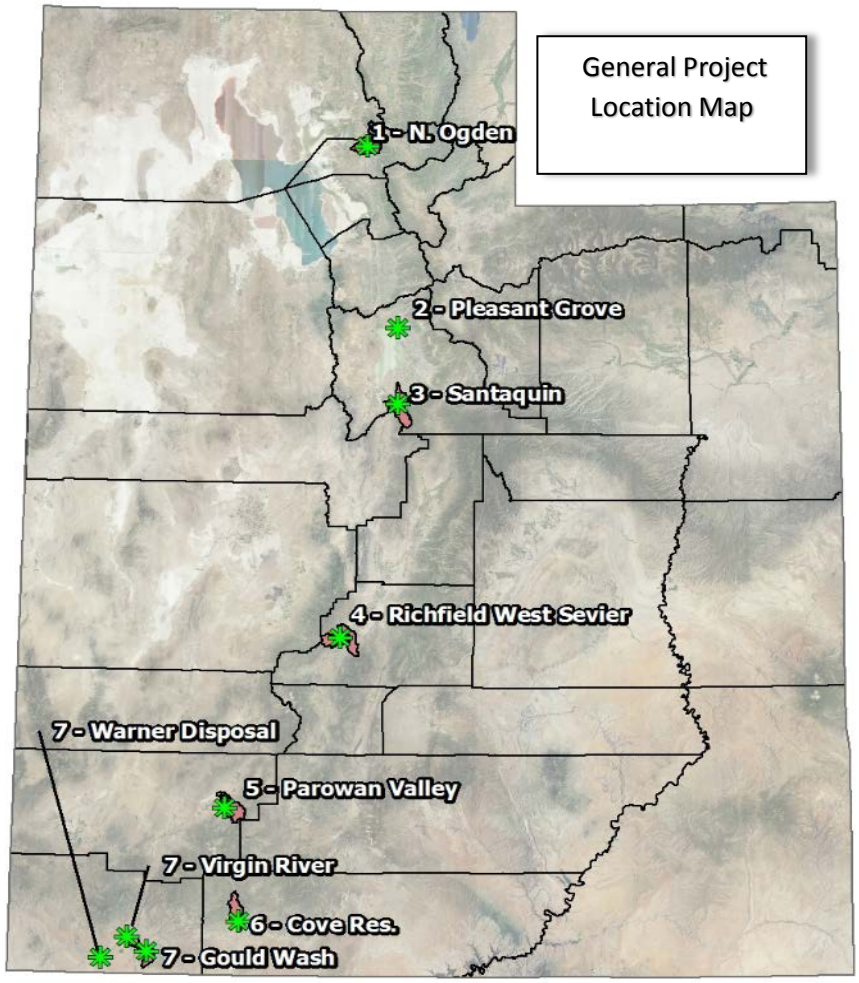
Thank you for your timely response and cooperation with these efforts. If you have any questions or comments, please contact Bronson Smart, State Conservation Engineer, at bronson.smart@ut.usda.gov or (801) 524-4559; or Norm Evenstad, Water Resources Coordinator, at norm.evenstad@ut.usda.gov or (801) 524-4569.

Sincerely,

TIMOTHY WILSON
State Conservationist

cc:
Mike Larsen, Acting Assistant State Conservationist-Field Operations (South), NRCS, Richfield, UT
Don Ashby, Assistance State Conservationist-Field Operations (N01th), NRCS, Ogden, UT
Bronson Smml, State Conservation Engineer-Rehab Program Manager, NRCS, Salt Lake City, UT
Norm Evenstad, Water Resources Coordinator, NRCS, Salt Lake City, UT

UTAH-NRCS - PL566 WATERSHED PLAN-ENVIRONMENTAL ASSESSMENT WORK



PL566 Project Name	Location/Various	Summary description of proposed work
1-North Ogden Weber-Box Elder Conservation District	41.301537° -111.975893°	Relocate & expand 2550 North Detention Basin, use basin for water storage, flood control, recreation. Water provided from North Ogden canal at about 2 cfs.
2-Pleasant Grove Pleasant Grove City	40.363114° -111.774560°	Pipe 3,100 feet of the open, unlined Mill Ditch located in Pleasant Grove City with 30-inch diameter HDPE pipe.
3-Santaquin Santaquin City	39.969369° -111.770505°	Evaluate the proposed installation of approximately 5 flood control structures along the East bench of Santaquin to protect homes, infrastructure and possibly provide aquifer recharge capability.
4-Richfield W. Sevier Sevier County	38.871435° -112.004222°	New Watershed Plan- Evaluate additional flood control measures needed throughout the Richfield-West Sevier County area (Flat Canyon). Recreation, trails, canal piping, habitat development.
5-Parowan Valley Iron County	37.868987° -112.783872°	New Watershed Plan - Evaluate additional flood control measures, debris basin/s, recreation opportunities, irrigation water management, and habitat restoration/enhancement.
6-Cove Reservoir Kane County	37.280257° -112.690638°	Construction of approximately 6,000 acre-foot capacity dam/reservoir for irrigation and recreation in Cove Canyon outside of Orderville, Utah.
7-Warner Draw Group Washington County Gould Wash DB Virgin River Habitat Warner Disposal Pipe	Gould- 37.116769° -113.230050° Virgin- 37.190211° -113.348204° Warner- 37.070515° -113.498451°	Construction of a debris basin in Gould Wash above Hurricane, Utah - located on BLM land. Piping of Hurricane canal for more efficient off/on farm irrigation water management and analysis of water savings to enhance Virgin River habitat. Evaluate enhancement of Virgin River endangered fish species and SW willow flycatcher habitat. Partner incl. The Nature Conservancy.

USDA

United States Department of Agriculture

Natural Resources
Conservation Service

Utah State Office

125 South State Street
Room 4010
Salt Lake City, UT 84138

Ph: 801-524-4550
Fax: 844-715-4928
www.ut.nrcs.usda.gov

Date: February 12, 2018

Mr. George Garcia
Spanish Fork District Ranger
400 West 400 North
Spanish Fork, Utah 84660

RE: Formal request to be a Cooperating Agency in the development of a Supplemental Watershed Environmental Assessment (EA) for proposed flood control measures to be located on the East bench of Santaquin City, Utah.

Dear Mr. Garcia,

In accordance with the Council on Environmental Quality regulations implementing the National Environmental Policy Act (NEPA) at 40 CFR Part 1501.6, Natural Resources Conservation Service (NRCS) is formally requesting that U.S. Forest Service (USFS) become a cooperating agency in the planning and development of the Santaquin City Watershed EA. The location of the proposed project area is summarized in Attachment-1 as area #3. Attachment-2 depicts the proposed project measures.

This request is made since your agency is identified as having special expertise or jurisdiction by law related to these projects. The EAs are being prepared to fulfill the NRCS NEPA compliance responsibilities pertaining to our Federal financial assistance through the Watershed Protection and Flood Prevention Program as authorized through Public Law 83-566.

Upon acceptance of this invitation, roles can be defined in an informal agreement or a formal MOU. If your agency is unable to participate as a cooperating agency please return a written explanation why your agency cannot participate.

Please send a letter confirming your decision by March 15, 2018 to: Timothy Wilson, State Conservationist, USDA-NRCS, Wallace F Bennett Federal Building, 125 South State Street, Room 4010, Salt Lake City, Utah 84138-1100.

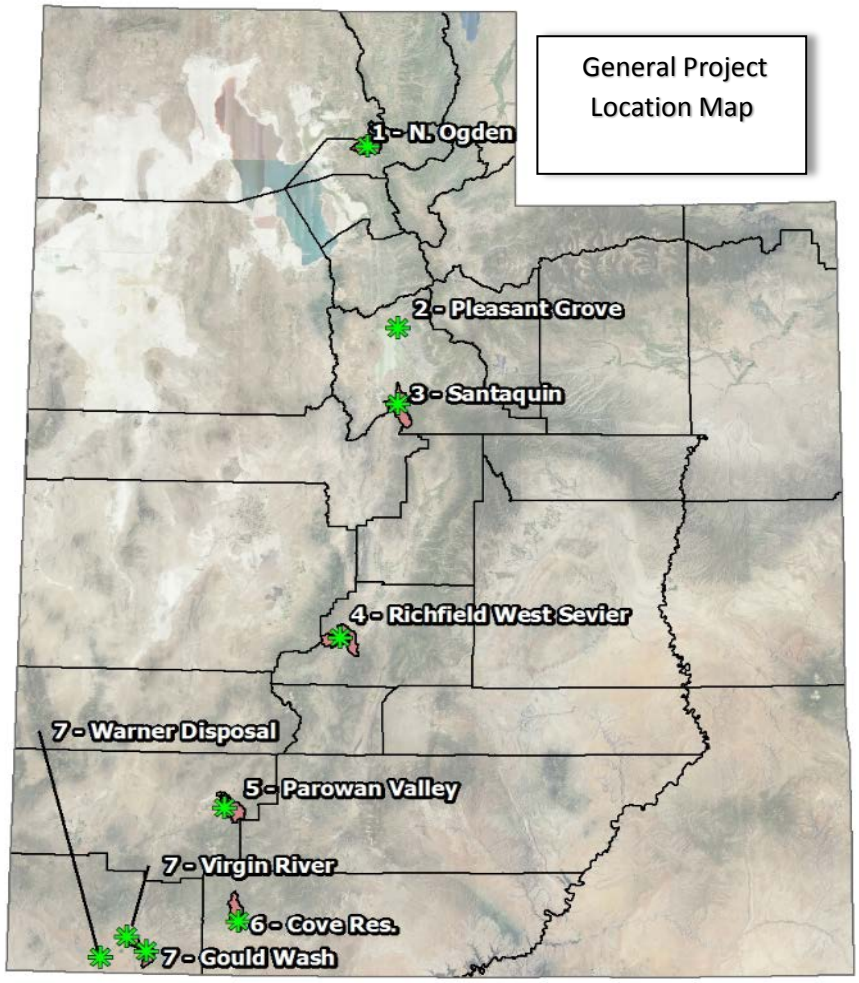
Thank you for your timely response and cooperation with these efforts. If you have any questions or comments, please contact Bronson Smart, State Conservation Engineer, at bronson.smart@ut.usda.gov or (801) 524-4559; or Norm Evenstad, Water Resources Coordinator, at norm.evenstad@ut.usda.gov or (801) 524-4569.

Sincerely,

TIMOTHY WILSON
State Conservationist

cc:
Mike Larsen, Acting Assitant State Conservationist-Field Operations (South), NRCS, Richfield, UT
Don Ashby, Assistance State Conservationist-Field Operations (North), NRCS, Ogden, UT
Bronson Smart, State Conservation Engineer-Rehab Program Manager, NRCS, Salt Lake City, UT
Norm Evenstad, Water Resources Coordinator, NRCS, Salt Lake City, UT

UTAH-NRCS - PL566 WATERSHED PLAN-ENVIRONMENTAL ASSESSMENT WORK



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United States Department of Agriculture

Natural Resources
Conservation Service

Utah State Office

125 South State Street
Room 4010
Salt Lake City, UT 84138

Ph: 801-524-4550
Fax: 844-715-4928
www.ut.nrcs.usda.gov

Date: February 12, 2018

Mr. Larry Crist
Utah Field Office-Supervisor
U.S. Fish and Wildlife Service
2369 West Orton Circle, Suite 50
West Valley City, Utah 84119

RE: Formal Request to be a Cooperating Agency in the development of several Environmental Assessments (EA) in Utah.

Dear Mr. Crist:

In accordance with the Council on Environmental Quality regulations implementing the National Environmental Policy Act (NEPA) at 40 CFR Part 1501.6, Natural Resources Conservation Service (NRCS) is formally requesting that U.S. Fish and Wildlife Service (USFWS) become a cooperating agency in the planning and development of several EA efforts in Utah. The names and locations of these proposed project areas are shown and summarized in Attachment 1.

This request is made since your agency is identified as having special expe1tise or jurisdiction by law related to these projects. The EAs are being prepared to fulfill the NRCS NEPA compliance responsibilities pertaining to our Federal financial assistance through the Watershed Protection and Flood Prevention Program as authorized through Public Law 83-566. As your agency may also have NEPA compliance responsibilities concerning these projects, preparation of the EAs should also assist in fulfilling environmental review requirements for your agency or other federal agencies and meet NEPA's intent of reducing duplication and delay between agencies.

Upon acceptance of this invitation, roles can be defined in an informal agreement or a formal MOU can be established. If your agency is unable to participate as a cooperating agency please return a written explanation why your agency cannot participate. The NRCS shall accept designation as the lead Federal agency to act on behalf of the USFWS for purposes of compliance with the Section 7 of the Endangered Species Act and Section 106 of the National Historic Preservation Act.

Please send a letter confirming your decision by March 15, 2018 to: Timothy Wilson, State Conservationist, USDA-NRCS, Wallace F Bennett Federal Building, 125 South State Street, Room 4010, Salt Lake City, Utah 84138-1100.

Thank you for your timely response and cooperation with these effo1ts. If you have any questions or comments, please contact Bronson Smart, State Conservation Engineer, at bronson.smart@ut.usda.gov or (801) 524-4559; or Norm Evenstad, Water Resources Coordinator, at norm.evenstad@ut.usda.gov or (801) 524-4569.

Sincerely,

TIMOTHY WILSON
State Conservationist

cc:
Mike Larsen, Acting Assistant State Conservationist-Field Operations (South), NRCS, Richfield, UT
Don Ashby, Assistance State Conservationist-Field Operations (North), NRCS, Ogden, UT
Bronson Smart, State Conservation Engineer-Rehab Program Manager, NRCS, Salt Lake City, UT
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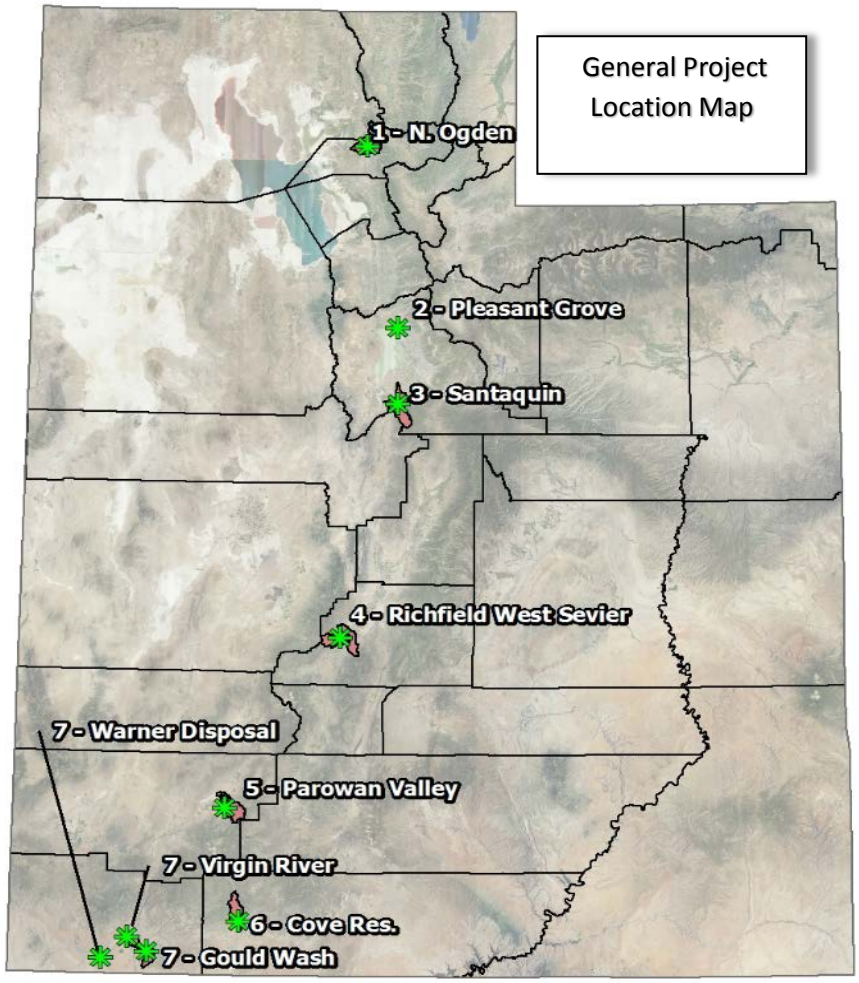
UTAH-NRCS - PL566 WATERSHED PLAN-ENVIRONMENTAL ASSESSMENT WORK



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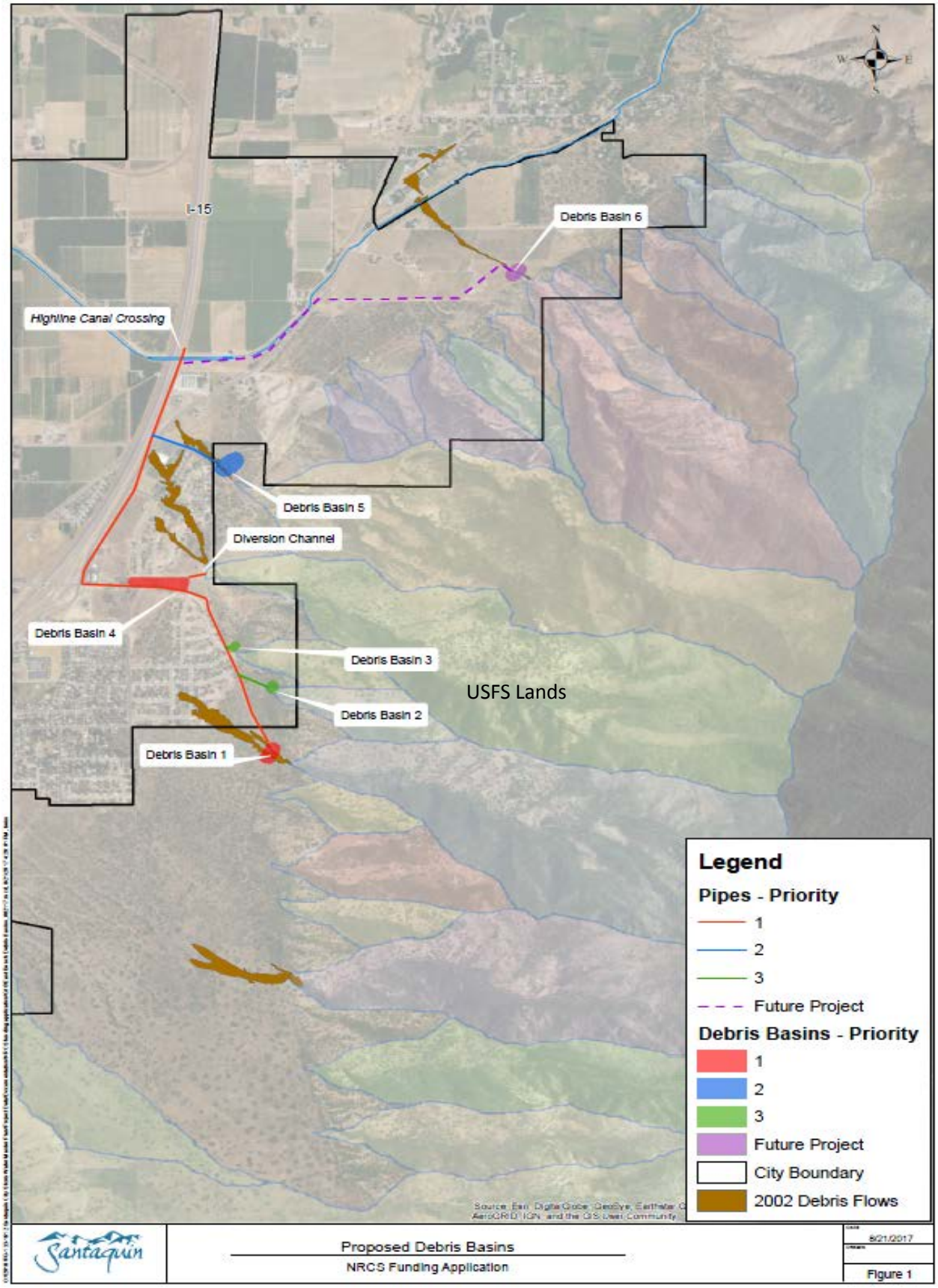
SANTAQUIN CITY, UTAH - Watershed Operations 2018 - Proposed Measures - General Location Map



From:	Evenstad, Norm - NRCS, Salt Lake City, UT
To:	stategrants@utah.gov
Cc:	Wyshnytzky, Cianna - NRCS, Salt Lake City, UT (Cianna.Wyshnytzky@ut.usda.gov); Todea, Nathaniel - NRCS, Salt Lake City, UT; Norm Beagley; Ben Reeves (breeves@santaquin.org); Aaron Spencer; Hanson, David - NRCS, Provo, UT
Subject:	State Clearinghouse Notification: Santaquin Watershed Project- per Executive Order 12372
Date:	Tuesday, November 21, 2017 4:06:00 PM
Attachments:	UT_WFPO_2017_SantaquinCity_FINAL.pdf

RE: USDA-NRCS PL566 – Watershed Operations Project – State Clearinghouse Notification per Executive Order 12372

Santaquin Watershed, Utah County, Utah

NRCS is required to notify the State of the attached type projects per Executive Order 12732.

Dear Mr. Matthews,

The attached project information file outlines the proposed watershed measures funded through the USDA-NRCS under authority of Public Law 83-566, the Watershed Protection and Flood Prevention Act (Watershed Program) of 1954, as amended. NRCS and the Sponsor (Sevier County Commission) will be developing a Plan-Environmental Assessment (Plan-EA) in the coming year for eventual construction of a new watershed measures within the Santaquin Watershed in Utah County.

USDA's Watershed Program authorizes the Secretary of Agriculture to *"cooperate with States and local agencies in planning and carrying out works of improvement for soil conservation and for other purposes."* It provides for technical, financial, and credit assistance by the USDA to local organizations representing the people living in watersheds. It also provides for needed additional treatment and protection of federally owned lands within such watersheds.

Let me know if you have any questions.

Regards,

Norm.

Norm Evenstad

Water Resources Coordinator

USDA-Natural Resources Conservation Service

Wallace F. Bennett Federal Building

125 S. State Street - Rm 4420

Salt Lake City, UT 84138-1100

Phone: *(801) 524-4569*
Cell: *(801) 557-7068*

USDA United States Department of Agriculture | Forest Service | Uinta-Wasatch-Cache National Forest Supervisor's Office | 857 West South Jordan Parkway South Jordan, UT 84095 801-999-2103 Fax: 801-253-8118

File Code: 2530; 1950
Date: February 22, 2018

Timothy Wilson
State Conservationist
USDA-NRCS
Wallace F. Bennet Federal Building
125 South State Street, Room 4010
Salt Lake City, UT 84138-1100

Dear Mr. Wilson:

We are in receipt of your letter dated February 12, 2018 requesting that the Uinta-Wasatch-Cache National Forest be a cooperating agency in the Supplemental Watershed Environmental Assess for proposed flood control structures on the east bench of Santaquin City, Utah. Based on the proposed action, we would qualify as a cooperating agency because of our jurisdiction by law in that it appears debris 5 is located on National Forest System Lands. We therefore agree to be a cooperating agency for the Supplemental Watershed Environmental Assessment (EA).

Please work directly with George Garcia, Spanish District Ranger who will serve as your primary contact for the Forest Service on this project. You can reach him at (801) 794-6761 or via e-mail at gcgarcia@fs.fed.us. George will coordinate the development of the cooperating agency agreement identifying the jurisdiction by law and/or outlining the special expertise you may want us to provide. George will coordinate the Uinta-Wasatch-Cache National Forest's participation on the project.

We would suggest that any flood control structures be located off National Forest System Lands where feasible. Any new debris basins or flood control structures on National Forest System Lands will require a special use permit, inspections, etc.

We look forward to working with you on the Cooperating Agency Agreement and the Environmental Analysis.

Sincerely,

DAVID WHITTEKIEND
Forest Supervisor

cc: George Garcia, Paul Cowley

United States Department of Agriculture

Natural Resources
Conservation Service

Utah State Office

125 So. State Street
Room 4010
Salt Lake City, UT
84138-1100

Voice: 801-524-4550
Fax: 801-524-4403

Memorandum of Understanding
Between
U.S. Department of Agriculture's Natural Resources Conservation Service
as the Lead Federal Agency
and
U.S. Forest Service
as Cooperating Agency for Preparation of a Supplemental Watershed Plan-Environmental Assessment
for the Santaquin East Bench Flood Prevention Project

I. Introduction

The Natural Resources Conservation Service (NRCS) is the Lead Federal Agency for the development of the Supplemental Watershed Plan-Environmental Assessment (PLAN-EA) as defined in 40 CFR Section 1501.5 for the Santaquin East Bench Flood Prevention Project, Santaquin, Utah. The U.S. Forest Service (USFS), herein referred to as the Cooperating Agency, is cooperating in the development of the PLAN-EA as defined in 40 CFR Section 1501.6.

This Memorandum of Understanding (MOU) outlines the roles and responsibilities of the NRCS and Cooperating Agency, herein referred to as Parties, with respect to preparation of the PLAN-EA. This MOU describes responsibilities and procedures agreed to by the Parties.

II. Purpose

The purposes of this MOU are:

1. To designate USFS as a Cooperating Agency in the PLAN-EA process.
2. To provide a framework for cooperation and coordination between the Parties that will ensure successful completion of the PLAN-EA in a timely, efficient and thorough manner.
3. To recognize that the NRCS is the Lead Federal Agency with responsibility for the completion of the PLAN-EA and the Finding of No Significant Impact (FONSI).
4. To describe the respective responsibilities, jurisdictional authority, and expertise of the Cooperating Agency in the planning process.

III. Authorities

The authorities and regulations of the NRCS to enter into and engage in the activities described within this MOU include, but are not limited to:

1. National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.).
2. Council on Environmental Quality regulations (40 CFR 1500-1508 et seq.)
3. NRCS Regulations Implementing the NEPA (7 CFR Part 650)
4. Watershed Protection and Flood Prevention Act (PL 83-566, 16 U.S.C. 1000 et seq.)

The authorities and regulations of Cooperating Agency to enter into this MOU include, but are not limited to:

1. National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.)
2. Council on Environmental Quality regulations (40 CFR 1501 et seq.)
3. Federal Land Policy and Management Act of 1976 (43 U.S.C. § 1701, et seq.)

This MOU does not alter any other written agreements, authorities, or responsibilities between the Parties and the project sponsors or other government agencies, or parties.

IV. Roles and Responsibilities

1. General Responsibilities

a. The Parties agree to participate in this planning process in good faith and make all reasonable efforts to resolve disagreements.

b. Each Party agrees to fund its own expenses associated with the PLAN-EA process, except that the NRCS may contract with the Cooperating Agency for technical studies within its jurisdiction or special expertise.

2. NRCS Responsibilities

a. The NRCS, as Lead Federal Agency, has primary responsibility for compliance with the requirements of the National Environmental Policy Act (NEPA) and preparation of the draft PLAN-EA, final PLAN-EA and FONSI.

b. NRCS will provide the Cooperating Agency with those PLAN-EA resource characterization studies and technical reports, as determined necessary by the respective cooperator, for review and comment.

c. NRCS will consult with the Cooperating Agency regarding the alternatives considered and associated mitigation measures to be evaluated in the PLAN-EA.

d. NRCS will identify the Cooperating Agency on the draft PLAN-EA and final PLAN-EA cover pages and will describe in the introduction sections, as provided by the Cooperating Agency, the specific roles and authorities of the Cooperating Agency with respect to the Santaquin East Bench Flood Prevention Project.

3. Cooperating Agency Responsibilities

a. The Cooperating Agency will provide early input to NRCS regarding issues to address in the resource characterization studies, technical reports, and PLAN-EA. The Cooperating Agency will also provide comments or analyses to NRCS in those areas where the Cooperating Agency has regulatory authority, technical expertise, and a need for the PLAN-EA to support decisions by the Cooperating Agency. The Cooperating Agency is recognized to have the following jurisdiction by law.

i. Landowner

b. The Cooperating Agency may review, and provide to NRCS, comments on the issued draft PLAN-EA and final PLAN-EA.

c. The Cooperating Agency and the NRCS will together coordinate under this MOU in order to maximize the use of resources and minimize duplication of effort during the preparation of the PLAN-EA.

d. Upon issuance of the final PLAN-EA and any resulting FONSI by NRCS, the Cooperating Agency may be able to then adopt the PLAN-EA and issue a separate decision notice under the Cooperating Agency's NEPA implementing regulations.

4. Other Responsibilities

a. Nothing in this MOU shall require any of the Parties to assume any obligation or expend any sum in excess of authorization and appropriations available.

b. Each Party retains all immunities and defenses provided by law with respect to any action based on or occurring as a result of this MOU.

c. Where the Parties disagree on substantive elements of the PLAN-EA, and these disagreements cannot be resolved, the NRCS will include a summary of the Cooperating Agency's views in the draft PLAN-EA and final PLAN-EA. The NRCS will also describe substantial inconsistencies between its proposed action(s) and the objectives of state, local, or tribal land use plans and policies.

d. Horrocks Engineers serves as the NRCS's contractor through Santaquin City for the PLAN-EA preparation. The Cooperating Agency may provide information and comments directly to the contractor as well as collaborate with the contractor's technical staff and subcontractors on matters within the Cooperating Agency's jurisdiction or special expertise. The Cooperating Agency acknowledges that the NRCS and Santaquin City retain the exclusive responsibility to authorize modifications to the contract with Horrocks Engineers, and that the Cooperating Agency is not authorized to provide technical or policy direction regarding the performance of this contract.

V. Agency Representatives

1. Each Party will designate a representative and alternate representative, as described in Attachment A, to ensure coordination between the Parties during the preparation of the PLAN-EA. Each Party may change its representative at will by providing written notice to the other Party.

VI. Administration of the MOU

1. This MOU becomes effective upon signature by the authorized officials of the NRCS and the Cooperating Agency.

2. This MOU may be modified by the Parties hereto by mutual agreement only. Any modification will be in writing.

3. This MOU does not alter the authority and responsibilities of the Cooperating Agency under their respective NEPA regulations.

4. This MOU is terminated when either the NRCS FONSI for the project is signed or when written notice is given by a respective agency.

USFS – Uinta-Wasatch-Cache National Forest
Forest Supervisor

DAVID WHITTEKIEND
Name

Forest Supervisor
Title

Signature

3/20/18
Date

NRCS - Utah
TIMOTHY WILSON
State Conservationist

Signature

4/2/18
Date

Attachment A
Agency Representatives

NRCS (Lead Federal Agency)

Primary Representative

Cianna Wyshnytzky	Geologist
Name	Title

Backup Representative

Nathaniel Todea	State Hydraulic Engineer
Name	Title

NRCS Contractor

Primary Representative

Jacob O'Bryant / Ryan Pitts	Eng Project Manager/NEPA Specialist
Name	Title

USFS – (Cooperating Agency)

Primary Representative

George Garcia	Spanish Fork District Ranger
Name	Title

Backup Representative

Sarah Flinders	Spanish Fork Recreation Staff Officer
Name	Title

Scoping Notice

The United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), in cooperation with Santaquin City as the project sponsor, is considering proposed improvements within the Santaquin east bench watersheds. The proposed improvements include the construction of up to six (6) stormwater debris basins and associated facilities along the eastern foothills in Santaquin. Improvements under consideration may be partially funded through the Watershed Protection and Flood Prevention Act of 1954 (PL83-566) and will address flood prevention and control, water conservation, and public safety risks while supporting existing agricultural and municipal land use.

The proposed project is located in Utah County along the east bench of Santaquin. The National Environmental Policy Act (NEPA) and the Council on Environmental Quality's regulations at 40 CFR Parts 1500-1508 require an evaluation of potential environmental impacts associated with federal projects and actions with input from the public.

You are invited to attend an agency scoping open house where your input is requested regarding issues and concerns relative to your respective specialties. After the agency meeting, there will be a public scoping open house to present the proposed improvements and solicit public input.

Agency Scoping Open House

Date: **February 27, 2018**

Time: **3:00 PM to 4:00 PM**

Location: **Santaquin Senior Citizen Center**
55 West 100 South, Santaquin, Utah 84655

Public Scoping Open House

Date: **February 27, 2018**

Time: **5:00 PM to 7:00 PM**

Location: **Santaquin Senior Citizen Center,**

55 West 100 South, Santaquin, Utah 84655

Comments may be submitted during the public scoping period starting February 14, 2018 and ending on March 19, 2018. Comments may be mailed to Horrocks Engineers, 2162 West Grove Parkway Suite 400, Pleasant Grove, Utah, 84602 or emailed to mendym@horrocks.com.

Additional information is available by contacting Ryan Pitts with Horrocks Engineers at 801-763-5184, ryanp@horrocks.com or the NRCS link for Public Notices: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/ut/newsroom/pnotice/.

The meeting location is accessible to persons with disabilities. A request for an interpreter for the hearing impaired or for other accommodations for persons with disabilities should be made at least 48 hours before the meeting to mendym@horrocks.com.

United States Department of Agriculture

Natural Resources
Conservation Service

Utah State Office

125 South State Street
Room 4010
Salt Lake City, UT 84138

Ph: 801-524-4550
Fax: 844-715-4928
www.ut.nrcs.usda.gov

April 9, 2019

Dr. Christopher Merritt, PhD
Deputy State Historic Preservation Officer - Archaeology
Utah Division of State History
300 Rio Grande Avenue
Salt Lake City, Utah 84101-1182

Reference: An Archaeological Inventory for the Santaquin East Bench Flood Prevention Project (UDSH Project No. U18HX0417).

Dear Dr. Merritt:

Included in this submission are a resources report titled *An Archaeological Inventory for the Santaquin East Bench Flood Prevention Project* and accompanying data. In brief, the Natural Resources Conservation Service (NRCS) is providing technical and financial assistance to Santaquin City to install debris basins in the foothills east of the city for flood prevention. In accordance with the National Environmental Policy Act (NEPA) and NRCS guidelines, a Supplemental Watershed Plan and Environmental Assessment (EA) is being prepared for the project. The accompanying cultural resources report details the pedestrian inventory that was completed by Horrocks Engineers on behalf of the NRCS and Santaquin City to identify cultural resources that could be affected by the proposed construction of the debris basins. The Area of Potential Effects (APE) encompasses a total of 188 acres. For the purposes of Section 106 consultation, the NRCS has assumed the role of lead Federal agency. The United States Forest Service and Bureau of Reclamation are cooperating agencies.

Pedestrian inventory of the project area was completed in February 2018 by Horrocks Engineers under authority of PLPCO Permit No. 232 (Peter Steele, MA, RPA) and Utah Division of State History Project No. U18HX0417. The inventory resulted in the identification of two previously recorded historic trash scatters (42UT1322 and 42UT1323), the Strawberry Highline Canal (42UT473), and two newly recorded historic sites (42UT2020 and 42UT2021). Of the sites, the Strawberry Highline Canal was previously determined eligible for the National Register of Historic Places (NRHP) in 2000. The NRCS concurs with this determination. The remaining sites are determined ineligible for the NRHP.

Following the cultural resources inventory, a preferred alternative was selected through the NEPA alternatives evaluation process. The Preferred Alternative consists of five separate sites with debris basins placed at strategic locations within the drainage areas. Only one site, 42UT1322, a historic trash scatter, will be partially destroyed by the construction of the debris basins. All other sites, including the Strawberry Highline Canal, are outside of the areas that will be disturbed by the debris basins.

The NRCS recommends that the proposed project proceed as planned with a determination of *no historic properties affected.* The NRCS requests concurrence for the determination of project effects. If you have any questions, comments, or concerns, please contact Tara S. Hoffmann, State Cultural Resources Specialist, at 801-524-4556 at your convenience.

Sincerely,

TIMOTHY WILSON
State Conservationist

Enclosure

cc: (w/o encl)
Norm Evenstad, Water Resources Coordinator, NRCS, Salt Lake City, Utah
Tara S. Hoffmann, State Cultural Resources Specialist, NRCS, Salt Lake City, Utah
Judy Imlay, Environmental Specialist, Horrocks Engineers, Pleasant Grove, Utah

USDA

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Ph: 801-524-4550
Fax: 844-715-4928
www.ut.nrcs.usda.gov

April 9, 2019

Mr. Zach Nelson
Archaeologist
Bureau of Reclamation
Provo Area Office
302 East 1860 South
Provo, Utah 84606-7317

Reference: An Archaeological Inventory for the Santaquin East Bench Flood Prevention Project (UDSH Project No. U18HX0417).

Dear Mr. Nelson:

Enclosed is a resources report titled *An Archaeological Inventory for the Santaquin East Bench Flood Prevention Project.* In brief, the Natural Resources Conservation Service (NRCS) is providing technical and financial assistance to Santaquin City to install debris basins in the foothills east of the city for flood prevention. In accordance with the National Environmental Policy Act (NEPA) and NRCS guidelines, a Supplemental Watershed Plan and Environmental Assessment (EA) is being prepared for the project. The accompanying cultural resources report details the pedestrian inventory that was completed by Horrocks Engineers on behalf of the NRCS and Santaquin City to identify cultural resources that could be affected by the proposed construction of the debris basins. The Area of Potential Effects (APE) encompasses a total of 188 acres. For the purposes of Section 106 consultation, the NRCS has assumed the role of lead Federal agency. The United States Forest Service and Bureau of Reclamation are cooperating agencies.

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Sincerely,

TIMOTHY WILSON
State Conservationist

Enclosure

cc: (w/o encl)
Norm Evenstad, Water Resources Coordinator, NRCS, Salt Lake City, Utah
Tara S. Hoffmann, State Cultural Resources Specialist, NRCS, Salt Lake City, Utah
Judy Imlay, Environmental Specialist, Horrocks Engineers, Pleasant Grove, Utah

USDA

United States Department of Agriculture

Natural Resources
Conservation Service

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Room 4010
Salt Lake City, UT 84138

Ph: 801-524-4550
Fax: 844-715-4928
www.ut.nrcs.usda.gov

April 9, 2019

Mr. Tom Flanigan
Archaeologist
Uinta-Wasatch-Cache National Forest
857 West South Jordan Parkway
South Jordan, Utah 84095

Reference: An Archaeological Inventory for the Santaquin East Bench Flood Prevention Project (UDSH Project No. U18HX0417).

Dear Mr. Flanigan:

Enclosed is a resources report titled *An Archaeological Inventory for the Santaquin East Bench Flood Prevention Project.* In brief, the Natural Resources Conservation Service (NRCS) is providing technical and financial assistance to Santaquin City to install debris basins in the foothills east of the city for flood prevention. In accordance with the National Environmental Policy Act (NEPA) and NRCS guidelines, a Supplemental Watershed Plan and Environmental Assessment (EA) is being prepared for the project. The accompanying cultural resources report details the pedestrian inventory that was completed by Horrocks Engineers on behalf of the NRCS and Santaquin City to identify cultural resources that could be affected by the proposed construction of the debris basins. The Area of Potential Effects (APE) encompasses a total of 188 acres. For the purposes of Section 106 consultation, the NRCS has assumed the role of lead Federal agency. The United States Forest Service and Bureau of Reclamation are cooperating agencies.

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Sincerely,

TIMOTHY WILSON
State Conservationist

Enclosure

cc: (w/o encl)
Norm Evenstad, Water Resources Coordinator, NRCS, Salt Lake City, Utah
Tara S. Hoffmann, State Cultural Resources Specialist, NRCS, Salt Lake City, Utah
Judy Imlay, Environmental Specialist, Horrocks Engineers, Pleasant Grove, Utah

USDA

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April 9, 2019

Ms. Candace Bear
Chairwoman
Skull Valley Band of Goshute Indians
Skull Valley Goshute General Council
P.O. Box 448
Grantsville, Utah 84029

Reference: An Archaeological Inventory for the Santaquin East Bench Flood Prevention Project (UDSH Project No. U18HX0417).

Dear Ms. Bear:

Enclosed is a resources report titled *An Archaeological Inventory for the Santaquin East Bench Flood Prevention Project.* In brief, the Natural Resources Conservation Service (NRCS) is providing technical and financial assistance to Santaquin City to install debris basins in the foothills east of the city for flood prevention. In accordance with the National Environmental Policy Act (NEPA) and NRCS guidelines, a Supplemental Watershed Plan and Environmental Assessment (EA) is being prepared for the project. The accompanying cultural resources report details the pedestrian inventory that was completed by Horrocks Engineers on behalf of the NRCS and Santaquin City to identify cultural resources that could be affected by the proposed construction of the debris basins. The Area of Potential Effects (APE) encompasses a total of 188 acres. For the purposes of Section 106 consultation, the NRCS has assumed the role of lead Federal agency. The United States Forest Service and Bureau of Reclamation are cooperating agencies.

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The NRCS recommends that the proposed project proceed as planned with a determination of *no historic properties affected*. The NRCS requests concurrence for the determination of project effects. If you have any questions, comments, or concerns, please contact Tara S. Hoffmann, State Cultural Resources Specialist, at 801-524-4556 at your convenience.

Sincerely,

TIMOTHY WILSON
State Conservationist

Enclosure

cc: (w/o encl)
Norm Evenstad, Water Resources Coordinator, NRCS, Salt Lake City, Utah
Tara S. Hoffmann, State Cultural Resources Specialist, NRCS, Salt Lake City, Utah
Judy Imlay, Environmental Specialist, Horrocks Engineers, Pleasant Grove, Utah

USDA

United States Department of Agriculture

Natural Resources
Conservation Service

Utah State Office

125 South State Street
Room 4010
Salt Lake City, UT 84138

Ph: 801-524-4550
Fax: 844-715-4928
www.ut.nrcs.usda.gov

April 9, 2019

Mr. Rupert Steele
Chairman
Confederated Tribes of the Goshute Reservation
HC61 Box 6104
195 Tribal Center Road
Ibapah, Utah 84034

Reference: An Archaeological Inventory for the Santaquin East Bench Flood Prevention Project (UDSH Project No. U18HX0417).

Dear Mr. Steele:

Enclosed is a resources report titled *An Archaeological Inventory for the Santaquin East Bench Flood Prevention Project.* In brief, the Natural Resources Conservation Service (NRCS) is providing technical and financial assistance to Santaquin City to install debris basins in the foothills east of the city for flood prevention. In accordance with the National Environmental Policy Act (NEPA) and NRCS guidelines, a Supplemental Watershed Plan and Environmental Assessment (EA) is being prepared for the project. The accompanying cultural resources report details the pedestrian inventory that was completed by Horrocks Engineers on behalf of the NRCS and Santaquin City to identify cultural resources that could be affected by the proposed construction of the debris basins. The Area of Potential Effects (APE) encompasses a total of 188 acres. For the purposes of Section 106 consultation, the NRCS has assumed the role of lead Federal agency. The United States Forest Service and Bureau of Reclamation are cooperating agencies.

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Sincerely,

TIMOTHY WILSON
State Conservationist

Enclosure

cc: (w/o encl)
Norm Evenstad, Water Resources Coordinator, NRCS, Salt Lake City, Utah
Tara S. Hoffmann, State Cultural Resources Specialist, NRCS, Salt Lake City, Utah
Judy Imlay, Environmental Specialist, Horrocks Engineers, Pleasant Grove, Utah

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April 9, 2019

Mr. Cleele Pete
Environmental Protection Department
Confederated Tribes of the Goshute Reservation
HC61 Box 6104
195 Tribal Center Road
Ibapah, Utah 84034

Reference: An Archaeological Inventory for the Santaquin East Bench Flood Prevention Project (UDSH Project No. U18HX0417).

Dear Mr. Pete:

Enclosed is a resources report titled *An Archaeological Inventory for the Santaquin East Bench Flood Prevention Project.* In brief, the Natural Resources Conservation Service (NRCS) is providing technical and financial assistance to Santaquin City to install debris basins in the foothills east of the city for flood prevention. In accordance with the National Environmental Policy Act (NEPA) and NRCS guidelines, a Supplemental Watershed Plan and Environmental Assessment (EA) is being prepared for the project. The accompanying cultural resources report details the pedestrian inventory that was completed by Horrocks Engineers on behalf of the NRCS and Santaquin City to identify cultural resources that could be affected by the proposed construction of the debris basins. The Area of Potential Effects (APE) encompasses a total of 188 acres. For the purposes of Section 106 consultation, the NRCS has assumed the role of lead Federal agency. The United States Forest Service and Bureau of Reclamation are cooperating agencies.

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Sincerely,

TIMOTHY WILSON
State Conservationist

Enclosure

cc: (w/o encl)
Norm Evenstad, Water Resources Coordinator, NRCS, Salt Lake City, Utah
Tara S. Hoffmann, State Cultural Resources Specialist, NRCS, Salt Lake City, Utah
Judy Imlay, Environmental Specialist, Horrocks Engineers, Pleasant Grove, Utah

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April 9, 2019

Mr. Luke Duncan
Chairman
Ute Indian Tribe of the Uintah & Ouray Reservation, Utah
P.O. Box 190
Fort Duchesne, Utah 84026

Reference: An Archaeological Inventory for the Santaquin East Bench Flood Prevention Project (UDSH Project No. U18HX0417).

Dear Mr. Duncan:

Enclosed is a resources report titled *An Archaeological Inventory for the Santaquin East Bench Flood Prevention Project.* In brief, the Natural Resources Conservation Service (NRCS) is providing technical and financial assistance to Santaquin City to install debris basins in the foothills east of the city for flood prevention. In accordance with the National Environmental Policy Act (NEPA) and NRCS guidelines, a Supplemental Watershed Plan and Environmental Assessment (EA) is being prepared for the project. The accompanying cultural resources report details the pedestrian inventory that was completed by Horrocks Engineers on behalf of the NRCS and Santaquin City to identify cultural resources that could be affected by the proposed construction of the debris basins. The Area of Potential Effects (APE) encompasses a total of 188 acres. For the purposes of Section 106 consultation, the NRCS has assumed the role of lead Federal agency. The United States Forest Service and Bureau of Reclamation are cooperating agencies.

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Sincerely,

TIMOTHY WILSON
State Conservationist

Enclosure

cc: (w/o encl)
Norm Evenstad, Water Resources Coordinator, NRCS, Salt Lake City, Utah
Tara S. Hoffmann, State Cultural Resources Specialist, NRCS, Salt Lake City, Utah
Judy Imlay, Environmental Specialist, Horrocks Engineers, Pleasant Grove, Utah

USDA

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Salt Lake City, UT 84138

Ph: 801-524-4550
Fax: 844-715-4928
www.ut.nrcs.usda.gov

April 9, 2019

Ms. Betsy Chapoose
Director
Cultural Rights Protection Department
Ute Indian Tribe of the Uintah & Ouray Reservation
P.O. Box 190
Fort Duchesne, Utah 84026

Reference: An Archaeological Inventory for the Santaquin East Bench Flood Prevention Project (UDSH Project No. U18HX0417).

Dear Ms. Chapoose:

Enclosed is a resources report titled *An Archaeological Inventory for the Santaquin East Bench Flood Prevention Project.* In brief, the Natural Resources Conservation Service (NRCS) is providing technical and financial assistance to Santaquin City to install debris basins in the foothills east of the city for flood prevention. In accordance with the National Environmental Policy Act (NEPA) and NRCS guidelines, a Supplemental Watershed Plan and Environmental Assessment (EA) is being prepared for the project. The accompanying cultural resources report details the pedestrian inventory that was completed by Horrocks Engineers on behalf of the NRCS and Santaquin City to identify cultural resources that could be affected by the proposed construction of the debris basins. The Area of Potential Effects (APE) encompasses a total of 188 acres. For the purposes of Section 106 consultation, the NRCS has assumed the role of lead Federal agency. The United States Forest Service and Bureau of Reclamation are cooperating agencies.

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Sincerely,

TIMOTHY WILSON
State Conservationist

Enclosure

cc: (w/o encl)
Norm Evenstad, Water Resources Coordinator, NRCS, Salt Lake City, Utah
Tara S. Hoffmann, State Cultural Resources Specialist, NRCS, Salt Lake City, Utah
Judy Imlay, Environmental Specialist, Horrocks Engineers, Pleasant Grove, Utah

Santaquin East Bench Flood Prevention - Environmental Assessment

Public Open House Summary Report

September 26, 2019

The following is a summary of the preparation and execution of the Public Open House for the Santaquin East Bench Flood Prevention Project located in Utah County, Utah.

Meeting Type: Santaquin City, as the project sponsor, and the United States Department of Agriculture - Natural Resources Conservation Service (USDA-NRCS) held a Public Open House to provide information regarding the proposal to install five debris basins along the East Bench as a flood prevention measure.

When/Where: The Public Open House was held on Thursday, September 26, 2019 from 5:00 to 7:00 p.m. at C.S. Lewis Academy, 364 North Hwy. 298, Santaquin, Utah 84655.

Advertisement: A variety of methods was employed to advertise the Public Open House (see Appendix Attachment 1).

- Approximately 30 Public Open House Notice letters were sent to a list of stakeholders provided by the USDA-NRCS.
- 1,050 postcards were sent to residents along the Santaquin East Bench area on September 13,2019. Of these 1,050 postcards, 105 were returned as undeliverable.
- The Public Open House was advertised in a major publication: The Payson Chronicle on September 11, 2019 and September 18, 2019.
- Santaquin City advertised the meeting on their Facebook page on September 25, 2019.
- Santaquin City posted the Public Notice of Availability on the city website Public Notices section September 11, 2019.

Attendance: 22 people signed in at the front entrance (see Appendix Attachment 2).

Information Presented at the Meeting: The meeting boards outlined the following items: the project background, the project purpose and need, the project area, the project description, a description of debris basins, impacts to environmental resources, the NEPA process and schedule, proposed debris basin locations, images of each proposed debris basin, and how to comment (see Appendix Attachment 3).

Project Background - Identifies the agencies leading the project, the type of document, and the purpose of the document.

Purpose and Need - Informs the public about the stormwater flooding and debris flows from the east bench impacting infrastructure and private properties.

Project Area - Shows Santaquin City boundaries, the East Bench Watershed, and the impacted areas.

Project Description - Describes the Proposed Alternative, which is five separate debris basins, the purpose of the debris basins, and the visibility of the basins.

What is a Debris Basin? - Descriptions of a debris basin and an excavated debris basin are provided.

Environmental Resource Impacts - Details each of the resources that will be impacted by this project and provides a discussion on why it is impacted and what type of mitigation is proposed.

NEPA Process and Schedule - Outlines each step of the NEPA process, where the project is currently, and the month/year of each step.

Debris Basin Locations - Shows the location of each of the proposed debris basin.

Debris Basin 1 - Provides an image and a description of Debris Basin 1.

Debris Basin 2&3 - Provides an image and a description of Debris Basin 2&3.

Debris Basin 4 - Provides an image and a description of Debris Basin 4.

Debris Basin 5 - Provides an image and a description of Debris Basin 5.

Debris Basin 6 - Provides an image and a description of Debris Basin 6.

How to Comment – Details the comment period deadline, mail, and email information for comments.

Comments: Commenting for the public was available in a variety of ways:

- Email: samantha.patterson@horrocks.com
- Mail: Horrocks Engineers
  Attn: Samantha Patterson
  2162 W. Grove Parkway, Suite 400
  Pleasant Grove, UT 84062
- The public had the chance to write and submit written comments during the public meeting

Three comments were received during the public open house (see Appendix Attachment 4).

Attachment 1: Public Hearing Advertisement

Public Notice of Availability

The United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), with assistance of Santaquin City as the project sponsor, announces the availability of a draft Environmental Assessment (EA) describing the proposed improvements within the Santaquin Watershed in Utah County, Utah. The project may be partially funded through the Watershed Protection and Flood Prevention Act of 1954 (PL83-566) and the Draft Plan-EA has been prepared in compliance with the National Environmental Policy Act (NEPA) per 40 CFR Parts 1500-1508.

You are invited to attend a public open house which will describe the alternatives analyzed and potential impacts to the environment from the project.

Public Open House

Date: September 26, 2019 - Thursday
Time: 5:00 PM to 7:00 PM (MST)
Location: C.S. Lewis Academy, 364 North Hwy 198, Santaquin, Utah 84655

Copies of the Draft Plan-EA are available for public review at:

- NRCS Salt Lake City Office, 125 State Street #4010, Salt Lake City, Utah 84138
- Santaquin City Offices, 275 West Main Street, Santaquin, UT 84655
- Santaquin City Library, 20 West 100 South, Santaquin, Utah 84655

An electronic copy of the Draft EA is also available for review on the NRCS website: bit.ly/waterops

Comments may be submitted during the public comment period starting September 9, 2019 and ending on October 15, 2019 to:

Mail: Draft Supplemental Watershed Plan No. 1 and Environmental Assessment for Santaquin Flood Prevention Project
c/o Horrocks Engineers
2162 W. Grove Parkway, Suite 400, Pleasant Grove, UT 84062

Email: samantha.patterson@horrocks.com

Phone: (208) 250-5538

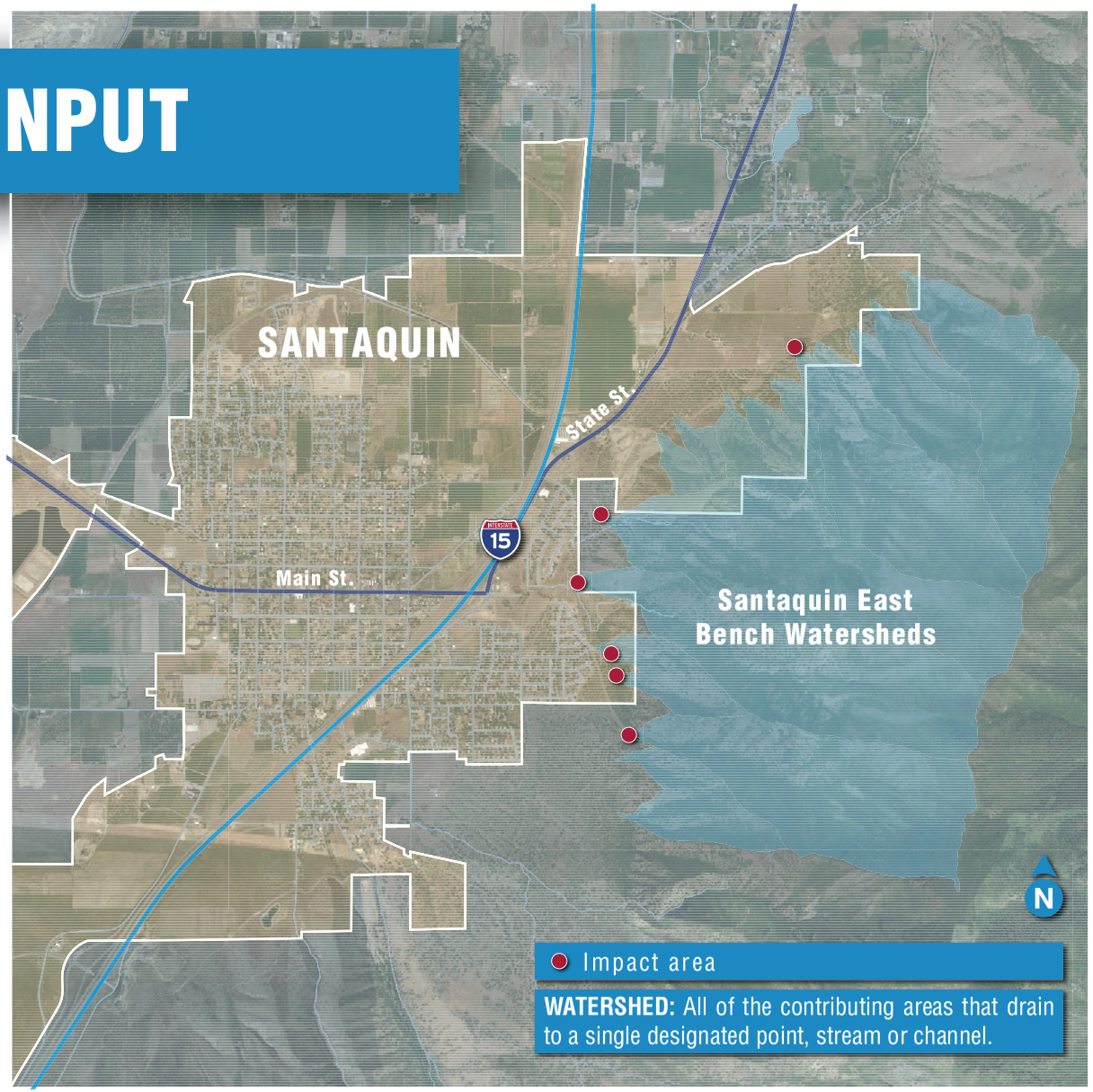
The meeting location is accessible to persons with disabilities. A request for an interpreter for the hearing impaired or for other accommodations for persons with disabilities should be made at least 48 hours before the meeting to Samantha Patterson at samantha.patterson@horrocks.com.

WE WANT YOUR INPUT

SANTAQUIN EAST BENCH FLOOD PREVENTION

ENVIRONMENTAL ASSESSMENT

Come to a public open house to provide input about potential improvements to Santaquin's east bench watersheds.



Santaquin

USDA United States Department of Agriculture

Natural Resources Conservation Service

Public Open House

Santaquin City, as the project sponsor and in partnership with the United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), is proposing to implement flood prevention measures within the Santaquin east bench watersheds.

You are invited to attend a public open house to review the Preferred Alternative and learn about the resource impacts from the study team. This is an opportunity for you to review the Draft Environmental Assessment and provide official comments. To view the Draft Environmental Assessment visit bit.ly/waterops.

WHEN	WHERE	CONTACT US
Thursday, Sep. 26, 2019 5-7 p.m.	C.S. Lewis Academy 364 North Hwy. 198, Santaquin, UT 84655	208-250-5538 samantha.patterson@horrocks.com

Feel free to attend anytime between 5 and 7 p.m.
Please contact us for additional study information.

The meeting location is accessible to persons with disabilities. A request for an interpreter for the hearing impaired or for other accommodations for persons with disabilities should be made at least 48 hours before the meeting by calling **208-250-5538** or emailing **samantha.patterson@horrocks.com**.

SANTAQUIN EAST BENCH FLOOD PREVENTION
ENVIRONMENTAL ASSESSMENT

Payson Chronicle

Publication Logo Unavailable

Publication Name:
Payson Chronicle

Publication URL:

Publication City and State:
Payson, UT

Publication County:
Utah

Notice Popular Keyword Category:

Notice Keywords:
Santaquin City

Notice Authentication Number:
20190912134020319774 2
1136056343

Notice URL:

Notice Publish Date:
Wednesday, September 11, 2019

Notice Content

Public Notice of Availability
The United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), with assistance of Santaquin City as the project sponsor, announces the availability of a draft Environmental Assessment (EA) describing the proposed improvements within the Santaquin Watershed in Utah County, Utah. The project may be partially funded through the Watershed Protection and Flood Prevention Act of 1954 (PL83-566) and the Draft EA has been prepared in compliance with the National Environmental Policy Act (NEPA) per 40 CFR Parts 1500-1508.
You are invited to attend a Draft Environmental Assessment public meeting, which will describe the alternatives analyzed and potential impacts to the environment from the project.
Draft Environmental Assessment Public Meeting
Date: September 26, 2019 - Thursday
Time: 5:00 PM to 7:00 PM (MST)
Location: C.S. Lewis Academy, 364 North Hwy 198, Santaquin, Utah 84655

Copies of the Draft EA are available for public review at:

NRCS Salt Lake City Office, 125 State Street #4010, Salt Lake City, Utah 84138
Santaquin City Offices, 275 West Main Street, Santaquin, UT 84655
Santaquin City Library, 20 West 100 South, Santaquin, Utah 84655

An electronic copy of the Draft EA is also available for review on the NRCS website: bit.ly/waterops
Comments may be submitted during the public comment period starting September 9, 2019 and ending on October 15, 2019 to:
Mail: Draft Supplemental Watershed Plan No. 1 and Environmental Assessment for Santaquin Flood Prevention Project
c/o Horrocks Engineers
2162 W. Grove Parkway, Suite 400, Pleasant Grove, UT 84062

Email: samantha.patterson@horrocks.com
Phone: (208) 250-5538

The meeting location is accessible to persons with disabilities. A request for an interpreter for the hearing impaired or for other accommodations for persons with disabilities should be made at least 48 hours before the meeting to Samantha Patterson at samantha.patterson@horrocks.com.
Published in The Payson Chronicle on September 11, 2019; and on September 18, 2019.

Attachment 2: Public Open House Attendance

Santaquin | USDA United States Department of Agriculture

SANTAQUIN EAST BENCH FLOOD PREVENTION

ENVIRONMENTAL ASSESSMENT

PUBLIC MEETING

SEPTEMBER 26, 2019

Name (Please print or write clearly)	Title/Representing	Email	Phone
Norm Evenstad	NRCS	norm.evenstad@usda.gov	801-524-4569
Daniel Ostrem	NRCS	daniel.ostrem@usda.gov	—
Lynne Cherrington	owner		
Steve Cherrington	"	sdcherr@gmail.com	435-660-6582
Michael Johnson	Self	mkj82939@gmail.com	
George L Brinkerhoff	Self	bgrandparents@hotmail.com	
Dave Sanchez	Self	dtsanchez740@gmail.com	801-471-9662
* Katie Dahl	Resident	dahlk10@yahoo.com	801-361-8908
Ben Reeves	City Manager	breeves@santaquin.org	(801) 420 2052
Derek Hamilton	NRCS	derek.hamilton@usda.gov	801/524-4560
Betsy Montoya	city council	bmontoya@santaquin.org	801-754-1399
Sheridan Meitzner	Self	meitzner@me.com	801-609-2198

Sign in sheet will become part of the public record for this project.

Santaquin USDA United States Department of Agriculture

SANTAQUIN EAST BENCH FLOOD PREVENTION

ENVIRONMENTAL ASSESSMENT

PUBLIC MEETING

SEPTEMBER 26, 2019

Name (Please print or write clearly)	Title/Representing	Email	Phone
Marilyn Ross	Resident	mountainministries@yahoo.com	801-368-6052
Jerry Ross	Resident		" " "
Marie Ashton			
Paul Ashton			801-318-0999
Bruce + Cathy Bradley	Resident		801-404-8175
* Mike Anderson		manderson@cslewisacademy.com	
Patty Jones	Resident	cookielady5@yahoo.com.	801-754-5220
Sam Bellows + LaRae	home owner	samlarae@gmail.com	801-228-8832

Sign in sheet will become part of the public record for this project.

Attachment 3: Public Open House Materials

Santaquin

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WELCOME

SANTAQUIN EAST BENCH FLOOD PREVENTION

ENVIRONMENTAL ASSESSMENT

PUBLIC OPEN HOUSE

September 26, 2019

5 - 7 p.m.

BACKGROUND

- Santaquin City, as the project sponsor and in partnership with the United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), has prepared an Environmental Assessment (EA) to evaluate environmental impacts associated with proposed flood prevention measures within the Santaquin east bench watersheds.
- The National Environmental Policy Act (NEPA) and the Council on Environmental Quality's regulations (40 CFR Parts 1500-1508) require an evaluation of potential environmental impacts associated with federal projects and actions with input from the public.

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PURPOSE & NEED

The purpose of the project is to control stormwater flooding and associated debris flow off Santaquin's east bench hillsides and prevent it from impacting private properties and public infrastructure.

The proposed action is needed because currently the study area lacks natural drainage channels to convey stormwater and debris flow away from residential and commercial properties along Santaquin's east bench and critical public infrastructure. Currently, due to the lack of natural channels in the area, stormwater and debris flow coming off the east bench results in sheet flow conditions within certain historic paths.

Debris Flow - September 2002

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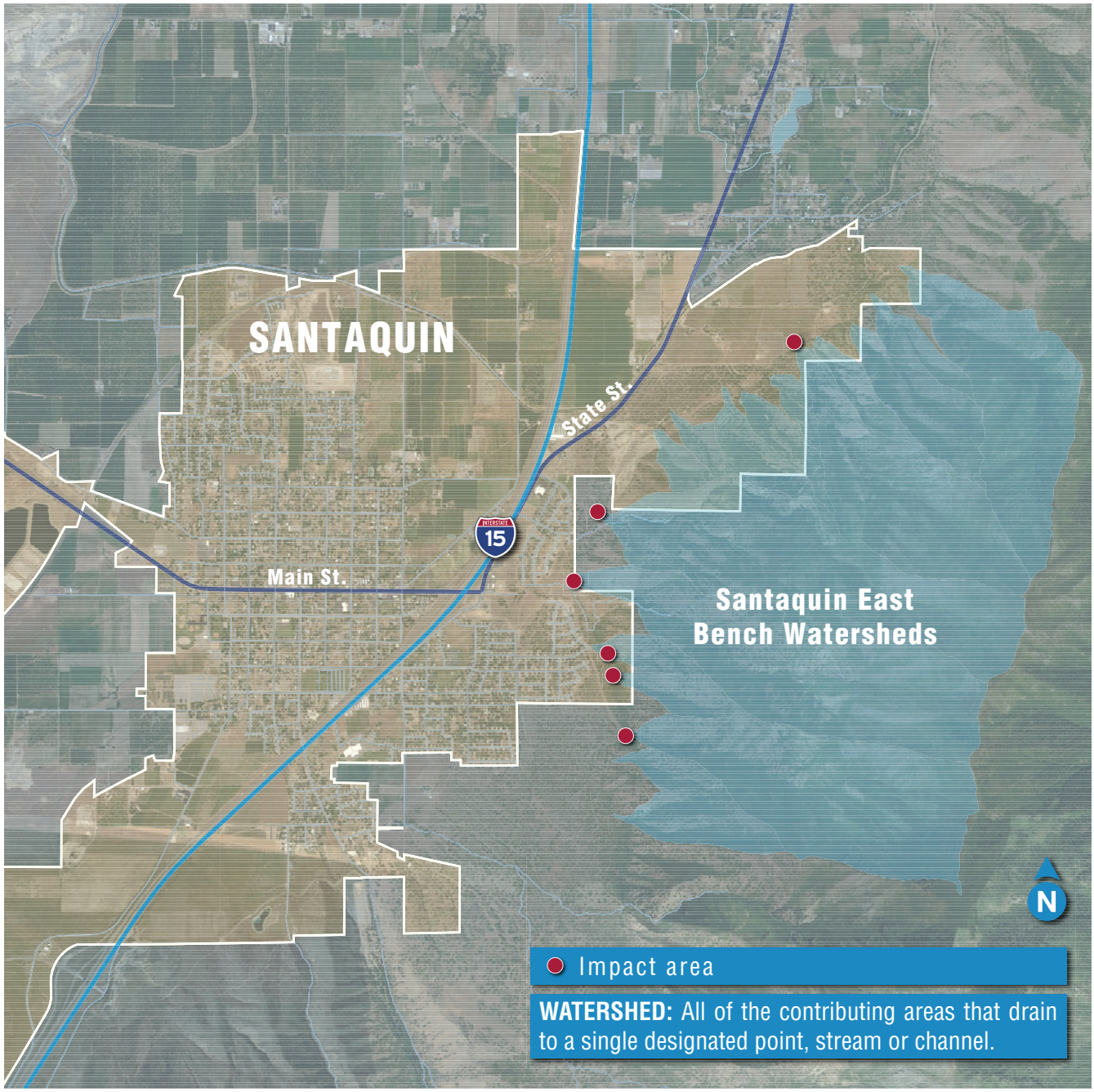
PROJECT AREA



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PROJECT DESCRIPTION

The Proposed Alternative includes five (5) separate debris basins at strategic locations associated with the drainage areas, as shown on the Project Area Map.

The NRCS designed all of the debris basins to channelize flooding and debris flows into debris basins that would be excavated into the hillsides, each with a principal spillway and a 50-foot-wide concrete structural auxiliary spillway to allow for a controlled release of water from the debris basins into existing channels or into the existing flow patterns that would be the drainage corridor absent the basin.

These debris basins would be below grade to the extent possible to reduce the risk of failure and to blend in with the natural hillsides to minimize impact on the viewshed, as well as save on the cost of construction and maintenance.

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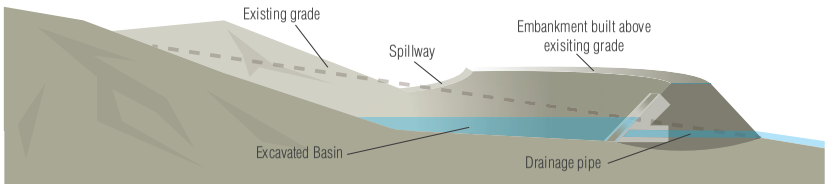
Natural Resources Conservation Service

WHAT IS A DEBRIS BASIN?

A debris basin is a basin that is specially engineered and constructed for storing large amounts of sediment in ephemeral stream channels. Typically located at the mouths of canyons, debris basins capture the sediment, gravel, boulders, and vegetative debris that are washed out of the canyons during storms.

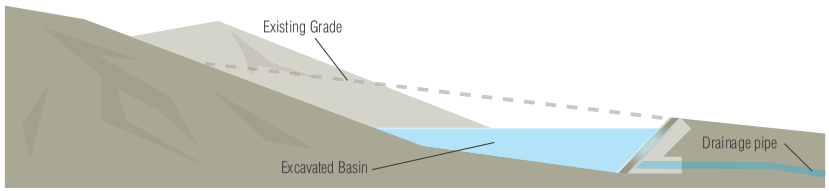
Debris Basin

Partially excavated basin and embankment built to collect debris and store stormwater.



Excavated Debris Basin

Fully excavated basin built to collect debris and store stormwater. No built up embankment.



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ENVIRONMENTAL RESOURCE IMPACTS

RESOURCE	ISSUE	DISCUSSION
SOILS		
SOILS AND GEOLOGIC CHARACTERST	Excavation required for the construction of proposed debris basins and associated features	The project would have an impact on soils in the study area during construction of the debris basin since the debris basins would require extensive excavation, but would not impact soil composition or otherwise impact geologic resources. The potential exists for impacts on the proposed flood prevention measures as a result of seismic activity, although the likelihood for seismic activity is low.
UPLAND EROSION	Erosion of upland soils impacting properties and infrastructure	The project would have a short-term increase in erosion during construction of the debris basins; however, protection measures would be installed during construction.
SEDIMENTATION	Prevention of debris flow	Debris basins are designed to catch sediment and flood flows during runoff events and reduce flood damage to properties below.
WATER RESOURCES		
HYDROLOGY	Prevention of flooding events from impacting properties and infrastructure	The project would have a minor alteration to the runoff hydrology in the project area in that it would catch flood flows to be safely released through the structures into historic drainage paths.
FLOODPLAIN MANAGEMENT	Prevention of flooding events from impacting properties and infrastructure	No FEMA-mapped floodplains are located in the study area. The debris basins would provide flood protection for properties below and are designed with outlets from the debris basins directing drainage into historic drainage paths.
AIR		
AIR QUALITY	Fugitive dust issues during construction	Construction activities would have temporary impacts to air quality in the study area.

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ENVIRONMENTAL RESOURCE IMPACTS

RESOURCE	ISSUE	DISCUSSION
VEGETATION		
VEGETATION COMMUNITIES/ HABITAT	Disturbing existing vegetation communities	Construction of the Debris Basin Alternative would temporarily impact existing vegetation communities and habitat. Disturbed areas would be reseeded with native vegetation in exposed, disturbed areas. Permanent impacts would result in those areas converted to flood prevention measures.
INVASIVE SPECIES	Construction activity that would disturb soils and allow for potential spread of invasive species	Due to construction activities, there is the potential to spread invasive species. BMPs would be used during construction to prevent the introduction or spread of invasive species.
WILDLIFE		
WILDLIFE COMMUNITIES	Disturbance to wildlife due to construction activities	There would be temporary impacts to wildlife communities during construction due to noise and other construction-related activities. No wildlife communities would be adversely impacted long-term.
HUMAN ENVIROMENT		
LAND USE	Required land acquisition	The proposed action would require land acquisition for the new drainage features (i.e., debris basins and associated structures), as well as easements for induced flooding concerns. **Any needed land for the proposed debris basins would be acquired by Santaquin without any NRCS involvement, as the PL 83-566 Watershed Program does not authorize funding for land acquisition.**
SCENIC BEAUTY/ VISUAL RESOURCES	Anticipated changes to the natural views in the study area due to the inclusion of new flood prevention mitigation measures	The proposed action would introduce new drainage features (i.e., debris basins and associated structures) into the viewshed. The majority of the project improvements would be below grade, with the extent of the visual intrusion into the viewshed dependent upon the height of dam structures, which varies by site.
PUBLIC HEALTH AND SAFETY	Prevention of flooding and debris flow events from impacting properties and infrastructure	The proposed action would address public health and safety concerns by reducing the risk of future flooding and debris flows from impacting residential and agricultural properties and public infrastructure.
SOCIOECONOMICS	Prevention of flooding and debris flow events from impacting properties and infrastructure	Due to the protection of private lands and public infrastructure with the implementation of flooding protection measures, the proposed action would protect existing and future properties, infrastructure, land uses and provide community peace of mind during flood events.

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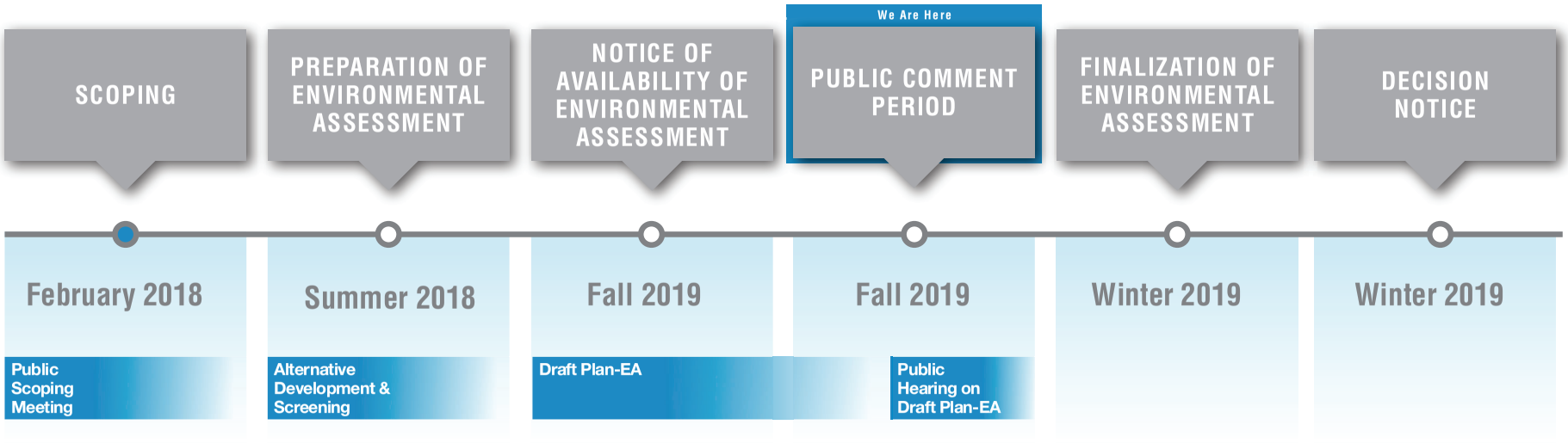
NEPA PROCESS & SCHEDULE



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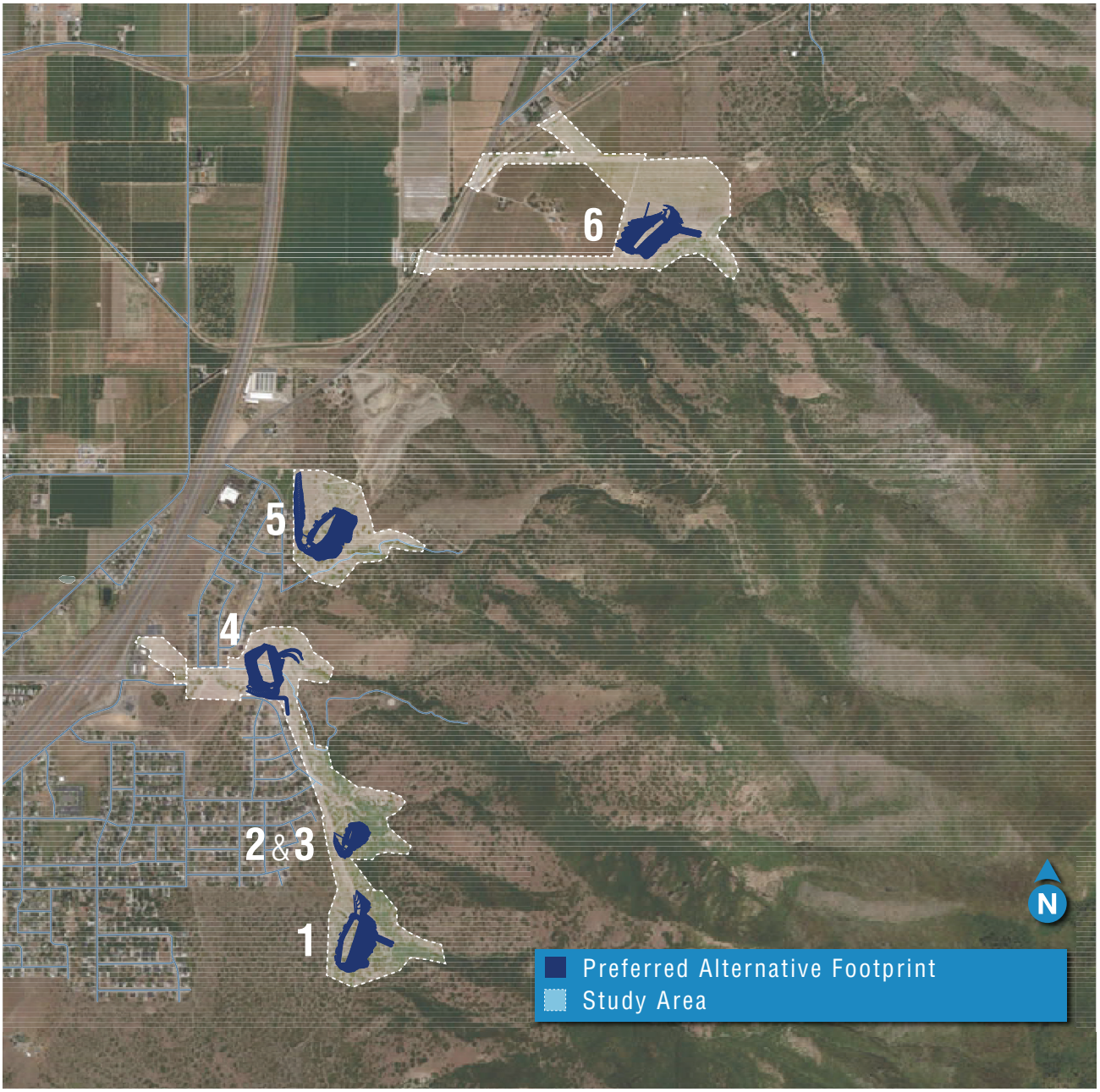
DEBRIS BASIN LOCATIONS



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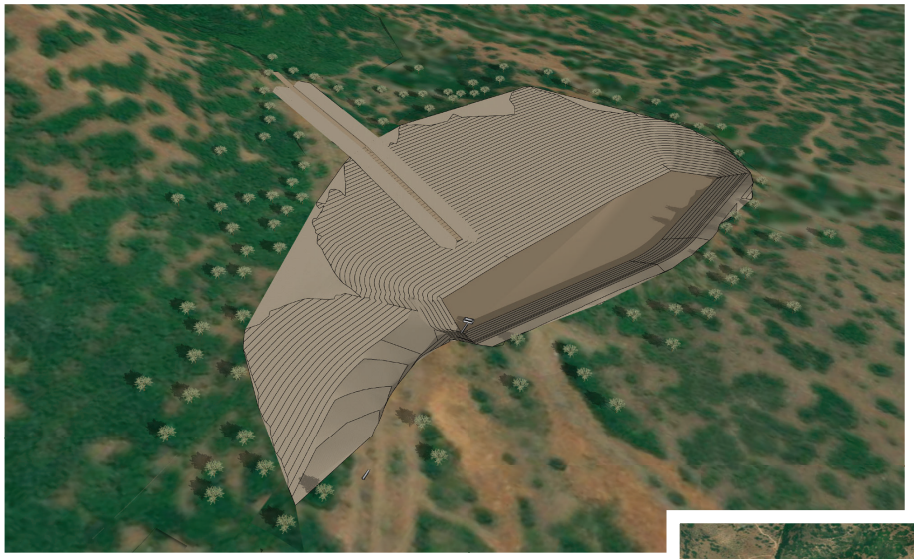
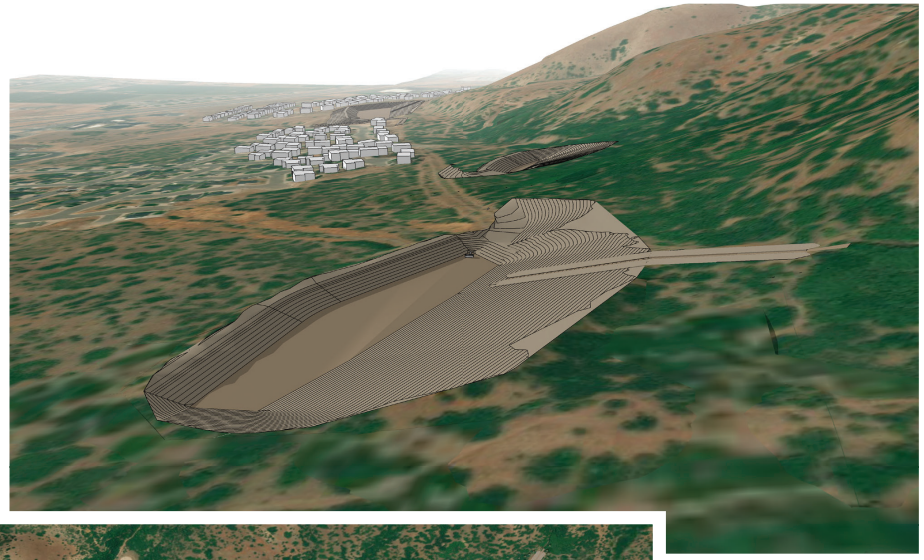
DEBRIS BASIN 1





Site 1 consists of a below-grade debris basin designed to capture debris flows to protect residential properties located downstream. It has a concrete spillway that would direct excess water flows back to the existing natural drainageway.

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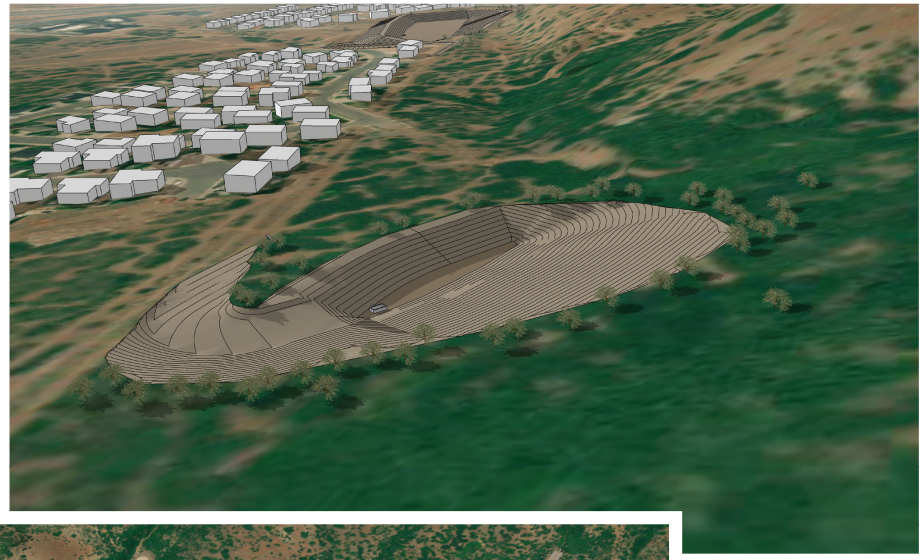
DEBRIS BASIN 2-3



The debris basin for the combined Sites 2 and 3 consists of a below-grade debris basin that would contain flows from both drainages and a concrete spillway that would allow excess water flows to exit the debris basin into the existing natural drainageway.

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DEBRIS BASIN 4

Site 4 consists of a debris basin that would be partially constructed above-grade with a 20-foot embankment that would be built about 19 feet above the existing grade. The existing hook channel would be diverted into this basin and capture flooding/ debris flow and conduct excess flows to the existing natural drainageway via a concrete spillway.

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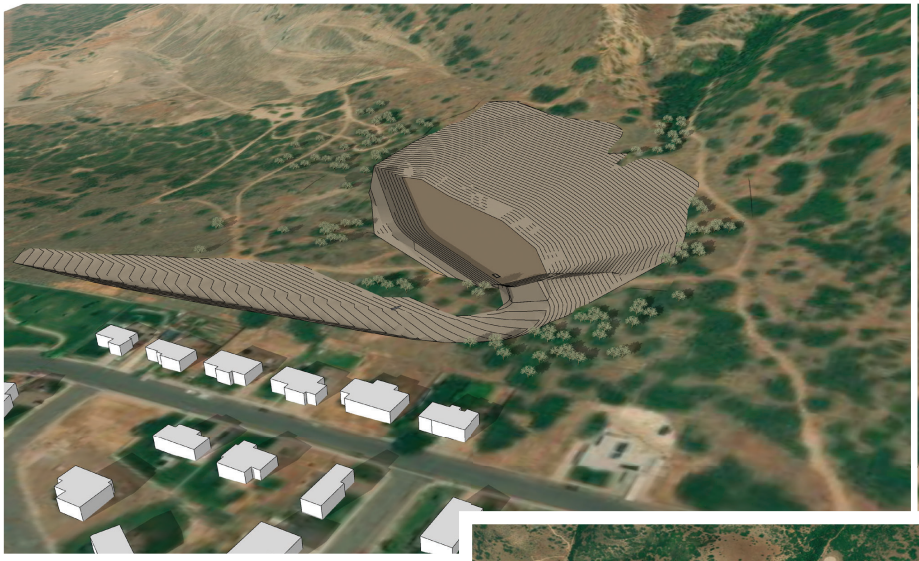
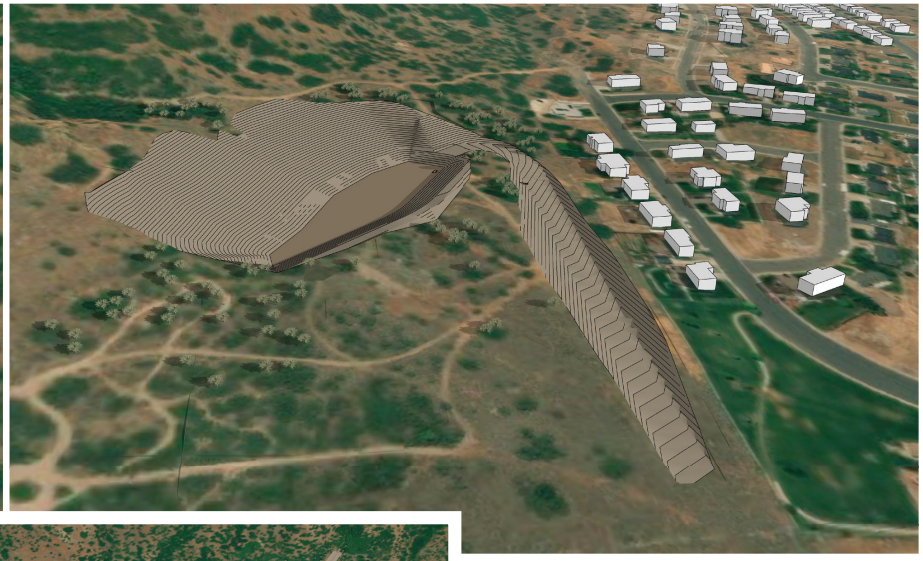
DEBRIS BASIN 5





Site 5 consists of a debris basin to be constructed mostly below-grade and designed to hold a large amount of debris in order to provide protection to residences downstream. Any excess flows would be directed to their historic path via a concrete spillway.

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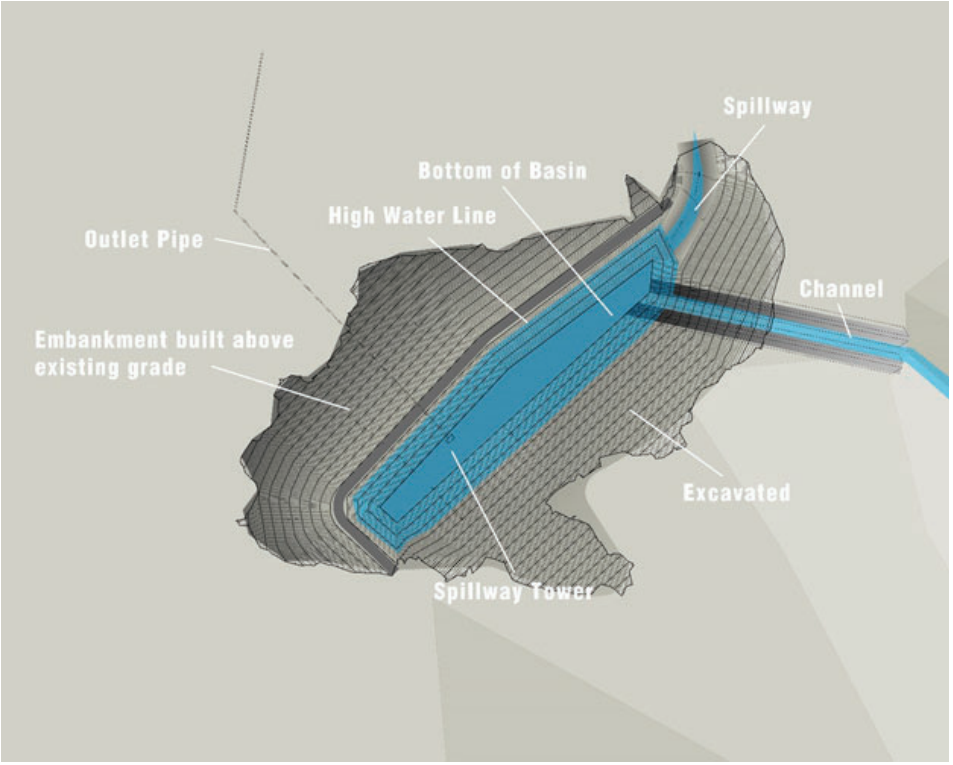
Natural Resources Conservation Service

DEBRIS BASIN 6



Site 6 consists of a debris basin that would be constructed partially above-grade with an 18-foot embankment that would be built about 23 feet above the existing grade. Excess flows would be directed to their historic pathways via a concrete spillway.

United States Department of Agriculture

HOW TO COMMENT

Comments are due by October 15, 2019

Submit comments tonight

Email: samantha.patterson@horrocks.com

Mail:

Horrocks Engineers
Attn: Samantha Patterson
2162 W. Grove Parkway, Suite 400
Pleasant Grove, UT 84062

Santaquin

USDA United States Department of Agriculture
Natural Resources Conservation Service

BEN
REEVES

Santaquin

USDA United States Department of Agriculture
Natural Resources Conservation Service

CIANNA
WYSHNYTZKY

Santaquin

USDA United States Department of Agriculture
Natural Resources Conservation Service

JACOB
O'BRYANT

Santaquin

USDA United States Department of Agriculture
Natural Resources Conservation Service

JUDY
IMLAY

Santaquin

USDA United States Department of Agriculture
Natural Resources Conservation Service

SAMANTHA
PATTERSON

Santaquin

USDA United States Department of Agriculture
Natural Resources Conservation Service

NORM
BEAGLEY

Santaquin

USDA United States Department of Agriculture
Natural Resources Conservation Service

NORM
EVENSTAD

Santaquin

USDA United States Department of Agriculture
Natural Resources Conservation Service

JASON
BOND

Attachment 4: Public Open House Comments

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COMMENT FORM

SANTAQUIN EAST BENCH FLOOD PREVENTION

ENVIRONMENTAL ASSESSMENT

CONTACT INFORMATION

Name: Marilyn Ross
Organization:
Address: 350 So 400 East
City: Santaquin
State: Ut
Zip: 84655
Phone Number: 801-368 6082
Email: mountainviewfire@yahoo.com

COMMENTS

Submit comments by October 15, 2019

Please provide any input or concerns about the proposed project.

This sounds like a good Project for the upper bench but we are on 400 East and we are sick of getting flooded with mud and water from the Rain Storms. All the water comes from the house above us that have sidewalks and all there water comes down & Floods us cause we are the lowest house with no sidewalks so are house sits below the road also. And the water goes right into our house with mud and water.

Please provide any other information or comments you feel would be helpful to the study team.

We are getting old and have to go out with a shovel to try and divert the water and mud. All these new homes have brought on a heck of a lot of water down to us from there sidewalks and curb. It causes trenches to which we have to buy gravel every year to make our yard look nice. It is a never ending battle. Been there 45 yrs and never had trouble untill all these homes were built.

Thank you for your input. We look forward to a successful project. Please email comments to **samantha.patterson@horrocks.com** or fold, secure and stamp this form and mail to the address on the back. **Please postmark them on or before October 15, 2019.**

Santaquin

USDA United States Department of Agriculture

COMMENT FORM

SANTAQUIN EAST BENCH FLOOD PREVENTION

ENVIRONMENTAL ASSESSMENT

CONTACT INFORMATION

Name: George L Brinkerhoff Organization: home owner

Address: 127 E 8 South 3620 West

City: Spring Lake (annexed in to Santaquin) State: Utah Zip: 84651

Phone Number: 801-465-4720

Email: bgrandparents@hotmail.com

COMMENTS

Submit comments by October 15, 2019

Please provide any input or concerns about the proposed project.

In the last year, starting on Oct 3rd We have been hit by 5 mud slides. Thousands of tons of mud, rocks, and water. 2 last October 3 in July of this year.

The Santaquin plan seems to address everything but us, and no where in Santaquin was affected nearly as seriously as we were. If the October floods had happened when the canal was full of water, the entire town of Spring Lake would have been flooded.

Please provide any other information or comments you feel would be helpful to the study team.

Why are we not being helped, are we not as important as other Santaquin residents? If we don't count, why did Santiquin annex us?

Thank you for your input. We look forward to a successful project. Please email comments to **samantha.patterson@horrocks.com** or fold, secure and stamp this form and mail to the address on the back. **Please postmark them on or before October 15, 2019.**

Santaquin

USDA United States Department of Agriculture

COMMENT FORM

SANTAQUIN EAST BENCH FLOOD PREVENTION

ENVIRONMENTAL ASSESSMENT

CONTACT INFORMATION

Name: Michael Johnson Organization:

Address: 319 N Appleview Dr

City: Santaquin State: UT Zip: 84655

Phone Number:

Email: MKJ82939@gmail.com

COMMENTS

Submit comments by October 15, 2019

Please provide any input or concerns about the proposed project.

Great Descriptions & Design of proposed debris Basins. All for it. especially if we have another fire on the mountain.

Please provide any other information or comments you feel would be helpful to the study team.

Thank you for your input. We look forward to a successful project. Please email comments to **samantha.patterson@horrocks.com** or fold, secure and stamp this form and mail to the address on the back. **Please postmark them on or before October 15, 2019.**

APPENDIX B

PROJECT MAPS

Supplemental Watershed Plan No. 1 and Environmental Assessment for Santaquin Flood Prevention

Santaquin Watershed
Utah County, Utah

October 2019

Legend

- City Boundary
- Current Study Watersheds
- Original Plan Watershed
- Townships
- Sections

N
W E
S

T9S R2E

Highline Canal

T10S R1E

T10S R2E

T11S R1E

T11S R1.5E

T11S R2E

0 0.5 1 2 3 4 Miles

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

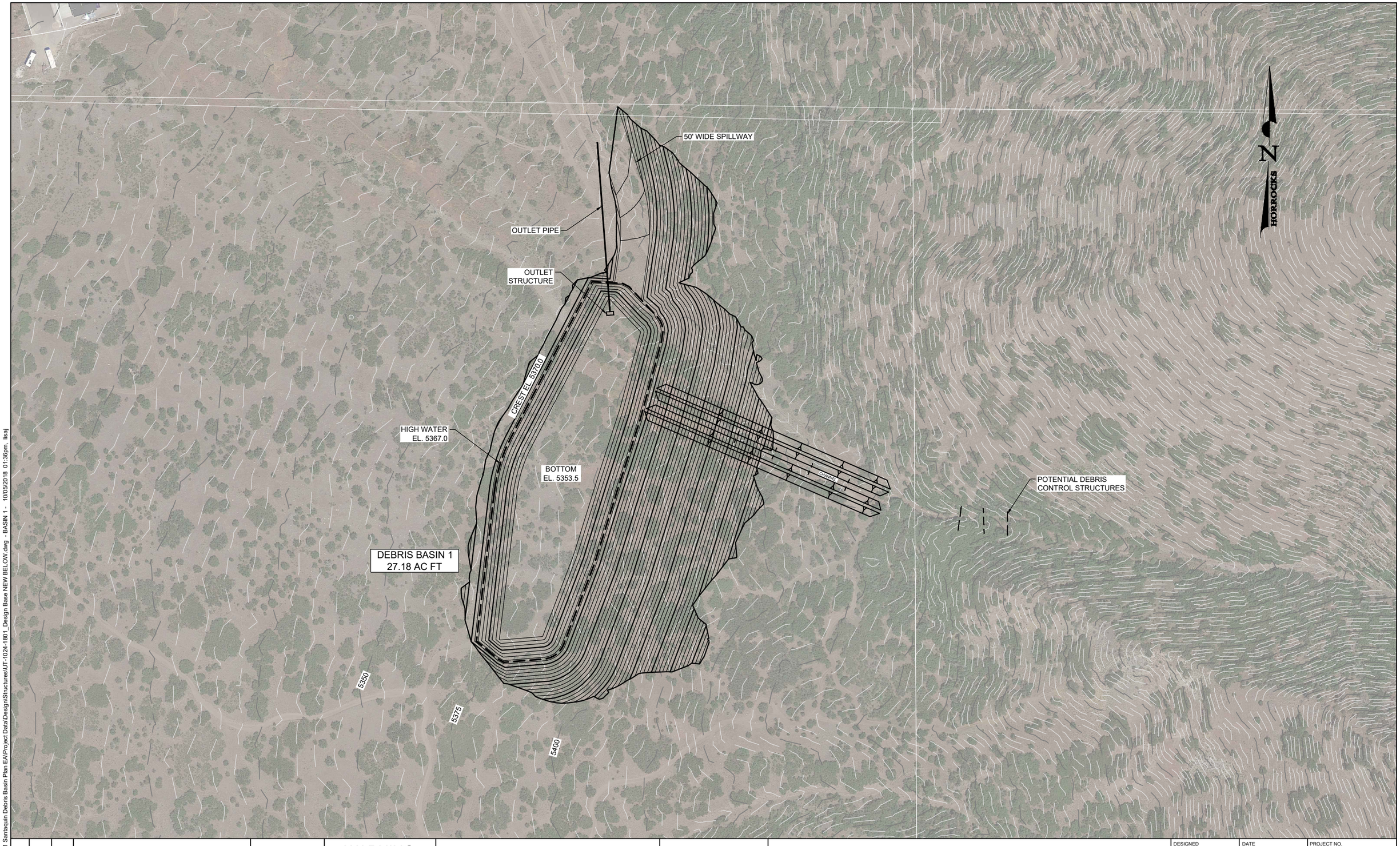
O:\2018\UT-1024-1801 Santaquin Debris Basin Plan EA\Project Data\GIS\Horrocks\Mxd\Santaquin Canyon Updated Map.mxd, 6/5/2019 10:35:50 AM, JacobO

Santaquin Canyon Watershed Map, Utah

U.S. Department of Agriculture, Natural Resources Conservation Service

DATE 6/5/2019

DRAWN



O:\2018\UT-1024-1801 Santaquin Debris Basin Plan EA\Project Data\Design\Structures\UT-1024-1801_Design Base NEW BELOW.dwg - BASIN 1 - 10/05/2018 01:36pm, lisaj

PRELIMINARY

NOT FOR CONSTRUCTION

REV	DATE	BY	DESCRIPTION
REVISIONS			

SCALE

HORIZONTAL 1" = 150'

VERTICAL N/A

WARNING

0 1/2 1

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

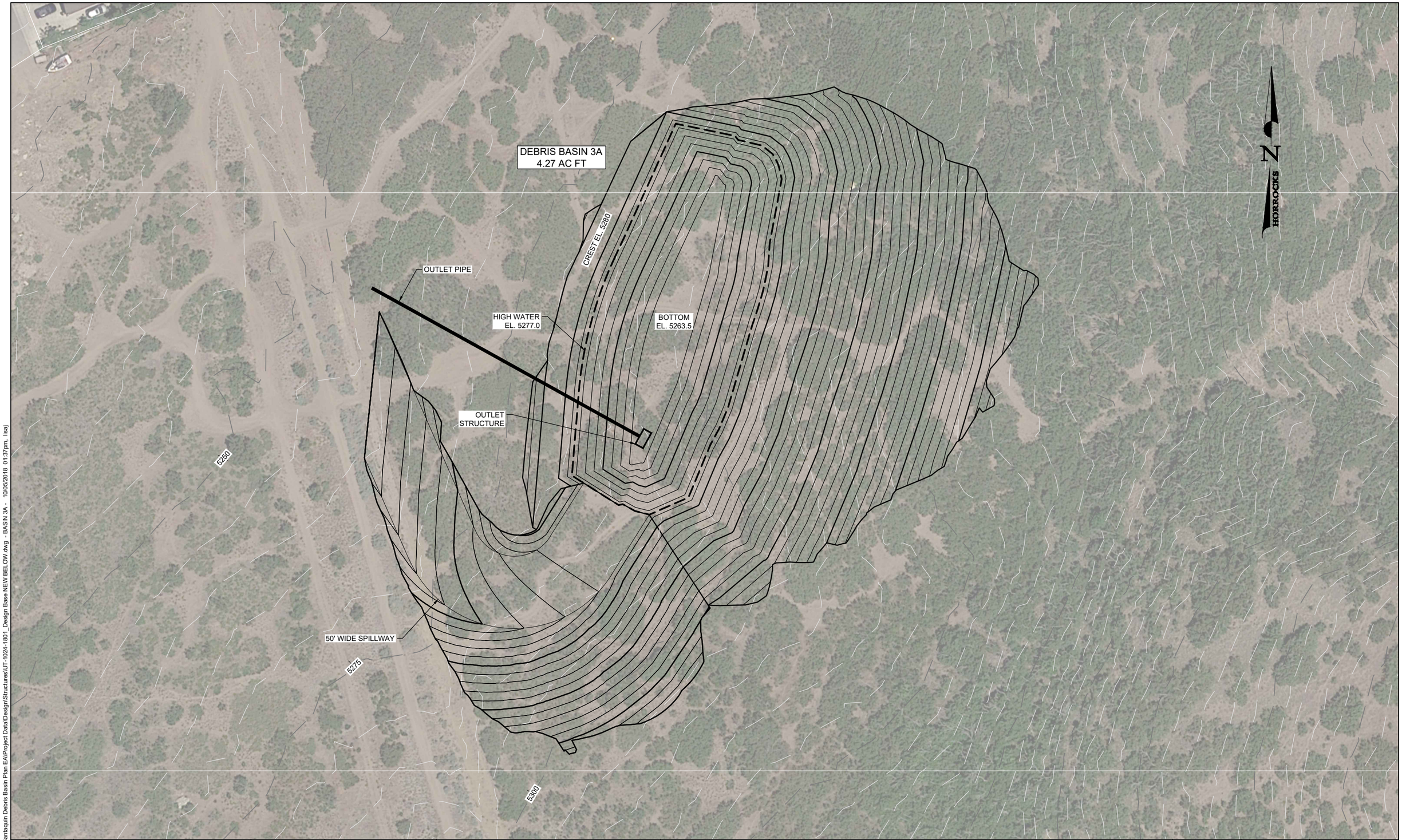
HORROCKS ENGINEERS

2162 West Grove Parkway
Suite 400
Pleasant Grove, UT 84062
(801) 763-5100

SANTAQUIN DEBRIS BASINS

BASIN 1 - BELOW GRADE

DESIGNED ####	DATE ####	PROJECT NO. PG-1024-1801
DRAWN ####	DATE ####	SHEET NO. # OF #
CHECKED ####	DATE ####	DRAWING NO. P-01



O:\2018\UT-1024-1801 Santaquin Debris Basin Plan EA\Project Data\Design\Structures\UT-1024-1801_Design Base NEW BELOW.dwg - BASIN 3A - 10/05/2018 01:37pm, lisaj

PRELIMINARY
NOT FOR CONSTRUCTION

REV	DATE	BY	DESCRIPTION
REVISIONS			

SCALE
HORIZONTAL 1" = 60'
VERTICAL N/A

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

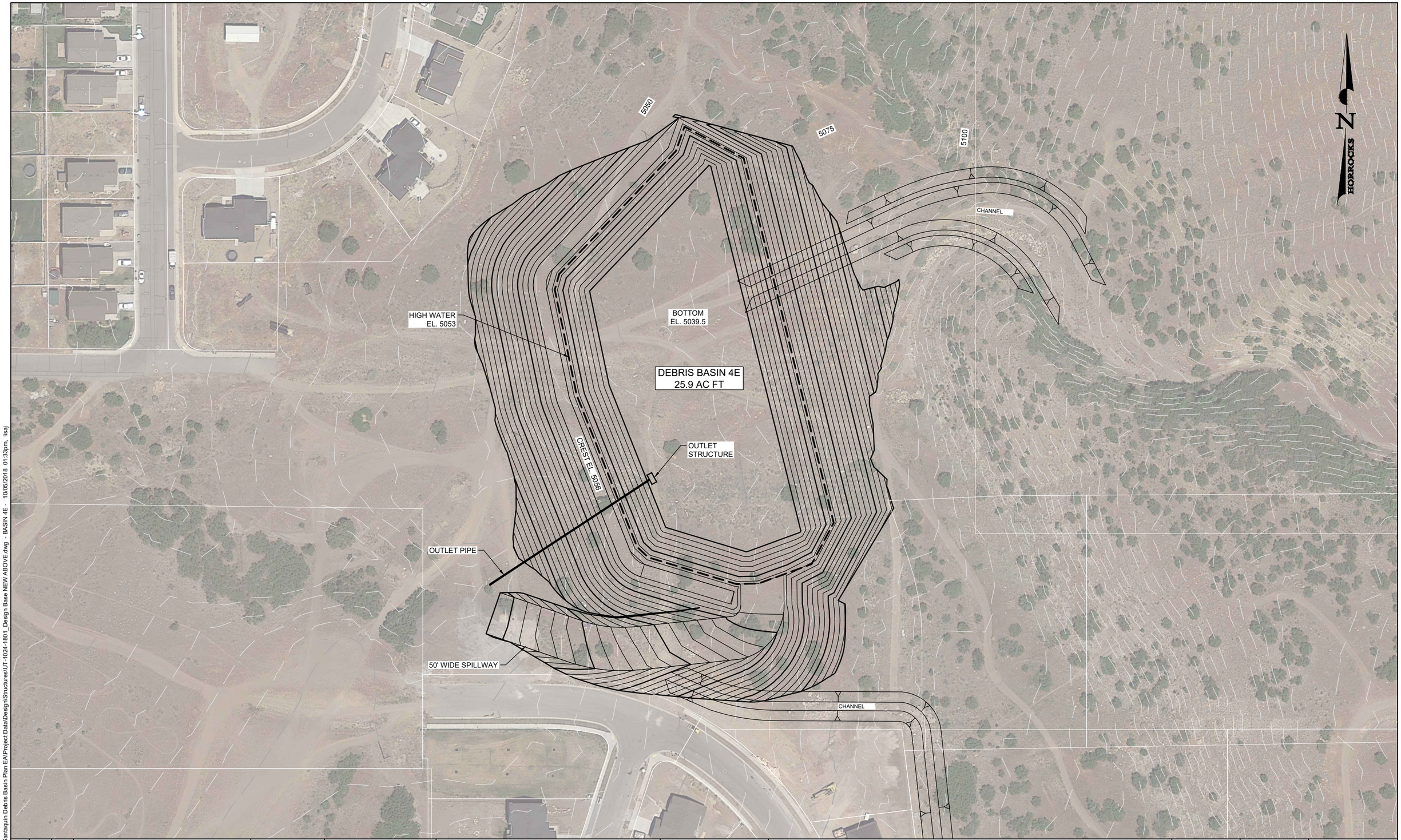
HORROCKS ENGINEERS

2162 West Grove Parkway
Suite 400
Pleasant Grove, UT 84062
(801) 763-5100

SANTAQUIN DEBRIS BASINS

BASIN 3A - BELOW GRADE (WATERSHEDS 2 & 3 COMBINED)

DESIGNED	DATE	PROJECT NO.
####	####	PG-1024-1801
DRAWN	DATE	SHEET NO.
####	####	# OF #
CHECKED	DATE	DRAWING NO.
####	####	P-05



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PRELIMINARY

NOT FOR CONSTRUCTION

REV	DATE	BY	DESCRIPTION

REVISIONS

SCALE

HORIZONTAL 1" = 100'

VERTICAL N/A

WARNING

0 1/2 1

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

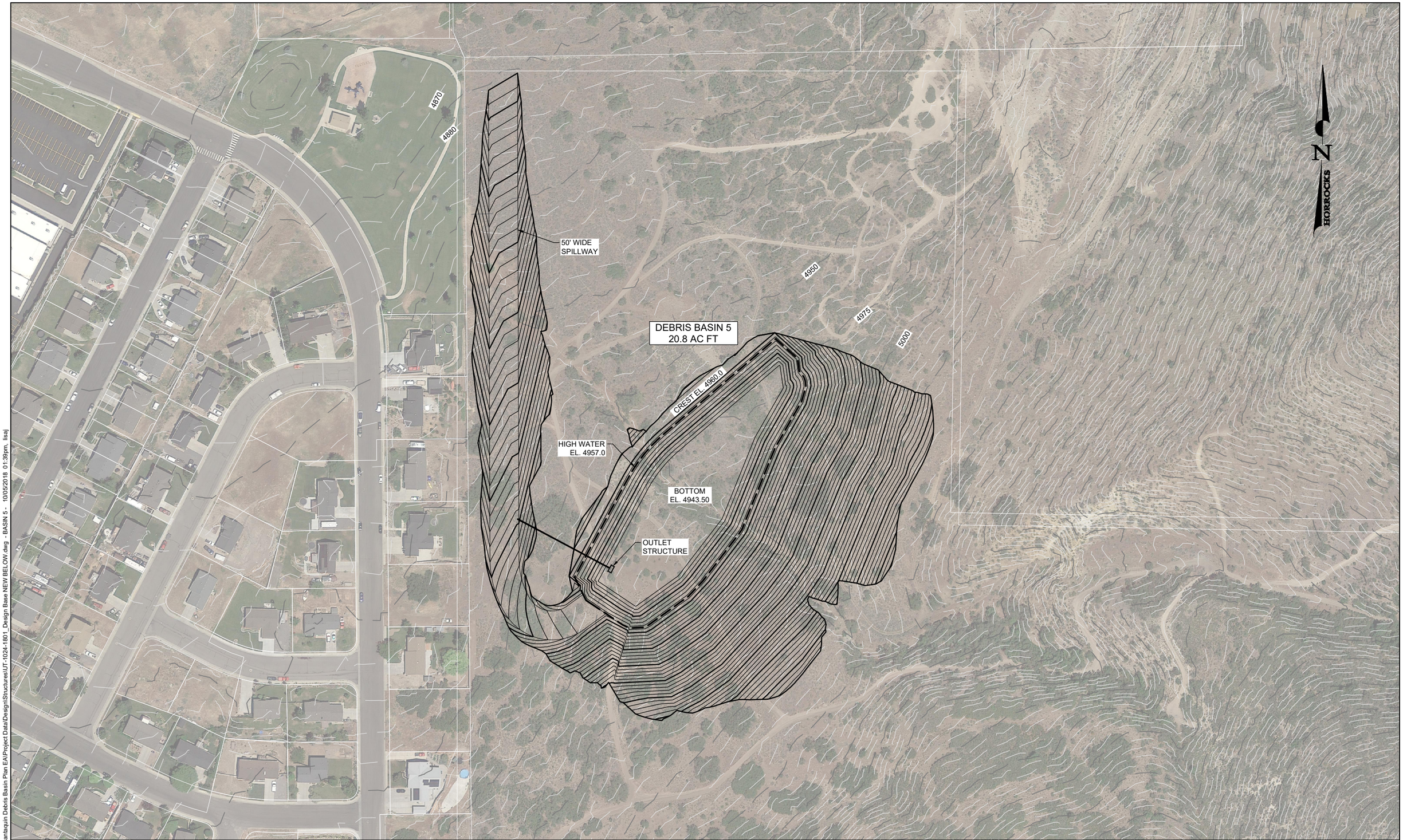
HORROCKS ENGINEERS

2162 West Grove Parkway
Suite 400
Pleasant Grove, UT 84062
(801) 763-5100

SANTAQUIN DEBRIS BASINS

BASIN 4E - ABOVE GRADE (WATERSHED ONLY)

DESIGNED	DATE	PROJECT NO.
####	####	PG-1024-1801
DRAWN	DATE	SHEET NO.
####	####	5 OF 12
CHECKED	DATE	DRAWING NO.
####	####	P-05



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PRELIMINARY

NOT FOR CONSTRUCTION

REV	DATE	BY	DESCRIPTION
REVISIONS			

SCALE	
HORIZONTAL	1" = 150'
VERTICAL	N/A

WARNING

0 1/2 1

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

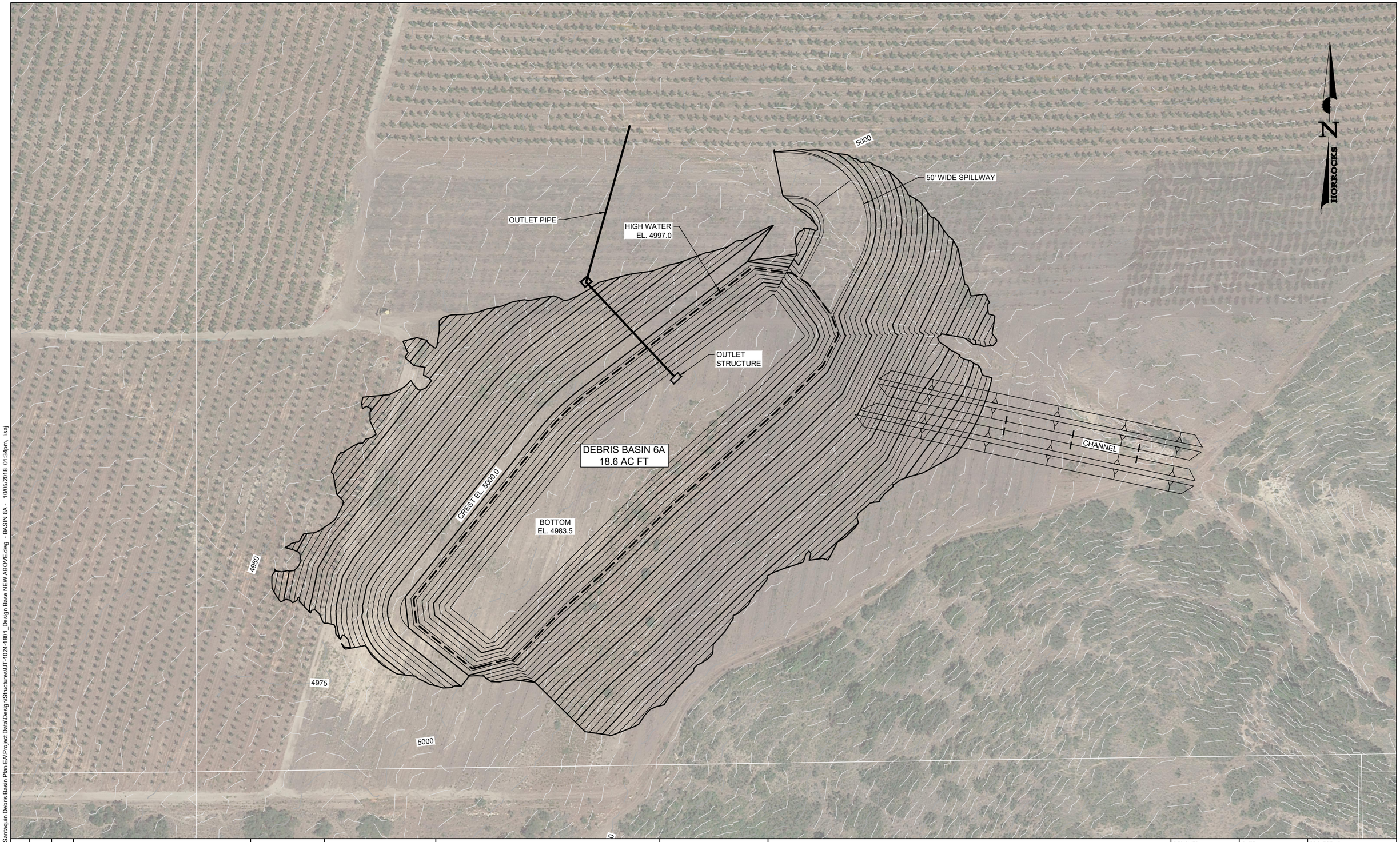
HORROCKS ENGINEERS

2162 West Grove Parkway
Suite 400
Pleasant Grove, UT 84062
(801) 763-5100

SANTAQUIN DEBRIS BASINS

BASIN 5 - BELOW GRADE

DESIGNED ####	DATE ####	PROJECT NO. PG-1024-1801
DRAWN ####	DATE ####	SHEET NO. # OF #
CHECKED ####	DATE ####	DRAWING NO. P-12



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PRELIMINARY

NOT FOR CONSTRUCTION

REV	DATE	BY	DESCRIPTION
REVISIONS			

SCALE

HORIZONTAL 1" = 100'

VERTICAL N/A

WARNING

0 1/2 1

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

HORROCKS ENGINEERS

2162 West Grove Parkway
Suite 400
Pleasant Grove, UT 84062
(801) 763-5100

SANTAQUIN DEBRIS BASINS

BASIN 6A - ABOVE GRADE

DESIGNED ####	DATE ####	PROJECT NO. PG-1024-1801
DRAWN ####	DATE ####	SHEET NO. # OF #
CHECKED ####	DATE ####	DRAWING NO. P-07

APPENDIX C

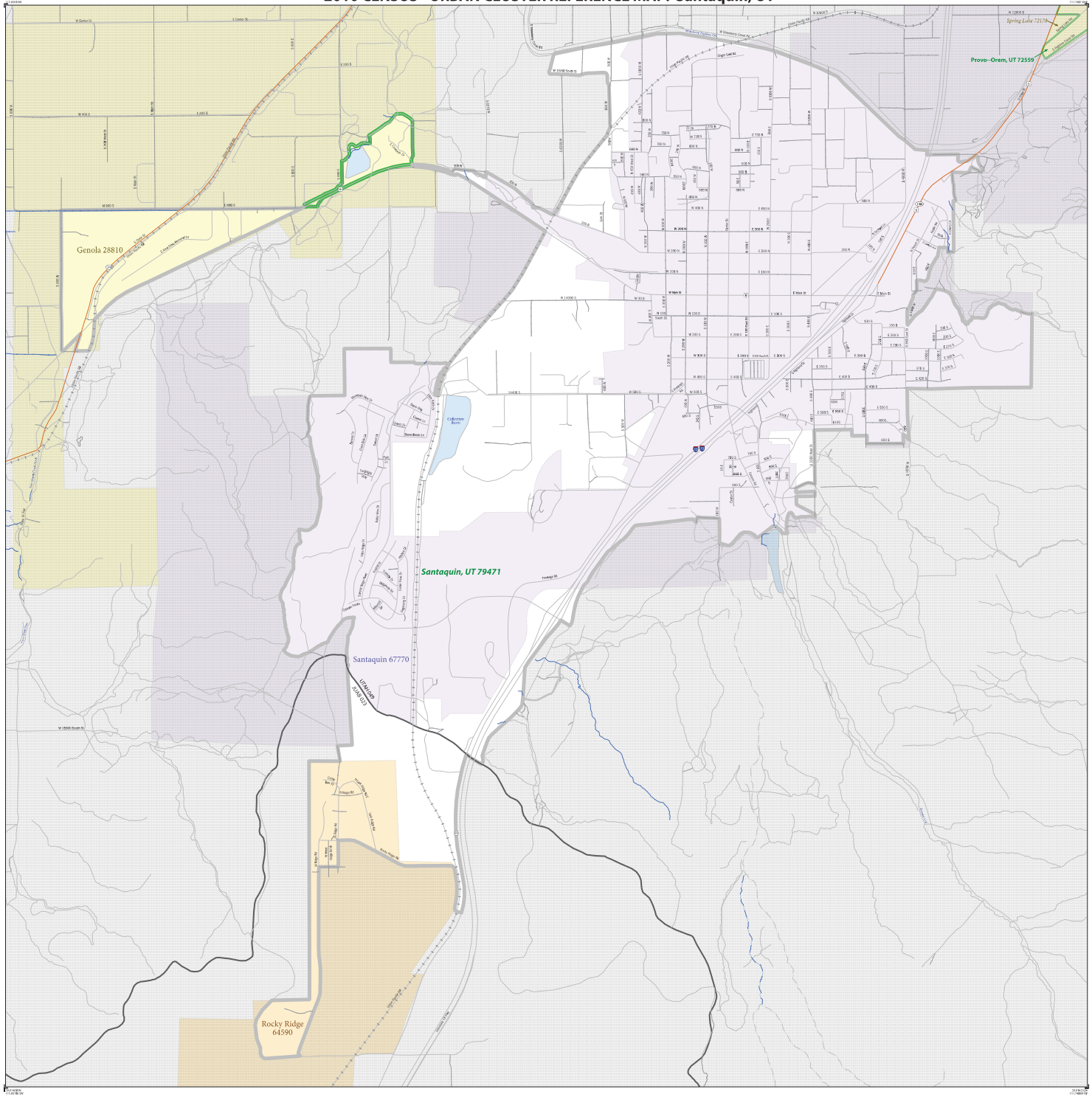
SUPPORT MAPS

Supplemental Watershed Plan No. 1 and Environmental Assessment for Santaquin Flood Prevention

Santaquin Watershed
Utah County, Utah

October 2019

2010 CENSUS - URBAN CLUSTER REFERENCE MAP: Santaquin, UT



LEGEND

SYMBOL DESCRIPTION	SYMBOL	LABEL STYLE
International		CANADA
Federal American Indian Reservation		L'ANSE RES 1880
Off-Reservation Trust Land		T1880
Urbanized Area		Dover, DE 24580
Urban Cluster		*Tooele, VT 88057*
State (or statistically equivalent entity)		NEW YORK 36
County (or statistically equivalent entity)		ERIE 029
Minor Civil Division (MCD)[1,2]		Bristol town 07485
Consolidated City		MILFORD 47500
Incorporated Place[1,3]		Davis 18100
Census Designated Place (CDP)[3]		*Incline Village 35100*

DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL
Interstate		Water Body	Pleasant Lake
U.S. Highway		Military	
State Highway		Outside Subject Area	
Other Road			
Railroad			
Perennial Stream			
Intermittent Stream			

Where international, state, county, and/or MCD boundaries coincide, the map shows the boundary symbol for only the highest-ranking of these boundaries.

1 A "*" following an MCD name denotes a false MCD. A "*" following a place name indicates that a false MCD exists with the same name and FIPS code as the place; the false MCD label is not shown.

2 *MCD boundaries are shown in the following states in which some or all MCDs function as general-purpose governmental units:* Connecticut, Illinois, Indiana, Kansas, Maine, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Hampshire, New Jersey, New York, North Dakota, Ohio, Pennsylvania, Rhode Island, South Dakota, Vermont, and Wisconsin. (Note that Illinois and Nebraska have some counties covered by nongovernmental precincts and Missouri has most counties covered by nongovernmental townships.)

3 Place label color corresponds to the place fill color.
Label colors: Davis Davis Davis Davis Davis

SUBJECT AREA COUNTIES ON MAP SHEET
49023 Utah
49049 Utah

All legal boundaries and names are as of January 1, 2010. Urban areas are based on results from the 2010 Decennial Census. The boundaries shown on this map are for Census Bureau statistical data collection and tabulation purposes only; their depiction and designation for statistical purposes does not constitute a determination of jurisdictional authority or rights of ownership or entitlement.

Geographic Vintage: 2010 Census (reference date: January 1, 2010)
Data Source: U.S. Census Bureau's MAF/TIGER database (TAB10)
Map Created by Geography Division: March 09, 2012

U.S. DEPARTMENT OF COMMERCE Economics and Statistics Administration U.S. Census Bureau

Projection: Albers Equal Area Conic
Datum: NAD 83
Spheroid: GRS 80
1st Standard Parallel: 37 49 54
2nd Standard Parallel: 41 10 82
Central Meridian: -111 32 46
Latitude of Projection's Origin: 36 59 52
False Easting: 0
False Northing: 0

0 0.2 0.4 0.6 0.8 Kilometers
0 0.2 0.4 0.6 0.8 Miles
The plotted map scale is 1:12748

PARENT SHEET 1

Total Sheets: 1
- Index Sheets: 0
- Parent Sheets: 1

UC NAME: Santaquin, UT
UC CODE: 79471
ENTITY TYPE: Urban Cluster (UC)
ST: Utah (49)

2010 CENSUS UC REF MAP (PARENT)
22237471001

Investigation and Analysis Report for Supplemental Watershed Plan No. 1 for Santaquin Flood Prevention

Appendix D

Santaquin East Bench
Utah County, Utah

The purpose of the Investigation and Analyses Report is to present information that supports the formulation, evaluation and conclusions of the Draft Supplemental Watershed Plan and Environmental Assessment for Santaquin East Bench Flood Prevention (Draft Plan-EA). The report is required and must be included as an appendix to the Final Plan-EA.

The procedures, techniques, assumptions, and the scope and intensity of the investigations for each subject is described in sufficient detail so that a reader not familiar with the watershed or its problems can form an opinion on the adequacy of the Draft Plan-EA. This report supplements information contained in the Draft Plan-EA and is not intended to replace or duplicate information contained therein.

October 2019

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ADDENDUM

D.1 Introduction

The planning studies presented in this Investigation and Analysis Report (I&A Report) are based on standard methods, procedures, and computer programs used and approved for use by the United States Department of Agriculture Natural Resources Conservation Service (NRCS). The following information gives a summary of the investigation and analysis for the key planning studies in the preparation of the Environmental Assessment (EA) for the Santaquin East Bench Debris Basins. Additional information relevant to each of the sections provided in this report is available upon request as part of the administrative record for the project. Requests for additional information can be submitted to the following address:

USDA-NRCS
Wallace F. Bennett Federal Building
125 S State St., Room 4010
Salt Lake City, UT 84138-1100

Santaquin City is located in the southernmost part of Utah County just south of Utah Lake. It is bordered on two sides by portions of the Wasatch Mountain range (on the west by West Mountain and Rocky Ridge and on the east by Dry Mountain. The Uinta-Wasatch-Cache National Forest is located east of Santaquin and is managed by the U.S. Forest Service (USFS). In 2001, the 8000-acre Mollie Fire burned across the steep mountain watersheds above Santaquin to the east, denuding the mountainside of all vegetation that stabilized the soils and retarded runoff. Because of the lack of soil-stabilizing vegetation on the east benches of Santaquin, intense storm bursts in 2002 and 2004 created two debris flows that damaged residential homes and property, flowed through agricultural land, and filled in and overtopped the Highline Canal, which is a critical regional irrigation distribution canal. The debris flow event in 2002 was nearly large enough to impact I-15, the major interstate freeway in the area. The purpose of the project is to control and prevent storm water flooding and associated debris flow resulting from erosion off the east bench hillsides that constitute the Santaquin Canyon subwatershed and from impacting private properties and public infrastructure. The project is intended to provide substantial flood reduction from the 100-year-storm event and to prevent flooding from the 25-year fire-related event and debris flow from the typical 5-year storm event.

Note on Vertical Datum: All elevations provided in this I&A Report for current conditions are in North American Vertical Datum of 1988 (NAVD88).

Debris basins and the subwatersheds they would protect against are shown in Figure D-1.

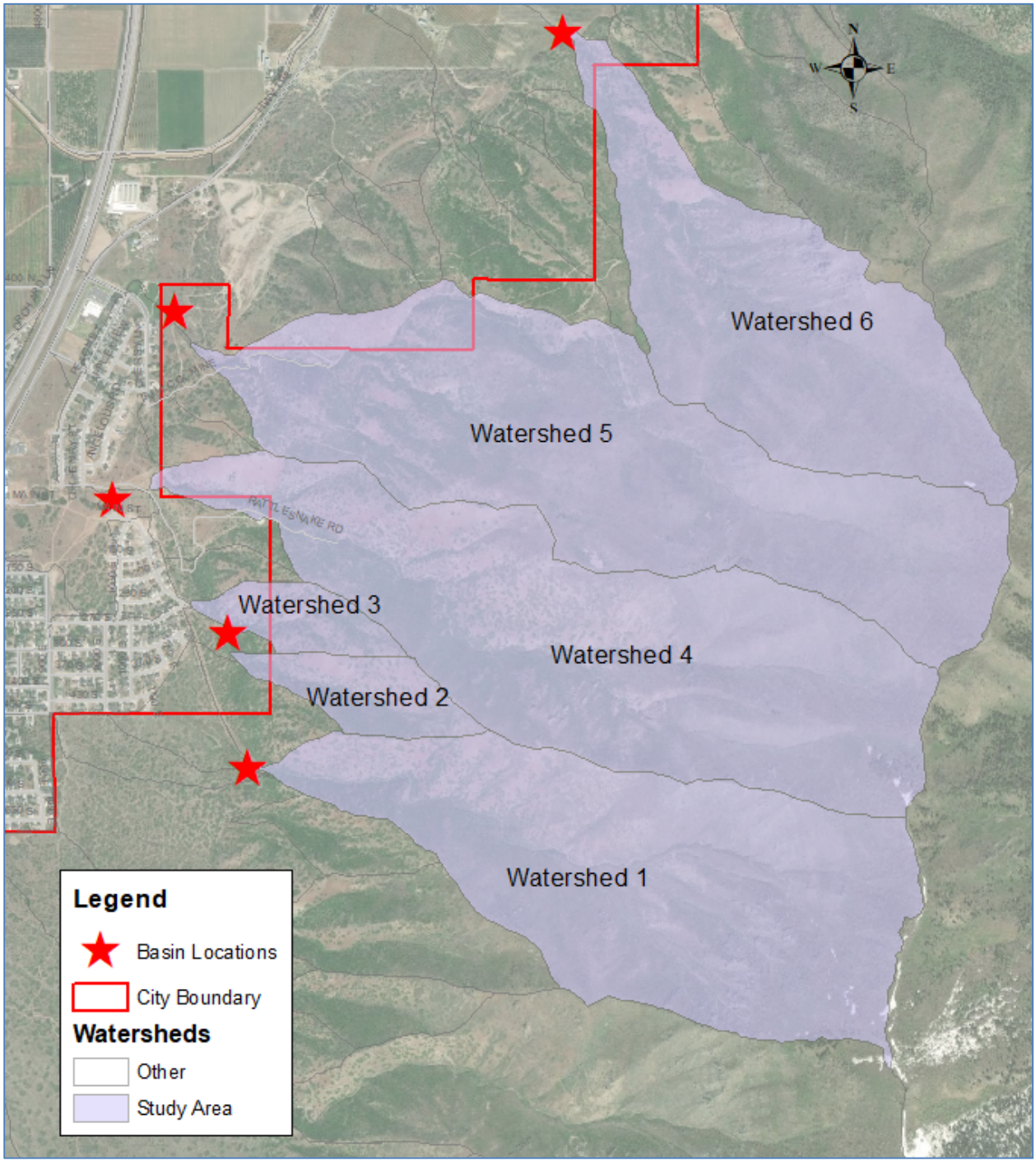

Figure D-1. Debris Basin and Watershed Map

Table D-1. Anticipated Structure Data

Basin Option (Approach B)	Total Height (ft)	Height at Aux. Spillway (ft)	Height at Principal Spillway (ft)	Aux. Spillway Width (ft)	Outlet Pipe Diameter (in)	Total Storage (ac-ft)	Active Storage (ac-ft)	Sediment Storage (ac-ft)
Basin 1 Below Grade	16	13	12	50	30	27.15	23.4	3.75
Basin 3A Below Grade	16	13	12	50	30	4.25	3.7	0.55
Basin 4E Above Grade (Watershed 4 Only)	16	13	12	50	30	25.9	23.4	2.5
Basin 5 Below Grade	16	13	12	50	30	20.8	18.8	2.0
Basin 6A Above Grade	16	13	12	50	30	18.6	16.1	2.5

D.2 Sedimentation

The sedimentation analysis conducted by Horrocks Engineers (Attachment 3-Sedimentation Report), includes event based, and long-term estimates for determining sediment yield. Multiple approaches were used and results from each were compared to arrive at an estimated sediment volume. The RHEM method was used for event-based volumes while the PSIAC is used for annual yields. Trap efficiencies, deposition volumes, and required sediment volumes for each basin are included in Attachment 3-Sedimentation Report. Sediment volumes are based on the 25-year cumulative load. The Sponsor will be responsible for periodic sediment removal. 50 and 25-year sediment storage volumes were investigated The 25-year sediment volume was used because it is large enough that it does not require constant maintenance by Santaquin City, but is not so large that makes the debris basins too large to construct based on hillside site constraints.

Table D-2. Sediment Volumes

Basin	Sediment Volume (ac-ft)
1	3.75
3A	0.55
4	2.5
5	2.0
6	2.5

D.3 Flooding and Risk Analysis

D.3.1 Breach Analysis

The flooding and risk associated with a dam breach analyses conducted by Horrocks Engineers (Attachment 2-Hydraulics Report) includes a breach inundation study and hazard classification for Basins 4 and 6. These are the basins that will be partially above grade. The other basins will be constructed below grade and not susceptible to breaching. Breach flows from Basin 4 would have high velocities combined with moderate

depths. There is some residential and commercial development downstream, as well as SR-198 and I-15, which would be impacted by a breach. For these reasons, and based on the criteria established in NEM Part 520, this would be a Class C dam. Breach flows from Basin 6 indicate velocities in excess of 15 ft/s with typical depths ranging from 1-3 feet and maximum depths at about 5 feet. Debris basins that are constructed above grade with an embankment holding the debris or water volume back have been found to be high hazard per NRCS and Utah Dam Safety guidelines. These basins will require additional inspections, maintenance, embankment, design, etc.

The inundation area encompasses 90 acres from Basin 4 and 75 acres from Basin 6, and flows through, residential properties, orchards, businesses and major roadways. The hazard classification of both dams is "high".

D.3.2 Induced Flooding Analysis

Induced flooding is causing flooding to occur where it did not previously historically occur. In order to prevent induced flooding, proposed debris basins will be constructed at or adjacent to the historic flow paths. The outlet and spillway works will be constructed such that the flows are directed to the historic flow path. Induced flooding has thus been greatly minimized. The spillway channels will be areas of induced flooding for either option. The induced flooding areas are minor/are incidental to the property that will be required to construct the debris basins. As the water reaches the end of the spillway channel, it enters its historic flow path. Induced flooding maps are included in Attachment 2.

D.4 Geology

Santaquin is located in Utah Valley, a deep, sediment-filled structural basin of Cenozoic age flanked by uplifted blocks, the Wasatch Range on the east ant the Spring Mountains and Western Mountains to the west. The proposed basins are located in Utah County, Utah. The basins are bound to the east by Dry Mountain and to the west by alluvial deposits on the bench and in the valley. The near-surface geology of Santaquin is dominated by sediments which were deposited within the last 30,000 years by Lake Bonneville. The near surface geology at the mouth of the drainage basins evaluated are mapped as age alluvial fan deposits overlying deltaic deposits. Landslide and colluvial deposits are mapped within the drainage basins and canyon walls. (GeoStrata, 2018)

Additional information regarding geologic conditions at the debris basins is described in the geotechnical report prepared by GeoStrata. The report is included as Attachment 5-Geotechnical Report.

D.4.1 Tectonic/Seismic Setting

Analysis of the ground shaking hazard along the Wasatch Front suggests that the Wasatch Fault Zone is the single greatest contributor to the seismic hazard in the Salt Lake City region. Each of the nearby faults show evidence of Holocene-age movement and are therefore considered active.

The likelihood of a seismic event occurring while one of the debris basins is loaded to be very low; therefore, seismic design of a fully loaded basin will not be required; however, the Nephi section of the Wasatch Fault Zone lies in close proximity to the proposed debris basin locations. An evaluation of the proximity of the fault to each of the proposed debris basin locations will be performed during final design as fault rupture could impact the stability and performance of the debris basin embankments/slopes. A preliminary fault study should include examining the footprint of the proposed debris basins compared to the mapped location of the Nephi section of the Wasatch Fault Zone to determine whether further studies will be required, including trenching within the footprint of the proposed debris basins, to clear the sites of

faults and/or identify the locations of faults. All fault studies should be completed by a licensed Professional Geologist.

D.5 Seismic Analysis

A preliminary seismic analysis was completed by a professional geotechnical engineer to ensure that the proposed slopes would be stable during a seismic event. The Wasatch Fault is located near the project location and has the greatest potential to generate the largest seismic event close to the debris basins. Several analysis types were used including full-static, full-pseud-ostatic, rapid drawdown, dry-static and dry- pseudo-static. Slope stability analysis for the basins assume embankments have a 3:1 sideslope, 12 foot top widths, and a height/depth of 16 feet. The seismic parameters are summarized in the table below:

Table D-3 Seismic Parameters

Drainage	1	2+3	4	5	6
Lat	39.9662	39.9705	39.9757	39.9817	39.9912
Long	-111.759	-111.76	-111.765	-111.761	-111.744
SS	1.303	1.32	1.341	1.355	1.362
S1	0.48	0.484	0.489	0.494	0.503
SMS	1.303	1.32	1.341	1.355	1.362
SM1	0.73	0.734	0.739	0.744	0.755
SDS	0.869	0.88	0.894	0.903	0.908
SD1	0.486	0.489	0.493	0.496	0.503
Fa	1	1	1	1	1
Fv	1.52	1.516	1.511	1.506	1.5
PGA	0.591	0.598	0.607	0.613	0.615
FPGA	1	1	1	1	1
PGAM	0.591	0.598	0.607	0.613	0.615

The seismic and slope stability analysis indicates that the debris basins will be meet minimum design requirements. A more in-depth seismic analysis will be conduted during the design phase of the project. The full preliminary seismic analysis is located in Attachment 5.

D.6 Geotechnical Analysis

The geotechnical investigation for this Plan-EA was conducted primarily to determine overall feasibility of the proposed debris basins and to assist in determining debris volumes. Additional geotechnical and geologic analysis will be required during the design phase of the project.

D.6.2 Subsurface Explorations

A subsurface investigation was conducted at several locations along the east bench of Santaquin. The exploration included multiple test pits near the planned debris basin locations. Test pits were dug to a depth of 6-10 feet. Stratigraphy was observed, photographed and logged. In general, the soils exposed in the test pits consisted of alluvial fan flooding sediments ranging from fluvial to debris flow deposits. Deeper subsurface investigations such as borings will be required during the design phase to determine bearing capacity and the suitability of the material for embankments.

D.6.3 Debris Volumes

Two methods were used to estimate debris flow volumes. The first method is based on a burned condition 25-yr peak flow rate with an assumed bulking rate of 75%. The second method uses a unit-volume approach which involves measuring and estimating the stored erodible material in the channel. These volumes are compared with 100-year 24-hour storm event volumes. To meet NRCS requirements the actual volumes used in the study are based on the 100-yr 24-hour storm event. Volumes estimating using Method 2 match the 100-yr 24-hour volumes reasonably well.

D.6.4 Geotechnical Recommendations

In order to evaluate the engineering properties of the existing soils in the vicinity of the proposed debris basins, a test pit was excavated in the approximate location of proposed debris retention/detention structures. A description of each of the test pits excavated and subsurface conditions encountered in each test pit is presented in Attachment 5-Geotechnical Report and the test pit locations are shown on Figure 2, Exploration Location Map.

Deeper subsurface investigations will be required in order to assess excavatability of subsurface soils if basins are to be constructed below the existing site grade or to assess bearing capacity of the subsurface strata if embankments are to be constructed above the existing site grade. Test pits TP-1, TP-2, TP-3, TP-5, and TP-6 were able to be excavated to depths requested for this preliminary investigation with a rubber-tired backhoe while digging was difficult and refusal was encountered in test pit TP-4 on either bedrock or large boulders.

A design level geotechnical investigation should be performed for each of the proposed debris basins including boreholes to sufficient depth to evaluate excavatability and bearing capacity of the subsurface soils, soil strength testing, soil permeability testing, slope stability analysis of proposed cuts and fills, foundation soil bearing capacity, and identification of borrow areas for proposed embankments (as needed).

Based on our preliminary engineering analysis of the proposed debris basin sites, the proposed locations are suitable for the proposed construction provided that design level geotechnical evaluations of each of the locations are performed and that recommendations from these studies are incorporated into the final design of the structures.

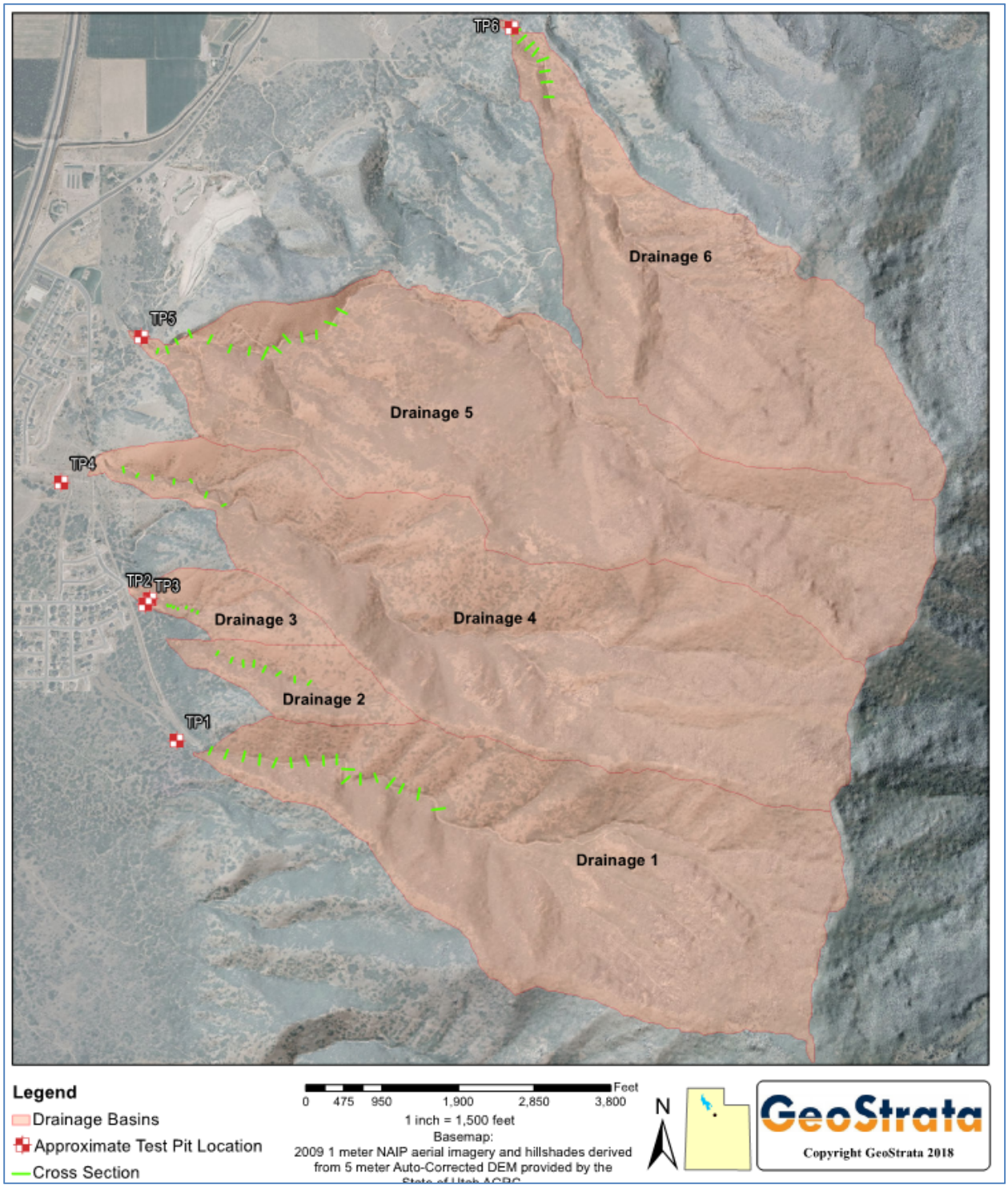

Figure D-2. Exploration Location Map

D.7 Water Quality

There is no permanent pool or perennial stream associated with the Santaquin Debris Basins. There will only be an improvement in water quality in that debris and sediment will be captured in the basins. Water quality is not anticipated to be an issue at the Santaquin Debris Basins.

D.8 Hydrologic Analysis

The Hydrologic Analyses (Attachment 1-Hydrology Report) included the identification of three design floods. They include the Freeboard Hydrograph (FBH) also referred to as the Inflow Design Flood (IDF) for the State of Utah, the Spillway Design Hydrograph (SDH), and the Principal Spillway Hydrograph (PSH). The FBH was defined as the 6-hour Spillway Evaluation Flood (SEF).

Various precipitation events were evaluated for each of the six watersheds to address various planning and design needs. The general categories and specific events evaluated are listed in Table D-4 below.

Table D-3. Precipitation Events

Purpose	Events Evaluated	Description
Economic Impact Analysis/Reservoir Sizing	2-, 5-, 10-, 25-, 50-, 100-, 200-, 500-year 24-hour precipitation events	Used for flood modeling to quantify changes in flood impacts after construction of basins. Sizing of reservoir.
Principal Spillway Sizing	PSH (Rainfall/Curve Number Method and Runoff Method, TR-60/NEH-4/SITES)	Used to evaluate minimum sizing of principal spillway and minimum elevation of auxiliary spillway
Auxiliary Spillway, Freeboard Evaluation, Wave Run-up	PMF, SEF, SDH, FBH, 100-year ARC III event	Auxiliary spillway sizing and minimum freeboard height.
Burned Condition Runoff	10-year 24-hour event	Reservoir Capacity Check
Debris Flow Event	5-year 1-hour event	Reservoir Capacity Check

The SCS Type II distribution was used as the temporal rainfall distribution. Curve numbers were generated using hydrologic soil type shape files (SSURGO) overlaid with land use data. The curve number of the watershed as a whole was obtained through ArcMap by calculating a weighted average based on the area and estimated CN of each region within the watershed. WIN TR-20 was used as the software to generate hydrographs and to import them into SITES software for routing calculations.

The land use data was obtained from the National Land Cover Dataset (NLCD), Multi-Resolution Land Characteristics (MRLC) Consortium. The land cover classification values were assigned comparable cover types from Chapter 9 of the National Engineering Handbook, Part 630 (NEH-630).

Time of concentration values were estimated using the velocity method with sheet flow, shallow concentrated flow and channel flow components.

Point Precipitation Frequency Estimates with 90% confidence levels were collected for 2-year, 5-year, 10-year, 25-year, 50-year, 100-year, 200-year, and 500-year 24-hour storm events. All depths were sourced from NOAA Atlas 14, Volume 1, Version 5, using the Precipitation Frequency Data Server (PFDS). The centroid of each watershed was used as the point to evaluate rainfall depths. The latitude and longitude of the analysis point used for each watershed and the corresponding depth for each 24-hr event is shown in Attachment 1-Hydrology Report

Table D-5 contains watershed data used in the hydrologic analysis.

Table D-4. Watershed Data

Watershed ID	Area (miles)	Area (acres)	Tc (hr)	CN	Burned Condition CN
1	0.627	401.9	0.54	71.8	77.8
2	0.069	44.3	0.21	69.2	75.2
3	0.053	34.1	0.21	70.9	76.9
4	0.688	440.7	0.53	70.9	76.9
5	0.711	455.2	0.68	67.3	73.3
6	0.451	288.9	0.45	72.1	78.1

Peak flow rates and volumes for each watershed are shown in Table D-6. These values were used in the economic analysis models.

Table D-5. Peak Flow Rates, Volumes

	Watershed	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	200-yr	500-yr
Peak Flow (cfs)	1	11.9	41.8	79.6	149	217.1	300.6	403.8	569.7
Volume (ac-ft)		4.7	8.5	12.4	18.3	23.4	28.7	34.5	42.6
Peak Flow (cfs)	2	0.6	3.8	8.6	18.2	27.9	40.3	55.2	80.4
Volume (ac-ft)		0.1	0.5	1.0	1.6	2.1	2.6	3.1	3.9
Peak Flow (cfs)	3	0.8	4.2	8.7	17.1	25.7	36.4	49.4	71.1
Volume (ac-ft)		0.1	0.4	0.7	1.2	1.6	2.0	2.5	3.2
Peak Flow (cfs)	4	8.8	35.9	71.2	139.1	207.8	291.6	395.8	563.8
Volume (ac-ft)		4.3	8.2	12.1	18.2	23.4	29.0	35.1	43.5
Peak Flow (cfs)	5	3.1	15.6	38.6	88.4	142.1	209.5	295.7	438.2
Volume (ac-ft)		2.5	5.6	8.8	14.2	18.8	23.8	29.4	37.2
Peak Flow (cfs)	6	9.5	35.3	67.9	127.8	188.8	262.5	352.6	502.1
Volume (ac-ft)		3.2	5.8	8.5	12.6	16.1	19.9	23.9	29.4

Detailed peak flow rate and volume information regarding Auxiliary Spillway events is included in Attachment 1-Hydrology Report.

D.9 Hydraulic Analysis

Numerous scenarios were modeled to analyze the impacts of different debris basin configurations. The modeling efforts included routing, spillway analysis, induced flooding and pre and post flood patterns. The various configurations included having some of the basins be constructed entirely below existing grade, or partly below and partly above existing grade. Watersheds 2 and 3 were modeled separately with separate debris basins. The debris basins were also combined into one basin (referred to as 3A, preferred option). The location of basin 4 was modeled such that it would intercept flows from the upstream basins, as well as being tucked up against the hillside so upstream basin flows would completely bypass it (preferred option).

D.9.1 Reservoir Routing and Sizing

The methodologies inherent in the SITES program developed and distributed by the NRCS was utilized to route the storms through the reservoirs. The program permits the designation of basic auxiliary spillway dimensions. Principal spillway combinations including low level outlets and upper weir crests, are all

directed to an outlet pipe. Combined spillways and direct input of stage-discharge curves are also possible. Basic assumptions are shown below:

Reservoir Dimensions:

Initial Volume: +/- 25-year 24-hour event volume at Auxiliary Spillway for Approach A; 50-year 24-hour event volume for Approach B
Initial Elevation of Auxiliary Spillway: 3 feet below crest
Internal Depth of Basin/Structural Height: 16 feet
Cut and Fill Slopes: 3:1

Auxiliary Spillway Dimensions:

Width: 50 feet
Length of Flat Section (spillway crest): 40 feet
Upstream Slope: 3:1
Downstream Slope: -2%
Side Slopes: 3:1

Principal Spillway:

Type: NRCS Standard Riser with Piped Outlet
Low Elevation Outlet: (2) 6”x12” openings (Approach A); Orifice as needed to meet 10-day draw down (Approach B)
Low Elevation Outlet Elevation: at +/- 20% Volume of Basin (Sediment Storage Elev.); Orifice as needed to meet 10-day draw down (Approach B)
Upper Weir Elevation: 1 foot below the auxiliary crest elevation
Upper Weir Length: 6 feet on each side of structure, total of 12 feet
Outlet Pipe Size: 30” (NRCS minimum size)

The principal spillway evaluation events were routed to verify the principal spillway met the regulations for size and capacity as stated in TR-60. The principal spillway hydrograph was routed through the reservoirs using standard NRCS methodology. The required input data were taken from the hydrologic analysis. All structures were able to pass all spillway design flows through a combined spillway while meeting freeboard requirements. Drawdown within 10 days was achieved in all debris basins. Refer to Attachment 2-Hydraulics report for more information.

Peak flow pre and post data are shown in Tables D-7 below.

Table D-6. Peak Flow Rates by Return Event

Watershed	Data/Option	Peak Flow by Return Interval (Approach B)				
		5-yr	10-yr	25-yr	50-yr	100-yr
1	Inflow (cfs)	41.8	79.6	149	217.1	300.6
	Inflow (ac-ft)	8.5	12.4	18.3	23.4	28.7
	Basin 1 Outflow	1.2	1.6	2.1	2.5	15.2
2,3	Inflow (cfs) (2 & 3 Combined)	8	17.3	35.3	53.6	76.7
	Inflow (ac-ft) (2 & 3 Combined)	0.9	1.7	2.8	3.7	4.6
	Basin 3A Below Grade Outflow (2 & 3 Combined)	0.6	0.9	1.1	1.3	3.6
4	Inflow (cfs) (Single Basin)	35.9	71.2	139.1	207.8	291.6
	Inflow (ac-ft) (Single Basin)	8.2	12.1	18.2	23.4	29.0
	Basin 4 Outflow	1.0	1.5	1.9	2.3	16.5
5	Inflow (cfs)	15.6	38.6	88.4	142.1	209.5
	Inflow (ac-ft)	5.6	8.8	14.2	18.8	23.8
	Basin 5 Outflow	0.7	1.1	1.5	1.8	

Watershed	Data/Option	Peak Flow by Return Interval (Approach B)				
		5-yr	10-yr	25-yr	50-yr	100-yr
6	Inflow (cfs)	35.3	67.9	127.8	188.8	262.5
	Inflow (ac-ft)	5.8	8.5	12.6	16.1	19.9
	Basin 6 Outflow	0.8	1.1	1.4	1.7	14.5

D.9.2 Flood Modeling

Because there is no outfall channel for the debris basins, a two-dimensional model was used to determine the existing and proposed condition flooding extents and damages. Existing hydrographs and proposed routed hydrographs were taken from SITES and used as input in a FLO-2D model. Output data from the FLO-2D model was obtained to map the depth, velocity, and inundation area for the existing and proposed conditions. Detailed flood maps are included in Attachment 2-Hydraulics Report. 2-D model input is listed in Table D-8.

Table D-7. 2-D Model Parameters

Model Component	Parameter Used
2-D Software	FLO-2D
Typical Floodplain Roughness Coefficients	0.04
Grid Size	10'x10'
Topographic Data	2 foot contour data

D.10 Design Criteria

The entities with jurisdiction over this project is Utah Dam Safety and NRCS. Utah Dam Safety requires compliance with Utah's Administrative Code R655-11 Requirements for the Design and Construction and Abandonment of Dams while NRCS requires compliance with Technical Release 60 (TR-60), and the National Engineering Handbook (NEH). The most conservative design criteria outlined in either the Utah's Administrative Code R655-11, TR-60, or NEH will be followed.

Because the debris basins have not been designed to a 100% level, some design criteria are assumed and will be finalized during the design phase of the project, pending design-level geotechnical analysis.

Typical design criteria are detailed in Attachment 1-Hydrology Report and Attachment 2-Hydraulics Report and are summarized in Table D-9.

Table D-8. Design Criteria

Description	Criterion
Principal Spillway Capacity (above grade dam)	Pass the 50-yr 24-Hour Event without activating the aux. spillway
Principal Spillway Capacity (below grade dam)	Pass the 50-yr 24-Hour Event without activating the aux. spillway
Auxiliary Spillway Capacity	Pass the freeboard hydrograph while maintaining freeboard
Side Slopes	3:1
Freeboard	3 feet
Top Width	15 feet
Height	Typically 16 feet
Drawdown Time	10 days
Principal Spillway Conduit Diameter	30 Inches, with a smaller orifice in the tower to allow for drainage

D.11 Agency Coordination

During the preliminary scoping period for the project, scoping questions, comments, and concerns were requested from government agencies, both orally at public meetings and via written submittal of comments. A scoping notice was prepared and mailed to interested parties. The scoping comment period was open for 30 days and several comments were received.

A public notice of availability of the Draft Plan-EA will be mailed to interested parties, published in the local newspaper or included in a utility mailer and posted to the NRCS project website. The Draft Plan-EA will be released for public review and comment and a public meeting will be held

Agency coordination and consultation is summarized and documented in the Plan-EA.

D.12 Alternatives Evaluation

The formulation process of alternatives for the Santaquin Debris Basins followed NRCS watershed planning policy. Numerous alternatives were developed by the project team. They were evaluated based on cost, constructability, whether they meet the purpose and need of the project, and net monetary benefit. Comments provided by the public and other agencies were incorporated into the evaluation process

Numerous alternatives were developed by the project team based on the ability to address the purpose and need of the project, and were formulated in consideration of four criteria outlined in the P&G (USWRC 1983): completeness, effectiveness, efficiency, and acceptability. If scoping comments had been received during the scoping period they would have been incorporated into the formulation process for the initial alternatives. General concepts evaluated include check structures, diversion berms, level spreaders and debris basins, each with several different types and variations.

D.12.1 Alternatives Studied in Detail

This section discusses the evaluation of alternatives for the Santaquin Debris Basins Project that were studied in detail. Three alternatives were evaluated in detail which include 1) the No Action, 2) Debris Basins with an extensive downstream pipe network, and 3) Larger debris basins without an extensive downstream pipe network. Concept design drawings for the Dam Rehabilitation Alternative are included in Attachment 4-Concept Drawings.

D.12.1.1 No Action Alternative

The No Action Alternative is the alternative in which no NRCS action occurs to mitigate potential flood damages along the east bench. This alternative must be studied to discover if it the alternative that makes the most sense from an economic, environmental and flood protection standpoint.

D.12.1.2 Debris Basins with Extensive Downstream Pipe Network (Option A)

This Alternative consists of debris basins which would roughly contain the 25-year volume. The basins would be constructed with an auxiliary spillway and principal spillway outlet structure which would be connected to a conduit network that together with the basin, can safely convey the entire 100-year flows. The approach is based on the assumption that there is adequate capacity for the flows located several miles to the north in Spring Creek and under Red Bridge in western Payson. The pipe conduit system for conveying the flows would need to go over or under (most likely under) the Strawberry-Highline Canal, and be piped or possibly kept in an open channel southward through private property, until it reaches Spring Creek. The pipe system would go under several overpass embankments, and be bored underneath I-15. In addition, several large diameter culverts downstream would need to be enlarged. Based on flow estimates and average slope, the downstream pipe system would be a 60 inch diameter pipe or equivalent from the Strawberry-Highline Canal and northward.

The alternative listed above represents an anticipated construction cost of $15.5M plus a property cost of $2.44M (paid for by Sponsor) and technical assistance costs of $1.37M for a total installation cost of $19.3M. The Sponsors estimated O&M costs are $20,920 per year. The cost estimates are included as Attachment 6-Cost Estimate.

D.12.1.3 Larger Debris Basins without Extensive Downstream Pipe Network (Option B)

Approach B consists of debris basins which would completely contain the 50-year volume. The basins would have a principal spillway tower with an outlet pipe. The principal spillway would have an orifice in the side of it to allow the basin to drain while restricting flows to a minimal flow rate. The principal spillway would be open only at the top and would only be activated when water within the basin is deep. This approach would not include an extensive downstream pipe network. Flows for events larger than the 50-year event would first fill up the basin, and then exit through the principal spillway tower and eventually overtop the auxiliary spillway, as needed. The flows would be directed into their historic flow paths so as to not cause induced flooding. Although this approach does not provide full containment of the 100-year event, it significantly reduces flood damages associated with the 100-yr event by reducing the peak flow rate to a non-threatening level.

This alternative represents an anticipated construction cost of $8.1M plus a property cost of $2.77M (paid for by Sponsor) and technical assistance costs of $1.41M for a total installation cost of $12.3M. The Sponsors estimated O&M costs are $20,920 per year. The cost estimates are included as Attachment 6 Cost Estimates.

D.13 Economic Evaluation

The NRCS National Watershed Manual was used as a reference for the economic analysis along with the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) (U.S. Water Resources Council 1983). P&G was developed to define a consistent set of project formulation and evaluation instructions for federal agencies that carry out water and related land resource implementation studies.

The objective of P&G is to determine whether or not benefits from proposed actions exceed project costs for federally funded projects. P&G also requires that the "National Economic Development" or NED Alternative, which maximizes monetary net benefits, is selected for implementation unless there is an overriding reason for selecting another alternative based on federal, state, local, or international concerns related to the social and environmental accounts.

Damage reduction benefits from floodwater and debris flow were analyzed for this project according to the P&G and the Manual.

D.13.1 Installation Costs

The total installation cost estimated for the preferred alternative (Option B) is $12,279,633 as detailed in the table below.

Table D-9. Summary of Installation Cost for the Preferred Alternative

Measure	Construction	Engineering	Real Property Rights	Admin	Total
Basin 1	$ 2,643,408	$ 440,418	$ 924,000	$ 22,021	$ 4,029,847
Basin 3A	$ 570,133	$ 95,022	$ 300,000	$ 4,751	$ 969,906
Basin 4	$ 1,060,079	$ 176,680	$ 700,000	$ 8,834	$ 1,945,593

Measure	Construction	Engineering	Real Property Rights	Admin	Total
Basin 5	$ 2,554,266	$ 425,711	$ 58,100	$ 21,286	$ 3,059,363
Basin 6	$ 1,265,467	$ 210,911	$ 788,000	$ 10,546	$ 2,274,924
Total	$ 8,093,353	$ 1,348,742	$ 2,770,100	$ 67,438	$ 12,279,633

D.13.1.1 Damage Reduction Benefits

Damage reduction benefits were assessed based on the equivalent annual damage reduction expected through implementation of the preferred alternative compared to the no action/existing alternative baseline. The life of the measures proposed in the preferred alternative are estimated at 100 years. The period of analysis is therefore 100 years, with all costs and benefits calculated at the Fiscal Year 2018 Federal Water Resources Discount Rate of 2.875%.

The sum of damages accrued due to the 2, 5, 10, 25, 50, 100, 200 and 500 year storm events were compared between all three alternatives. These damages are estimated by developing inundation extents of each of the storm events using a hydraulic model, overlaying the boundaries of the various events onto aerial maps, determining the structures that intersect the storm event extents, and estimating the damages based on the severity of exposure for each structure.

D.13.1.2 Floodwater/Debris flow

Residential Property and Contents

Monetary damage from debris flow to residences was differentiated between those exposed to less than 1 foot of flood waters and debris flow, 1 to 3 feet, and greater than 3 feet. The U.S. Army Corps of Engineers Catalog of Residential Depth Damage Functions (USACE) was used to estimate damage to the homes affected. Damages were not differentiated between debris flow and floodwater.

A median home structure value of $216,500 was estimated from a sample of houses in the damage area from tax records. This was used as a proxy value for all homes affected. A replacement value of eighty percent of this value was used to estimate the actual dollar value of structure damages to flooded homes. Fifty percent of this replacement value was used to estimate contents value, as per suggested from the USACE document. Although a basement survey was not conducted, in observations from field visits, it was assumed that all the homes in the area had basements.

Damage to outbuildings, landscaping, and automobiles was estimated at fifteen percent of the average annual damages to the property damage to homes hit with flooding and debris flow.

Homeowner time away from employment to deal with damages was estimated by assuming one week of income lost for each home inundated, calculated by dividing the median household income per year of the project area by 52 weeks.

Other (Road) Damages

Road damage was estimated by using a square footage repair cost based on the depth of flooding. Pavement/asphalt repair costs range $2 to $3 per square foot, depending on the total area to be worked on. For roads flooded less than 1 foot, $.50 per square foot was estimated for a post-flood repair cost, and $1 per square foot was estimated for roads flooded greater than 1 foot. These cost estimates account for the large volume of work that would need to be performed after a flood, and the assumption that damage would most likely be uneven or sporadic along streets.

Agricultural Damages

Agricultural flood damage was estimated using procedures outlined in SCS Technical Note UD-28 (1972). Monthly damage factors for hay were used for estimation, as it is the predominant crop in Utah County (NASS, 2012). Crop values were estimated from hay crop budgets. A monthly flash flood distribution for Utah was estimated from NOAA Technical Memorandum NWS WR-147 (1979). Using the damage factors, crop value, and flood distribution, a weighted per acre damage was estimated. This was applied to the acres flooded by storm event to arrive at an average annual flood damage for crop land.

Table D-11 provides damages calculated for floodwater for the With Project and Without Project, and the resulting damage reduction.

Table D-110. Debris Flow Damage Reduction Benefits

Item	Estimated Average Annual Damage Reduction Benefits		
	With Project[1]	Without Project	Damage Reduction
Crop and Pasture	$400	$4,900	$4,500
Residential	$34,300	$488,700	$454,400
Other	$800	$3,000	$2,200
Total	$35,500	$496,600	$461,100

D.13.1.3 Benefit Cost Ratio

The total average annual economic benefits are $461,100 for the preferred alternative. Table D-12 provides the calculated annual benefits, costs, benefit cost ratio, and net annual benefit for each of the alternatives.

Table D-12. Alternatives Benefit Cost Ratios and Net Benefits[1]

Alternative	Total Annual Benefits	Total Annual Costs	Benefit Cost Ratio	Net Annual Economic Benefit
No Action Alternative	$ --	$ --	--	$ --
Alternative A	$487,100	$633,500	0.77	$-146,400
Alternative B	$461,100	$397,000	1.16	$64,100

1/ Price base 2018. Calculated using FY 2019 Water Resources Discount Rate (2.875%), annualized over 100 year period of analysis.

D.13.1.4 Economic Evaluation Summary

The economic analysis determined that alternative B has the highest net economic benefits, and therefore is the NED plan. It has a benefit cost ratio of 1.16 to 1. The other alternative evaluated resulted in a benefit cost ratio of .77 to 1. Alternative A provides a higher level of protection, but at much higher cost. Alternative B, the preferred alternative, provides a level of protection that is adequate at a lower cost.

D.15 References

U.S. Army Corps of Engineers (USACE), 1992. Catalog of Residential Depth Damage Functions.

U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS), 2014. Title 390: National Watershed Program Manual.

National Oceanic and Atmospheric Administration (NOAA). 1979. Technical Memorandum NWS WR-147. Occurrence and Distribution of Flash Floods in the Western Region.

Soil Conservation Service (SCS). 1972. TSC Technical Note: Watersheds: UD-28. A Manual Procedure to Estimate Annual Crop and Pasture Flood Damages.

National Agricultural Statistics Service (NASS). 2012 Census of Agriculture. Utah County, Utah Profile.

U.S. Water Resources Council, 1983. Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies.

NRCS (U.S. Department of Agriculture, Natural Resources Conservation Service). 2005. Earth Dams and Reservoirs Technical Release – 60. 210-VI. Conservation Engineering Division. July 2005.

NRCS, 2014c. National Engineering Handbook.

UAC (Utah Administrative Code). 2019. Natural Resources, Water Rights; Requirements for the Design, Construction and Abandonment of Dams. As in effect on February 26, 2019.

ATTACHMENT 1

HYDROLOGY REPORT

2162 West Grove Parkway, Ste 400
Pleasant Grove, Utah 84062
801-763-5100
www.horrocks.com

To: **Nathaniel Todea**
Natural Resources Conservation Service (NRCS), USDA
From: **Aaron Spencer, P.E.**
Date: August 23, 2018 **Technical Memo**
Subject: **Santaquin City Flood Control Plan-EA – Hydrology Report**
Project: **UT-1024-1801**

1.0 INTRODUCTION

In order to determine the proper size and nature of flood control structures for the watersheds along the eastern boundary of Santaquin City multiple storm events must be evaluated for each site. This memo summarizes the methods, data sources, and results of these analyses. Events had to be evaluated for several purposes:

- Evaluating the economic impact of the improvements based on the change in flood impacts
- Determining the likely runoff volume after a wildfire including sediment to ensure it could be contained
- Determining the likely volume of debris flow that must be contained
- Determining the governing storms for sizing spillways and required freeboard.
- Provide supporting data for sedimentation analysis (see Sedimentation Technical Memo)

These evaluations were performed in accordance with requirements of the NRCS as a funding partner and agency with technical oversight, and Utah Dam Safety requirements. Other design goals which are not directly covered by either agency's design criteria, such as debris flow and burned condition analysis, used the best available methods and information, with assistance from NRCS and other technical experts.

The input data collected and evaluations done are broken out and discussed below in the following sections:

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Pleasant Grove, Utah 84062
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2.0 BACKGROUND

The City of Santaquin is in the process of developing a storm drain master plan which was the impetus for planning and seeking funding from the NRCS for flood and debris control structures for the watersheds studied in this report. The six most critical watersheds were identified based on a combination of factors, including past issues and proximity of threatened infrastructure and development.

The watersheds that are the subject of this report lie to the southeast of Santaquin. They are steep, dry canyons located at the base of the Wasatch Front. The watersheds drain onto alluvial fans, with no defined outlet channels down through the community. The regionally critical Highline Canal crosses along the base of the alluvial fans. Heavily used highways and arterials, including the regionally critical I-15 freeway, are also located downstream. Over time development has moved up the alluvial fan towards the watersheds, with further development anticipated in a community that is experiencing rapid growth.

The Mollie Fire in 2001 caused subsequent debris flows from five of the canyons directly above Santaquin, with at least two of those resulting in significant damage to homes and public property, and threatening the safety of residents. Development below these canyons has only continued, increasing the need for measures to be taken to control flooding and debris flows. Multiple other canyons in the burned area also experienced debris or hyperconcentrated flows (Giraud & McDonald, 2007)

Initial analysis and sizing of the basins was done using the generalized criteria of the draft Santaquin Storm Drain Master Plan (SDMP), but those criteria were reevaluated when NRCS funding was secured in order to meet NRCS design criteria, and to refine the concept design. All the data possible was carried over from that report, such as basin characteristics, curve numbers, and burned flow and debris flow data and evaluations. The data, sources, and development are repeated in this memo such that reference to the SDMP is not required.

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801-763-5100
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3.0 STORM EVENTS

Multiple different precipitation events were evaluated for each of the six watersheds to address various planning and design needs. The general categories and specific events evaluated are listed in Table 1 below.

Table 1. Storms Evaluated.

Purpose	Events Evaluated	Description
Economic Impact Analysis/Reservoir Sizing	2-, 5-, 10-, 25-, 50-, 100-, 200-, 500-year 24-hour precipitation events	Used for flood modeling to quantify changes in impact after construction. Sizing of reservoir.
Principal Spillway Sizing	PSH (Rainfall/Curve Number Method and Runoff Method, TR-60/NEH-4/SITES)	Used to evaluate minimum sizing of principal spillway and minimum elevation of auxiliary spillway
Auxiliary Spillway, Freeboard Evaluation, Wave Runup	PMF, SEF, SDH, FBH, 100-year ARC III event	Auxiliary spillway sizing and minimum freeboard height.
Burned Condition Runoff	10-year 24-hour event	Reservoir Capacity Check
Debris Flow Event	5-year 1-hour event	Reservoir Capacity Check

3.1 Precipitation Depth

The sources, methods, and resulting precipitation depths for the design storms are outlined below according to the evaluation and storm type.

3.1.1 Economic Analysis Events Precipitation

Point Precipitation Frequency Estimates with 90% confidence levels were collected for 2-year, 5-year, 10-year, 25-year, 50-year, 100-year, 200-year, and 500-year 24-hour storm events. All depths were sourced from NOAA Atlas 14, Volume 1, Version 5, using the Precipitation Frequency Data Server (PFDS). The centroid of each watershed was used as the point to evaluate rainfall depths. Table 2 below displays the latitude and longitude of the analysis point used for each watershed and the corresponding depth for each 24-hr event.

Table 2. NOAA Rainfall 24-Hour ARI Depths – Economic Analysis Events

Watershed 1 (Latitude: 39.9818, Longitude: -111.7354)							
2yr	5yr	10yr	25yr	50yr	100yr	200yr	500yr
1.57	1.88	2.14	2.49	2.76	3.10	3.30	3.66

Watershed 2 (Latitude: 39.9691, Longitude: -111.7535)							
2yr	5yr	10yr	25yr	50yr	100yr	200yr	500yr
1.60	1.92	2.18	2.54	2.81	3.09	3.36	3.73

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Watershed 3 (Latitude: 39.9716, Longitude: -111.7564)							
2yr	5yr	10yr	25yr	50yr	100yr	200yr	500yr
1.57	1.88	2.14	2.49	2.76	3.03	3.30	3.66

Watershed 4 (Latitude: 39.9709, Longitude: -111.7432)							
2yr	5yr	10yr	25yr	50yr	100yr	200yr	500yr
1.58	1.90	2.16	2.52	2.79	3.06	3.34	3.70

Watershed 5 (Latitude: 39.977, Longitude: -111.7428)							
2yr	5yr	10yr	25yr	50yr	100yr	200yr	500yr
1.58	1.90	2.16	2.52	2.79	3.06	3.34	3.70

Watershed 6 (Latitude: 39.9818, Longitude: -111.7354)							
2yr	5yr	10yr	25yr	50yr	100yr	200yr	500yr
1.57	1.88	2.14	2.49	2.76	3.03	3.30	3.66

3.1.2 Principal Spillway Evaluation Events Precipitation

Precipitation depths used in the Principal Spillway Hydrograph (PSH) analysis were developed in accordance with NRCS Technical Release 60 (TR-60). TR-60 requires that the principal spillway pass the greater of two different methods of determining runoff prior to allowing flow to pass over the auxiliary spillway, the Runoff Method and the Curve Number Method.

In order to make initial decisions on hazard dependent designs, guidance was provided by the Utah NRCS office as follows, which they stated is arbitrary and must be verified, but provides a reasonable starting assumption: fully excavated ponds were generally considered low hazard, single purpose dams unless they were located in series, in which case the lower dam was considered significant or high hazard depending on its design and location. For earthfill embankment structures high hazard criteria was assumed. These hazard rating assumptions will be validated utilizing breach analysis and floodplain mapping based on the breach flow and classification methods outlined in TR-60. This analysis will be included in the Hydraulics Technical Memo to be submitted separately.

3.1.2.a Principal Spillway Runoff Method

The PSH Runoff Method (also referred to as the "snowmelt" method) utilizes Table 2.2 to determine the design event, and Figures 2-2 and 2-3 in TR-60 to determine total runoff. Assuming a vegetated spillway, single purpose structure, and a storage/effective height product below 30,000, these result in the following precipitation depth values:

High Hazard, 100-year event:

- 10-day runoff = 3.0 in.
- 1-day runoff = 0.9 in.

Low Hazard, 25-year event (see note, Fig. 2.2):

- 10-day runoff = 2.25 in.
- 1-day runoff = 0.675 in.

In the case of dams in series, high hazard will be assumed for the lower structure PSH.

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3.1.2.b Principal Spillway Curve Number Method

The TR-60 PSH curve number procedure (referred to as the "Rainfall" method in SITES) used rainfall depths gathered from NOAA Atlas 14 shown in the previous section. The recurrence interval is selected and the depth is adjusted as necessary from these values in accordance with the criteria shown in Table 2-2 of TR-60. Vegetated spillways, single purpose structures with storage/effective height products less the 30,000 were assumed in all cases. Low and high hazard structures were assumed as described previously. If upstream dams were anticipated the high hazard rating result will be used. The resulting design storms were evaluated as follows:

- Low hazard structures - P_{25} storm
- High hazard structures - P_{100} storm

The precipitation values are as follows:

Table 3.Precipitation Values – Principal Spillway Evaluation Events

Basin	Hazard Rating	Event	10-day Precipitation
Basin 1 Above Grade	High	P_{100}	5.96
Basin 1 Below Grade	Low	P_{25}	4.16
Basin 2 Above Grade	High	P_{100}	5.82
Basin 2 Below Grade	Low	P_{25}	4.75
Basin 3 Above Grade	High	P_{100}	5.57
Basin 3 Below Grade	Low	P_{25}	4.56
Basin 4 Above Grade	High	P_{100}	5.81
Basin 4 Below Grade	Low	P_{25}	4.74
Basin 5 Above Grade	High	P_{100}	5.78
Basin 5 Below Grade	Low	P_{25}	4.74
Basin 6 Above Grade	High	P_{100}	5.78
Basin 6 Below Grade	Low	P_{25}	4.72

3.1.3 Auxiliary Spillway Evaluation Events Precipitation

Freeboard Hydrographs (FBH) and Stability Design Hydrographs (SDH) were generated according to the criteria in Table 2-5 of TR-60. Separate evaluations were given for "Above Grade" and "Below Grade" options for each watershed. These correspond to traditional earthfill dam type structures, or basins that are fully excavated having no significant earthfill, respectively. Earthfill dams were evaluated as high hazard, and excavated basins were assumed to be low hazard per correspondence with Nathaniel Todea of the NRCS. If the excavated basin was located downstream of other basins it will be evaluated as a significant or high hazard structure per TR-60 policy.

Precipitation data for the 100-year event used in the calculation of the SDH or FBH for each watershed was taken from NOAA Atlas 14 and are shown previously in the Economic Analysis Events section in Table 2.

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Pleasant Grove, Utah 84062
801-763-5100
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Probable Maximum Precipitation values were taken from the studies by Jensen (1995) and Jensen (2003) that were studies performed in cooperation with the Utah - Dam Safety Section to develop adjusted values from Hydrometeorological Report No. 49 (HMR49) (NOAA, 1984) to compensate for local variables unique to Utah. Utah Administrative Code R655-11 requires that all high and moderate hazard dams in Utah route the critical precipitation value obtained USUS (Jensen, 1995), or USUL (Jensen, 2003). The NRCS in Utah has adopted the same approach.

Precipitation depths developed from HMR49 are referred to as Probable Maximum Precipitation (PMP). Precipitation developed from USUS or USUL are referred to as Spillway Evaluation Precipitation (SEP) per the Utah Code. The values used and shown in Table 4 as the "PMP" in the formulas for the SDH and FBH as prescribed in TR-60 are in fact the "SEP" values determined from these studies. In partnership with the Utah - Dam Safety Section a program was also developed in which latitude, longitude, and duration can be entered to determine the rainfall depths. The Utah Code requires the evaluation of the 6-hour and 72-hour events. TR-60 requires the evaluation of the 6-hour and 24-hour events.

Table 4. Precipitation Values – Auxiliary Spillway Evaluation Events.

	Precipitation Event	6hr	24hr	72hr
Basin 1	Basin 1 Above Grade (High Hazard)			
	PMP (in)	5.04	9.14	10.87
	SDH (in)	3.60	4.67	5.12
	FBH (in)	5.04	9.14	10.87
	Basin 1 Below Grade (Low Hazard)			
	PMP (in)	5.04	9.14	10.87
	SDH (in)	3.1	3.1	3.1
	FBH (in)	3.33	3.83	4.03

	Event	6hr	24hr	72hr
Basin 2	Basin 2 Above Grade (High Hazard)			
	PMP (in)	5.37	9.22	10.96
	SDH (in)	3.68	4.68	5.14
	FBH (in)	5.37	9.22	10.96
	Basin 2 Below Grade (Low Hazard)			
	PMP (in)	5.37	9.22	10.96
	SDH (in)	3.09	3.09	3.09
	FBH (in)	3.36	3.83	4.03

	Event	6hr	24hr	72hr
Basin 3	Basin 3 Above Grade (High Hazard)			
	PMP (in)	5.39	9.25	10.99
	SDH (in)	3.64	4.65	5.10

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	FBH (in)	5.39	9.25	10.99
	Basin 3 Below Grade (Low Hazard)			
	PMP (in)	5.39	9.25	10.99
	SDH (in)	3.03	3.03	3.03
	FBH (in)	3.13	3.78	3.99

Basin 4	Event	6hr	24hr	72hr
	Basin 4 Above Grade (High Hazard)			
	PMP (in)	5.10	9.15	10.88
	SDH (in)	3.59	4.64	5.09
	FBH (in)	5.1	9.16	10.88
	Basin 4 Below Grade (Low Hazard*)			
	PMP (in)	5.10	9.15	10.88
	SDH (in)	3.06	3.06	3.06
	FBH (in)	3.31	3.79	4.00

Basin 5	Event	6hr	24hr	72hr
	Basin 5 Above Grade (High Hazard)			
	PMP (in)	5.1	9.14	10.87
	SDH (in)	3.59	4.64	5.09
	FBH (in)	5.1	9.14	10.87
	Basin 5 Below Grade (Low Hazard)			
	PMP (in)	5.1	9.14	10.87
	SDH (in)	3.06	3.06	3.06
	FBH (in)	3.30	3.79	4.00

Basin 6	Event	6hr	24hr	72hr
	Basin 6 Above Grade (High Hazard)			
	PMP (in)	5.23	9.11	10.83
	SDH (in)	3.60	4.61	5.06
	FBH (in)	5.23	9.11	10.83
	Basin 6 Below Grade (Low Hazard)			
	PMP (in)	5.23	9.11	10.83
	SDH (in)	3.03	3.03	3.03
	FBH (in)	3.29	3.76	3.97

*High hazard results will be used in the case that other dams are located upstream.

3.1.3.a State of Utah Freeboard Wave Runup Event Precipitation

The State of Utah Administrative Rules (R-655-11-4) requires that sufficient freeboard be provided to contain the wave runup on the dam while passing a 100-year precipitation event occurring on a saturated watershed. The duration of the event is dependent on whether the

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local or general SEF event controls. In order to perform this evaluation precipitation for either the 6-hour or the 24-hour precipitation event is required, depending on which SEP event produces the controlling flood (local or general). The 24-hour precipitation depths are the same as those reported for the matching economic analysis events, but are repeated here for convenience. The precipitation depths are shown in Table 5 below.

Table 5. Freeboard Wave Runup Analysis Precipitation

Freeboard 100-year Wave Runup Event Precipitation		
Watershed	6-Hour (Local)	24-Hour (General)
1	2.16	3.10
2	2.14	3.09
3	2.11	3.03
4	2.15	3.06
5	2.15	3.06
6	2.15	3.03

3.1.4 Burned Condition Events Precipitation

The purpose of performing the TR-20 models with watersheds 1 thru 6 during a 10-year 24-hour event in 'post-burn' conditions is to assure that the debris basin volumes would be sufficient to reduce the risk of injury and damage after a wildfire. The resulting volumes and peak flows from the TR-20 volume will then be bulked in accordance with NRCS TN-4 in order obtain the final design values.

The precipitation values are the same as those for the 10-year 24-hour events included in the section 3.1.1 Economic Analysis Event Precipitation.

3.1.5 Debris Flow Events Precipitation

In accordance with the publication by the USGS "Predicting the Probability and Volume of Post-Wildfire Debris flows in the Intermountain Western United States" (Cannon, Gartner, Rupert, Michael, Rea, Parrett, 2010) the types of events that "most strongly control the debris-flow response of burned basin in the Intermountain West" are short-duration, low-recurrence-interval convective thunderstorms. The study identifies these as less than one hour and less than 2-year or up to 10-year recurrence intervals. To match the recommended criteria, and to select an event that would be likely to occur in the lifespan of the structure, a 1-hour 5-year event was chosen based on engineering judgement. In the study "The 2000–2004 fire-related debris flows in Northern Utah" by Giraud and McDonald (2007) they examined both recent debris flows (including those above Santaquin) and other past studies to conclude that triggering rainfall typically has a recurrence interval of two years or less, and the durations cited were all less than an hour.

The rainfall depth for the event was based on one common point in the area of the drainages in question. Since all of the watersheds are in such close proximity the same value was

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used for all watersheds in the debris flow calculations. This matches the approach taken in Santaquin City's Storm Drain Master Plan, so it was adopted in this study as well.

Table 6. Debris Flow Precipitation Depth

Debris Flow Precipitation (all basins)	
Event	Depth (in)
5-year 1-hour	0.729

3.2 Hyetographs

The source and development of temporal distributions for rainfall depended on the type of event being analyzed, and the requirements of the agency with jurisdiction. The distribution development is described in the sections below based on event type.

3.2.1 Economic Analysis Events Hyetographs

The NOAA Atlas Data with Smoothing is a function within the WinTR-20 software that, "In order to best reflect the updated NOAA Atlas 14 & Northeast Regional Climate Center (NRCC) precipitation data, a site specific distribution is developed based on the CSV/text file download from the web site (English units only)." The process critically stacks events starting with the shortest duration and adding longer durations up to the 24-hour storm. This process is done for each recurrence interval. Reference is made to NRCS WinTR-20 supporting documentation for further information, which is available freely online. The NOAA Atlas 14 data was downloaded using the longitude and Latitude of each centroid (calculated in GIS) for each of the six basins. Due to the limitations of the WinTR-20 software (the software can only import one (1) set of NOAA Atlas data per model), six separate models were created, one for each watershed. An example of the distribution developed for Basin 1 is provided below.

3.2.2 Principal Spillway Analysis Events Hyetographs

The hyetograph for the principal spillway evaluation is developed in accordance with the procedure in chapter 21, NEH-4, and uses both the 1-day and 10-day runoff volumes. The SITES software performs this analysis automatically, and was used to develop the hyetograph as part of the program run.

3.2.3 Auxiliary Spillway Evaluation Events Hyetographs

TR-60 provides a temporal distribution (Figure 2-4) which can be used where no temporal distribution from a NWS publication is available. This distribution is termed the "6-Hour storm" in the SITES program. TR-60 titles the distribution "Dimensionless design storm distribution, auxiliary spillway and freeboard."

The NWS publication applicable to Utah is HMR-49. It contains sufficient data to develop a 6-hour local storm temporal distribution, but despite providing precipitation data for the 72-hour event, it does not have data to develop a distribution for the 72-hour storm.

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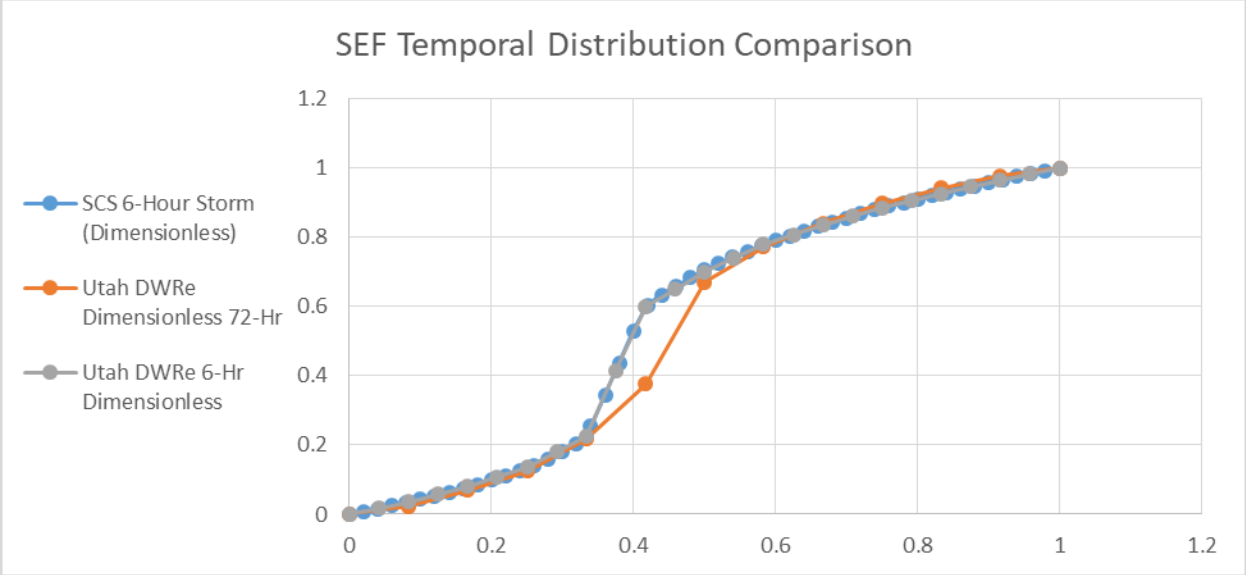
Evaluation of the 72-hour storm is required by the Administrative Rules of the State of Utah.

The Utah Division of Water Resources (DWRe) developed and has used in general practice a curve for the 72-hour general storm in Utah. For short duration storms the DWRe internally developed program "STORM" uses the SCS 6-hour storm. When compared as a dimensionless curve to the SCS 6-hour curve, the 72-hour distribution is similar, though the peak rainfall period for the general 72-hour storm appears to have a comparatively flatter, or less severe, peak rainfall period. In reality, applied to a 72-hour period, this peak rainfall period would be longer in duration, but would generally have a relatively lower intensity, dependent upon the total precipitation. This is consistent with typical general storm behavior. Use of the DWRe 72-Hour distribution is documented and suggested for use in Utah in the publication by Norm Stauffer of the Utah Division of Water Resources (1992). A comparison of the distributions is shown below in Figure 1.

Figure 1. Auxiliary Spillway Evaluation Temporal Distributions



The office of the NRCS in Utah has adopted the USUL and USUS studies (Jensen) discussed previously in developing the Probable Maximum Flood (PMF) and Spillway Evaluation Flood (SEF), and has made a practice of coordinating the use of matching temporal distributions with the State of Utah. This study used the same approach. Therefore, the SCS 6-hour storm was used for local events (6-Hour), and the DWRe 72-Hour distribution was used for the 72-hour general storm. For the 24-hour storm a dimensionless version of the SCS 6-Hour storm was used. This is in line with TR-60 since no curve is provided for the 24-Hour storm in any of the adopted NWS or State of Utah publications, so use of this curve is permitted.

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3.2.3.a State of Utah Freeboard Wave Runup Event Hyetograph

The State of Utah Administrative Rules (R-655-11-4) requires that sufficient freeboard be provided to contain the wave runup on the dam while passing a 100-year precipitation event occurring on a saturated watershed. The State of Utah does not specify a specific hyetograph to be used. For the 6-hour storm, An NRCS Type II storm was modified to a 6-hour duration by extracting the peak six hours in the distribution and scaling the percentages of rainfall accordingly.

TR-60 also requires that the design height of an earth embankment must be sufficient to prevent overtopping during passage of either the freeboard hydrograph or stability design Hydrograph, plus the freeboard required for frost conditions or wave action, whichever is larger. This will be evaluated in the Hydraulics Technical Memo.

3.2.4 Burned Condition Hyetograph

The analysis discussed here is normal flow on burned watersheds with typical sediment loads. It is not for debris flow, which is discussed in the next section.

A 10-year storm was deemed reasonable for the burned condition analysis because the combined probability of both a wildfire and a 10-year storm event is still quite low. In “The 2000-2004 Fire-Related Debris Flows in Northern Utah” (Giraud & McDonald, 2007) the authors cite Forest Service reports indicating the fire return period for mountain brush as 20 to 40 years, and for subalpine forest as 150 to 300 years. Using the lower end of this scale the probability of the evaluated event would be 0.5% in a given year, or a return interval of 200 years.

The temporal distribution used was the NOAA Atlas Data with Smoothing method which is integrated into the WinTR-20 program.

3.2.5 Debris Flow Events Hyetograph

In the method for determining debris flow volume outlined in the study by Cannon, et al (2010) only the precipitation volume is required. Therefore, there is no temporal distribution associated with this analysis. A separate debris flow analysis being undertaken by the geotechnical engineer using channel cross-sectioning methods uses data from the economic analysis events to inform the debris flow volume analysis. Their analysis will be submitted independently of this report.

4.0 WATERSHED DATA

The specific watershed data required to perform the necessary hydrologic analysis are outlined below with explanations of their development, including the loss method, time of concentration, and unit hydrograph used.

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4.1 Geometric Watershed Characteristics

Tools within the ArcGIS software were used to delineate each watershed and to evaluate critical parameters, such as the watershed area and the longest flow path. The basins as delineated are shown in Appendix 1. Basic geometric data is provided in Table 7 below.

Table 7. Basic Geometric Watershed Data

Watershed	Area (Mi^2)	Area (Acre)	Longest Flow Path (ft)
BASIN 1	0.6266	401.9	9003.2
BASIN 2	0.0688	44.3	3396.6
BASIN 3	0.0531	34.1	2883.3
BASIN 4	0.6875	440.7	11099.6
BASIN 5	0.7109	455.2	12349.6
BASIN 6	0.4510	288.9	8552.7

4.2 Runoff Methodology

The Curve Number method was used to evaluate the precipitation loss and total runoff. The Curve Numbers were developed using the data as outlined below.

4.2.1 Soil Data

The SSURGO soil data was downloaded in GIS format and the Hydrologic Soil Group. A soil region covering much of the watersheds did not have a Hydrologic Soil Group (HSG) identified in the GIS data. It was noted that both above and at the downstream ends of the watersheds the soils HSG was identified as C. Similar neighboring watersheds were identified primarily as B and C, with some locations showing group D. It was assumed based on the location of neighboring type C soils, and the type of soils seen in neighboring watersheds, that an HSG of C was a reasonable assumption for the region with none identified. A figure showing the soil group layout is included in Appendix 2.

4.2.2 Land Use Data

Land use data was determined by downloading GIS data National Land Cover Dataset (NLCD) from the Multi-Resolution Land Characteristics (MRLC) Consortium. The land cover classification values were assigned comparable cover types from Chapter 9 of the National Engineering Handbook, Part 630 (NEH-630). A copy of the spreadsheet showing the cover types used for each NLCD land cover classification is included as Appendix 4. A figure showing the NLCD land cover types is included in Appendix 3.

4.2.3 Curve Number Development

Utilizing the table in Appendix 4, each region of overlapping land use a soil type was assigned a Curve Number (CN). The CN of the watershed as a whole was obtained through ArcGIS by performing a weighted average based on the area and the CN of each region within the watershed. The resulted weighted Curve Numbers are shown below.

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Table 8. Curve Number

Watershed	Weighted CN
1	71.8
2	69.2
3	70.9
4	70.9
5	67.3
6	72.1

4.3 Time of Concentration

Time of Concentration (Tc) was originally calculated as part of the Santaquin SDMP and were carried over for use in this Plan-EA, but the process is fully described herein. The longest flow paths were identified using GIS, and by visual review of site conditions broken down into lengths of overland, shallow concentrated, and channel flow. TR-55 methods were used, except that for shallow concentrated flow the formula in HEC-22 was used since it is more directly adaptable to spreadsheet use. The calculations are included in Appendix 5. Basic assumptions used in the calculations include the following:

Table 9. SDMP Times of Concentration Assumptions

Time of Concentration Assumptions		
Parameter	**Value**	**Description**
Sheet Flow Roughness, n	0.4	Woods: Light Underbrush (TR-55 Table 3-1)
Shallow Conc. Intercept coeff., k	0.076	Forest with heavy ground litter (HEC-22, Table 3-3)
Channel Roughness, n	.035	Mountain streams (Chow, 1959)
Hydraulic Radius, R	0.7	Approx. 2 foot wide channel, 1.25 feet deep, 1:1 slopes, other configurations possible

In an effort to review and refine the Tc for the Plan-EA analysis, the velocities of each section were checked. It was noted that sheet flow velocities were very low and the channel velocities high, though the overall average velocities were reasonable, though perhaps faster than typical. To verify the Tc calculations, an independent check of the lengths and slopes was undertaken, the roughness values were revisited, and the method of calculation of the shallow concentrated flow velocity was changed to use the velocity lookup table in Chapter 15 of NEH-630. The revised calculations are included as Attachment 6. The following changes were made:

Table 10. Time of Concentration Quality Control Check Adjustments

Time of Concentration Quality Control Adjustments		
Parameter/Method	**Value**	**Description**
Shallow Concentrated Flow, V	3.0 to 3.75	Used "…woodlands" line in Figure 15-4 of NEH-630, Ch. 15 (value varies with slope)
Channel Roughness, n	0.07	Mountain Stream, upper limit
Hydraulic Radius, R	.8	Approx. 2 foot wide channel, 1.5 feet deep, 1:1 side slopes, other configurations possible

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The adjustments resulted in more reasonable velocities for each type of flow, but the overall time and velocity did not change significantly, except in the case of Basin 5. The results are as follows:

Table 11. Time of Concentration Quality Control Check Results

Time of Concentration QC Results			
Basin	**SDMP Results (hr)**	**QC Results (hr)**	**Difference (hr)**
1	0.572	0.537	-0.035
2	0.293	0.207	-0.087
3	0.263	0.210	-0.053
4	0.602	0.527	-0.075
5	0.406	0.667	0.261
6	0.406	0.454	0.048

By observation, most of these differences were recognized as not being large enough to have a significant impact, and are certainly within the margin of error of either method. All of the evaluations for Basin 5 were rerun though with the adjusted time of concentration since its change was sufficient to merit correction.

4.4 Burned Condition Runoff Methodology Adjustments

For burned condition analysis the values determined under normal conditions had to be adjusted to accommodate the changes that occur after a wildfire. The changes were made in accordance with the general recommendations of "Suggested Changes to AGWA to Account for Fire (V 2.1)" (Canfield and Goodrich, USDA-ARS, 2005) and the NRCS Technical Note #4 (TN-4).

Canfield et al (2005) and McLin et al. (2001) noted that post-fire total runoff generally does not have a significant change in volume, but peak flows can increase up to an order of magnitude.

In order to accommodate this, Canfield et al (2005) recommended using a change in the cover when evaluating the curve number to obtain a new CN value for post-burn conditions. Their paper provided tables of new curve numbers based on NLCD land use type, for several common land uses.

4.4.1 Curve Number Post-Burn Adjustments

In order to accommodate the change in volume, Canfield et al (2005) recommended using a change in the cover when evaluating the curve number to obtain a new curve number value for post-burn conditions. Their paper recommended numerical changes in quantity of cover based on burn severity, and they provided tables of new curve numbers based on NLCD land use type for several common land uses. Cerelli (2005) also suggested a method of adjusting the curve number based on adjusting the hydrologic condition, or "cover type".

To accomplish the same end, the hydrologic condition we used to determine the curve number for normal conditions, (see NEH-630 - Chapter 9) was adjusted to the next worse condition from its current state, and the curve number adjusted accordingly. For example, a hydrologic condition of "good" was reduced to "fair", and so forth. Since the soil type in the watersheds southeast of Santaquin are largely Type C, with similar land use types across them, the increase in Curve Number was fairly consistent averaging about 4, and

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ranging from 2 to 7 for the predominant cover types in the area. Therefore, to be conservative, a uniform increase of 6 was applied to the Curve Numbers on these basins to obtain new runoff results. The resulting curve numbers are shown in Table 12. The adjusted curve number calculations are shown on the second page of Appendix 4.

4.4.2 Time of Concentration Post-Burn Adjustments

The "Suggested Changes to AGWA" and TN-4 publications both suggest that for the velocity method time of concentration, the manning's roughness value be adjusted. This results in a higher peak flow, even with minimal increase in volume. Adjusting the Manning's n only changes the overland flow portion of the calculation, which is over a relatively short distance. The n values were adjusted from 0.4 (Woods with light underbrush, TN-4, Table 10) to 0.11. The adjusted times of concentration are reflected in Table 12.

Table 12. Burned Condition Data and Results

BURN CONDITIONS INPUT AND RESULTS SUMMARY						
BASIN	**Curve Number**	**Time of Concentration (T_C)**	**AREA**	**Precipitation Q_{10}**	**Peak Flow Q_{10}**	**Volume Q_{10}**
		[HR]	[SQ MI]	[IN]	[CFS]	[AC-FT]
Watershed 1	77.8	0.469	0.6266	0.586	174	19.6
Watershed 2	75.2	0.232	0.0688	0.477	19	1.8
Watershed 3	76.9	0.188	0.0531	0.494	21	1.4
Watershed 4	76.9	0.531	0.6875	0.533	157	19.5
Watershed 5	73.3	0.330	0.7109	0.404	147	15.3
Watershed 6	78.1	0.321	0.4510	0.569	154	13.7

Upon review it was realized that the burned condition roughness used for sheet flow, 0.11, was a typo. It was intended to put in a highly conservative value of 0.011 (smooth surface, concrete, asphalt, bare soil, etc.). A value of 0.11 was still considered a reasonable assumption, as it reflected roughness one fourth of the unburned condition. Upon review of the roughness values in Table 15-1 of NEH-630, Ch. 15, it was decided that a value of 0.05 (Fallow, no residue) would be a conservative but realistic assumption. But, upon applying this value the changes in the times of concentration were so small that the changes were deemed unnecessary and the original values were retained.

4.5 Hydrograph Development

Both the WinTR-20 and SITES programs from NRCS utilize integrated unit hydrographs to develop the storm hydrograph. A full discussion of their methodologies will not be attempted here. These programs are designed to follow specific NRCS hydrograph generation methodologies. These programs were utilized to develop all of the discharge hydrographs for the watersheds.

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5.0 COMPARISON AND VALIDATION OF MAGNITUDE OF RESULTS

The watersheds in question do not have regular stream flows, only producing runoff during significant storm events or high snowmelt. No stream gauges exist. Comparisons to local stream gauges would have considerable unknown errors due to the many differing characteristics of these watersheds from those that produce continuous measurable flows.

Streamstats (USGS) was used to estimate 100-year flows, but reported that the watershed parameters were outside the limits of the method, resulting in unknown errors. It produced considerably lower design flows.

The USGS streamgage analysis performed as part of the Santaquin Canyon hydrology technical memorandum (McMillen, 2016) was also consulted for comparison. This study found that the average flow in cubic-feet per second per square mile of area (CSM) for the streams in the area was roughly 21. The results for streams in the region tended to cluster between 15 CSM and 30 CSM, with the two highest results at 37.6 and 40.6 CSM. The higher values corresponded to some of the smaller watersheds analyzed, and the general trend appeared to be that the smaller the watersheds the higher the CSM values. The table below uses Basin 1 to show how the results from our analysis compare to these other statistical methods for the 100-year event. This comparison also assumes that the 100-year precipitation corresponds with the 100-year stream flow, which is not necessarily the case.

Table 13. Magnitude Validation Summary

	Basin 1	Streamstats
100-Year Peak Flow (cfs)	300.6	39.6
CSM	480	62

With the very high CSM values, this data both suggests that our calculated flows are likely conservative, but also demonstrates that the conditions between the small, steep watersheds being analyzed in this study and the conditions in the larger watersheds that produce regular streamflows cannot be readily compared statistically. The synthetic, deterministic methods utilized in this study will therefore be relied upon without further calibration. Calibration appears merited, but no reliable means of such is available. Refining and comparing time of concentration and lag time methods does affect the peak flows, but not sufficiently to alter the order of magnitude difference shown in Table 12.

6.0 MODELING RESULTS

WinTR-20 could be used to perform hydrologic analysis only, but the nature of modeling in SITES merges the input and output for both the hydrologic and hydraulic analysis together. Therefore, the section below tabulates some of the key data points derived from these models, but not all of the data generated by the SITES model runs. The number of models and runs are significant, so the input and output data are not included directly with this memo, but can be supplied separately.

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6.1 Economic Analysis Events Modeling Results

Table 14 includes the peak inflows and total volumes of the Economic Analysis Events. The corresponding hydrographs were generated based on the precipitation depths shown in Table 2 and the time of concentration, area and CN determined for each watershed. Example hydrographs for Watershed 1 are shown in Figure 2 below.

Figure 2. Economic Analysis Events Example Hydrographs

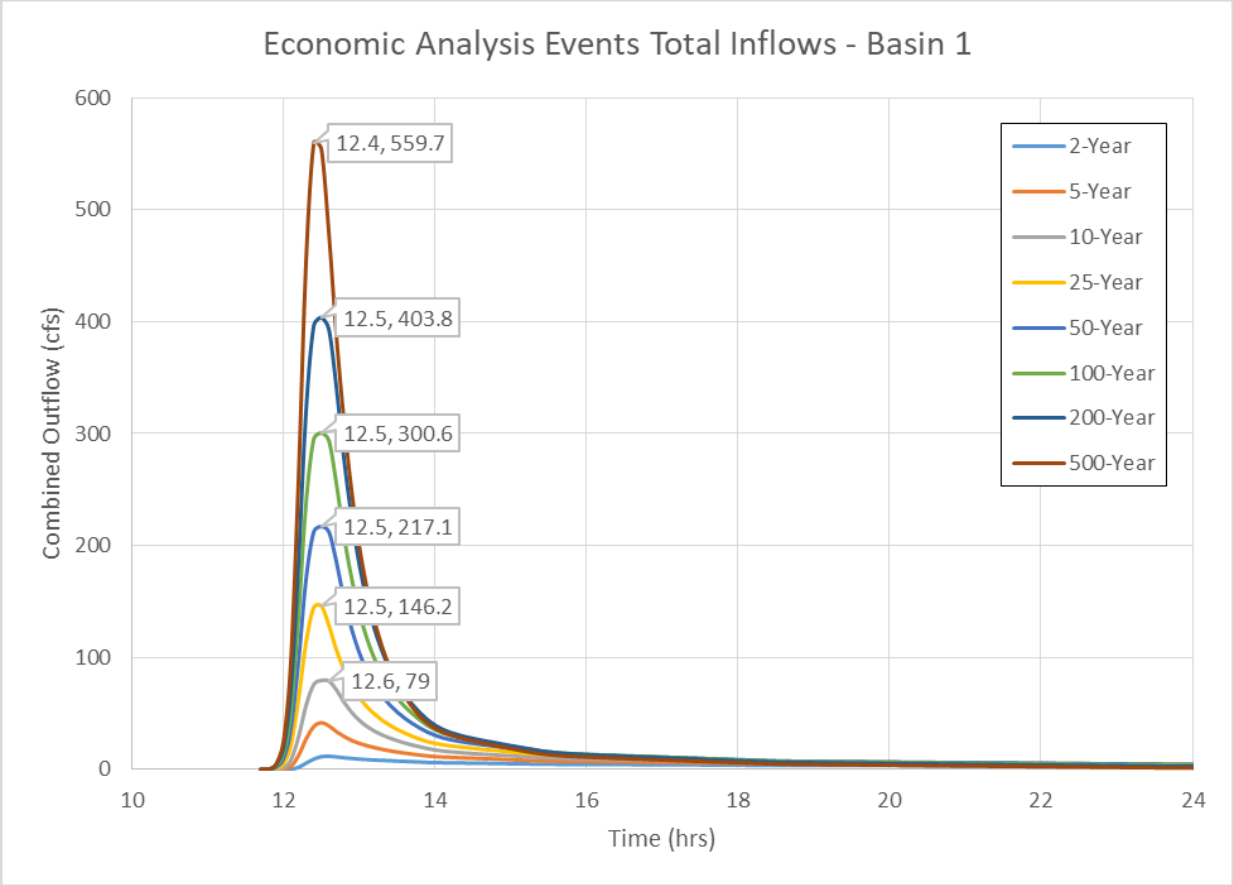

Table 14. Peak Flow and Total Volume – Economic Analysis Events

Watershed 1	2yr	5yr	10yr	25yr	50yr	100yr	200yr	500yr
Peak Flow (cfs)	11.9	41.8	79.6	149	217.1	300.6	403.8	569.7
Volume (acre-ft)	4.7	8.5	12.4	18.3	23.4	28.7	34.5	42.6

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Watershed 2	2yr	5yr	10yr	25yr	50yr	100yr	200yr	500yr
Peak Flow (cfs)	0.6	3.8	8.6	18.2	27.9	40.3	55.2	80.4
Volume (acre-ft)	0.1	0.5	1.0	1.6	2.1	2.6	3.1	3.9

Watershed 3	2yr	5yr	10yr	25yr	50yr	100yr	200yr	500yr
Peak Flow (cfs)	0.8	4.2	8.7	17.1	25.7	36.4	49.4	71.1
Volume (acre-ft)	0.1	0.4	0.7	1.2	1.6	2.0	2.5	3.2

Watershed 4	2yr	5yr	10yr	25yr	50yr	100yr	200yr	500yr
Peak Flow (cfs)	8.8	35.9	71.2	139.1	207.8	291.6	395.8	563.8
Volume (acre-ft)	4.3	8.2	12.1	18.2	23.4	29.0	35.1	43.5

Watershed 5	2yr	5yr	10yr	25yr	50yr	100yr	200yr	500yr
Peak Flow (cfs)	3.1	15.6	38.6	88.4	142.1	209.5	295.7	438.2
Volume (acre-ft)	2.5	5.6	8.8	14.2	18.8	23.8	29.4	37.2

Watershed 6	2yr	5yr	10yr	25yr	50yr	100yr	200yr	500yr
Peak Flow (cfs)	9.5	35.3	67.9	127.8	188.8	262.5	352.6	502.1
Volume (acre-ft)	3.2	5.8	8.5	12.6	16.1	19.9	23.9	29.4

6.2 Principal Spillway Analysis Events Modeling Results

Table 15 includes the peak inflow values for the PSH Curve Number Method ("Rainfall Method") and the PSH Runoff Method. Precipitation depths shown in Table 3 resulted in the flows shown for the PSH CN Method. Refer to the Precipitation Depth section of this report for further details on the events analyzed.

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Table 15. Peak Inflow – Principal Spillway Analysis Events

	Peak Flow	PSH CN Method	PSH Runoff Method
Basin 1	Basin 1 Above Grade (High Hazard - P_{100})		
	Peak Flow (cfs)	61.44	67.51
	Basin 1 Below Grade (Low Hazard – P_{25})		
	Peak Flow (cfs)	50.33	50.72

	Peak Flow	PSH CN Method	PSH Runoff Method
Basin 2	Basin 2 Above Grade (High Hazard - P_{100})		
	Peak Flow (cfs)	5.65	7.58
	Basin 2 Below Grade (Low Hazard – P_{25})		
	Peak Flow (cfs)	0.3	5.7

	Peak Flow	PSH CN Method	PSH Runoff Method
Basin 3	Basin 3 Above Grade (High Hazard - P_{100})		
	Peak Flow (cfs)	5.07	5.85
	Basin 3 Below Grade (Low Hazard – P_{25})		
	Peak Flow (cfs)	2.7	4.38

	Peak Flow	PSH CN Method	PSH Runoff Method
Basin 4	Basin 4 Above Grade (High Hazard - P_{100})		
	Peak Flow (cfs)	61.27	73.83
	Basin 4 Below Grade (Low Hazard – P_{25})		
	Peak Flow (cfs)	33.37	55.39

	Peak Flow	PSH CN Method	PSH Runoff Method
Basin 5	Basin 5 Above Grade (High Hazard - P_{100})		
	Peak Flow (cfs)	44.0	75.44
	Basin 5 Below Grade (Low Hazard – P_{25})		
	Peak Flow (cfs)	13.0	56.56

	Peak Flow	PSH CN Method	PSH Runoff Method
Basin 6	Basin 6 Above Grade (High Hazard - P_{100})		
	Peak Flow (cfs)	44.74	49.52
	Basin 6 Below Grade (Low Hazard – P_{25})		
	Peak Flow (cfs)	24.55	37.16

6.3 Auxiliary Spillway Evaluation Events Modeling Results

Table 16 shows the resulting peak flows and total volumes generated by the storm events shown in Table 4. Below grade and above grade options exist for the same watershed, and the precipitation depth considered varies based on the hazard classification as described in Section 3.1.3. The runoff results of the 100-year 6-hour saturated watershed are also

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included for use in the freeboard analysis which will be discussed in the Hydraulics Technical Memo.

Table 16. Peak Inflow – Auxiliary Spillway Analysis Events

	Event	6hr SEF	24hr SEF	72hr SEF	6hr ARCIII
Basin 1	Basin 1 Above Grade				
	Peak Flow (cfs)	548	507	183.5	418.5
	Volume (acre-ft)	73.9	189.9	242.5	#
	Basin 1 Below Grade				
	Peak Flow (cfs)	221.1	110.5	42.7	418.5
	Volume (acre-ft)	33.4	44.4	49.0	#

	Event	6hr SEF	24hr SEF	72hr SEF	6hr ARCIII
Basin 2	Basin 2 Above Grade				
	Peak Flow (cfs)	76.5	55.1	19.8	60.7
	Volume (acre-ft)	8.2	19.9	25.6	#
	Basin 2 Below Grade				
	Peak Flow (cfs)	26.4	11	4.3	60.7
	Volume (acre-ft)	3.2	4.3	4.8	#

	Event	6hr SEF	24hr SEF	72hr SEF	6hr ARCIII
Basin 3	Basin 3 Above Grade				
	Peak Flow (cfs)	65.5	44.6	15.7	51.8
	Volume (acre-ft)	6.8	16.1	20.5	#
	Basin 3 Below Grade				
	Peak Flow (cfs)	23.1	6.2	3.5	51.8
	Volume (acre-ft)	2.7	3.5	3.9	#

	Event	6hr SEF	24hr SEF	72hr SEF	6hr ARCIII
Basin 4	Basin 4 Above Grade				
	Peak Flow (cfs)	582.7	544.7	199.4	442.5
	Volume (acre-ft)	80.1	204.6	262.0	#
	Basin 4 Below Grade				
	Peak Flow (cfs)	215.6	111.6	44.5	442.5
	Volume (acre-ft)	34.2	45.7	50.9	#

	Event	6hr SEF	24hr SEF	72hr SEF	6hr ARCIII
Basin 5	Basin 5 Above Grade				
	Peak Flow (cfs)	476.6	510.4	196.0	355.9
	Volume (acre-ft)	71.9	194.2	251.7	#
	Basin 5 Below Grade				
	Peak Flow (cfs)	157.5	91.3	39.2	355.9
	Volume (acre-ft)	28.8	39.2	44.1	#

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	Event	6hr SEF	24hr SEF	72hr SEF	6hr ARCIII
Basin 6	Basin 6 Above Grade				
	Peak Flow (cfs)	494.6	373.5	132.3	367
	Volume (acre-ft)	57.4	136.9	174.7	#
	Basin 6 Below Grade				
	Peak Flow (cfs)	251.7	80.4	30.5	367
	Volume (acre-ft)	31.3	31.3	34.8	#

Value Not Reported in SITES Output

6.4 Burned Condition Runoff Modeling Results

The peak flows and volume from the hydrographs developed for the burned condition analysis are summarized below. The peak flows were then bulked using the methodology described in the NRCS Technical Note 4, "Sediment Bulking", using equation 11. It should be noted, Equation 11 in TN-4 appears to have an error in the denominator. The correct form is shown below.

$$BF = \frac{Q_w + Q_{sed}}{Q_w} = \frac{1}{1 - C_v}$$

The volumes were bulked using a simple assumption that:

$$V_{bulked} = V_{water} + V_{sediment}$$

An assumption of 20% sediment concentration was assumed to be conservative. A 20% concentration is generally assumed to be the transition point between standard flow and hyper-concentrated flow (TN-4, Elliot et al. 2005, Santi et al. 2006, Pierson 2005). According to documentation by USGS (Pierson 2005), which is cited in TN-4, normal suspended sediment concentrations are 5 to 10 percent.

Table 17. Post-Burn Conditions Analysis Results

BURN CONDITIONS INPUT AND RESULTS SUMMARY					
BASIN	**Precipitation Q_{10}** [IN]	**Peak Flow Q_{10}** [CFS]	**Bulked Peak Flow Q_{10}** [CFS]	**Volume Q_{10}** [AC-FT]	**Bulked Volume Q_{10}** [AC-FT]
Watershed 1	0.586	174	218	19.6	23.52
Watershed 2	0.477	19	24	1.8	2.16
Watershed 3	0.494	21	26	1.4	1.68
Watershed 4	0.533	157	196	19.5	23.4
Watershed 5	0.404	147	184	15.3	18.36
Watershed 6	0.569	154	193	13.7	16.44

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6.5 Debris Flow Event Modeling Results

The debris flow volumes determined for each of the watersheds are tabulated below in Table 18. The calculations can be seen in Attachment 9. For comparison, the largest estimated debris flow volume reported in the ten "Dry Mountain" watersheds that had similar flows, which includes the watersheds in this study, was 20,000 cubic yards, or 12.4 acre-feet (assumed to be Watershed 4 in this study). The remainder ranged from 30 to 13,000 cubic yards, or 0.02 to 8.1 acre-feet, respectively (Giraud and McDonald, 2007).

Table 18. Debris Flow Volumes

Debris Flow Volumes	
Watershed	Volume (acre-feet)
1	11.0
2	1.62
3	1.25
4	11.9
5	11.6
6	7.6

7.0 CONCLUSIONS

The events considered most critical to the scale of the basins are the economic analysis events, burned condition events, and debris flows. These design events are larger than previously considered in the preliminary Santaquin SDMP due to the addition of the 24-hour duration into the analysis as part of the NRCS required analysis, and have higher peak flows due to the more conservative critically stacked temporal distributions used in the WinTR-20 program. NOAA Atlas 14 distributions, which were used in the draft SDMP, attempt to mimic historic storms in the region. The end result is that the approach of retaining the entire 100-storm originally contemplated for the city will likely be infeasible, making the outflow system a critical part of the design in order to handle the flows that may be encountered. The storm for which we provide "full protection" may also have to be reconsidered based on the economics and feasibility of designing flood control systems to handle the larger events. This is especially true considering that NRCS criteria require that if the auxiliary spillway is earthen or vegetated the Principal Spillway Hydrograph (a 100-year 10-day storm) must be able to pass through the outlet system ("principal spillway") without any flow going over the auxiliary spillway. This will be addressed in the Hydraulics Technical Memo.

The assumptions involved in the bulking calculations may deserve reevaluation if they prove to have a significant effect on the final system design.

No final conclusions can be drawn from this data, as this data must be routed through the proposed reservoirs before the full meaning of these results can be determined. This will be discussed in the Hydraulics Technical Memo. It is acknowledged that in the case of the SITES program much of this hydraulic analysis was performed simultaneously with the hydrologic modeling. A summary

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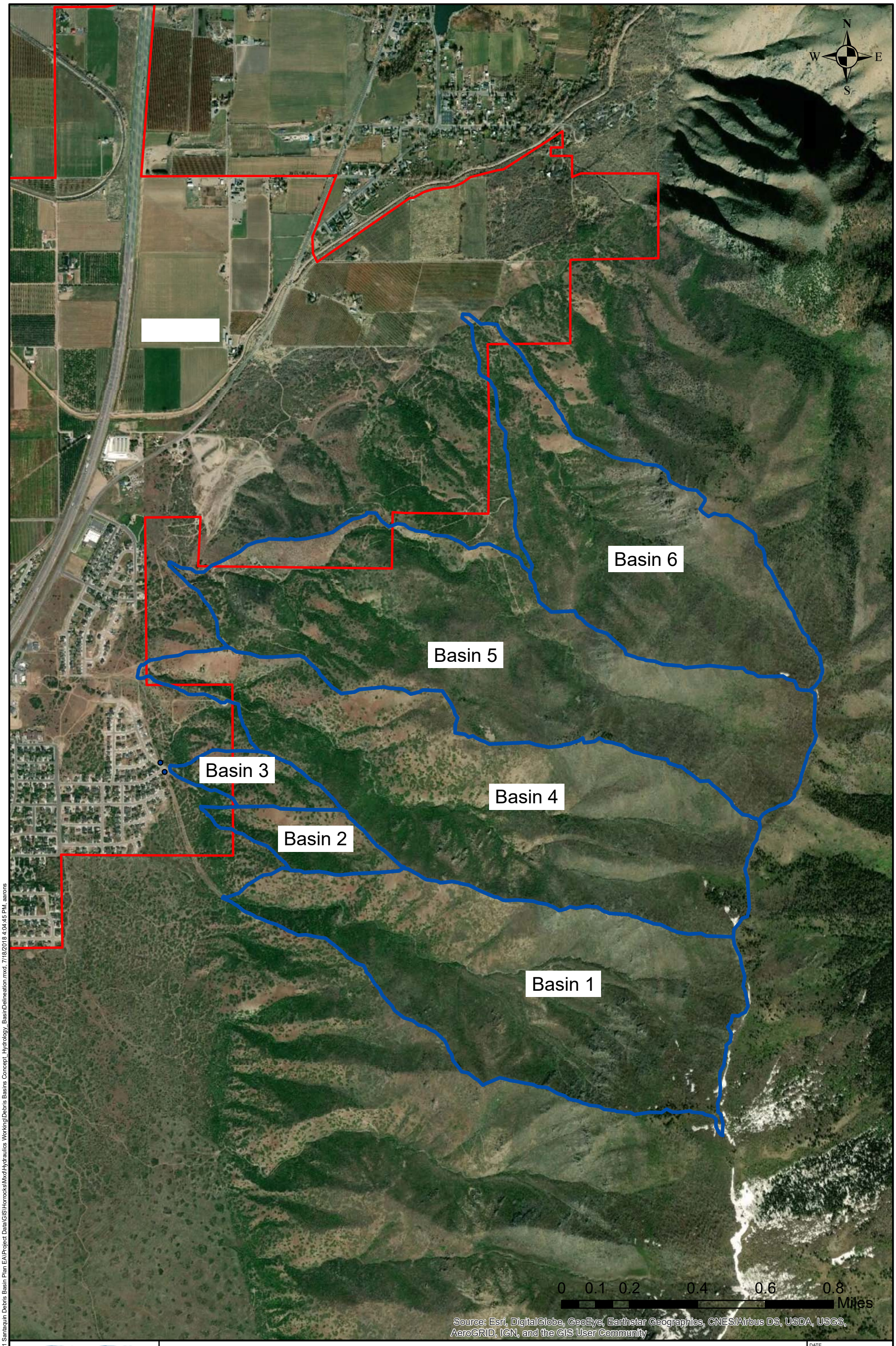
of the combined results will be included in the Hydraulics Technical Memo. A separate sedimentation memo will also be prepared and submitted.

8.0 APPENDICES

1. Watershed Map
2. Soil Map
3. Land Use Map
4. NLCD Land Use Curve Number Table
5. Time of Concentration Calculations
6. Time of Concentration Calculations Quality Control Check
7. Time of Concentration Calculations – Burned Condition
8. Burned Watershed Bulking Calculations
9. Debris Flow Volume Calculations



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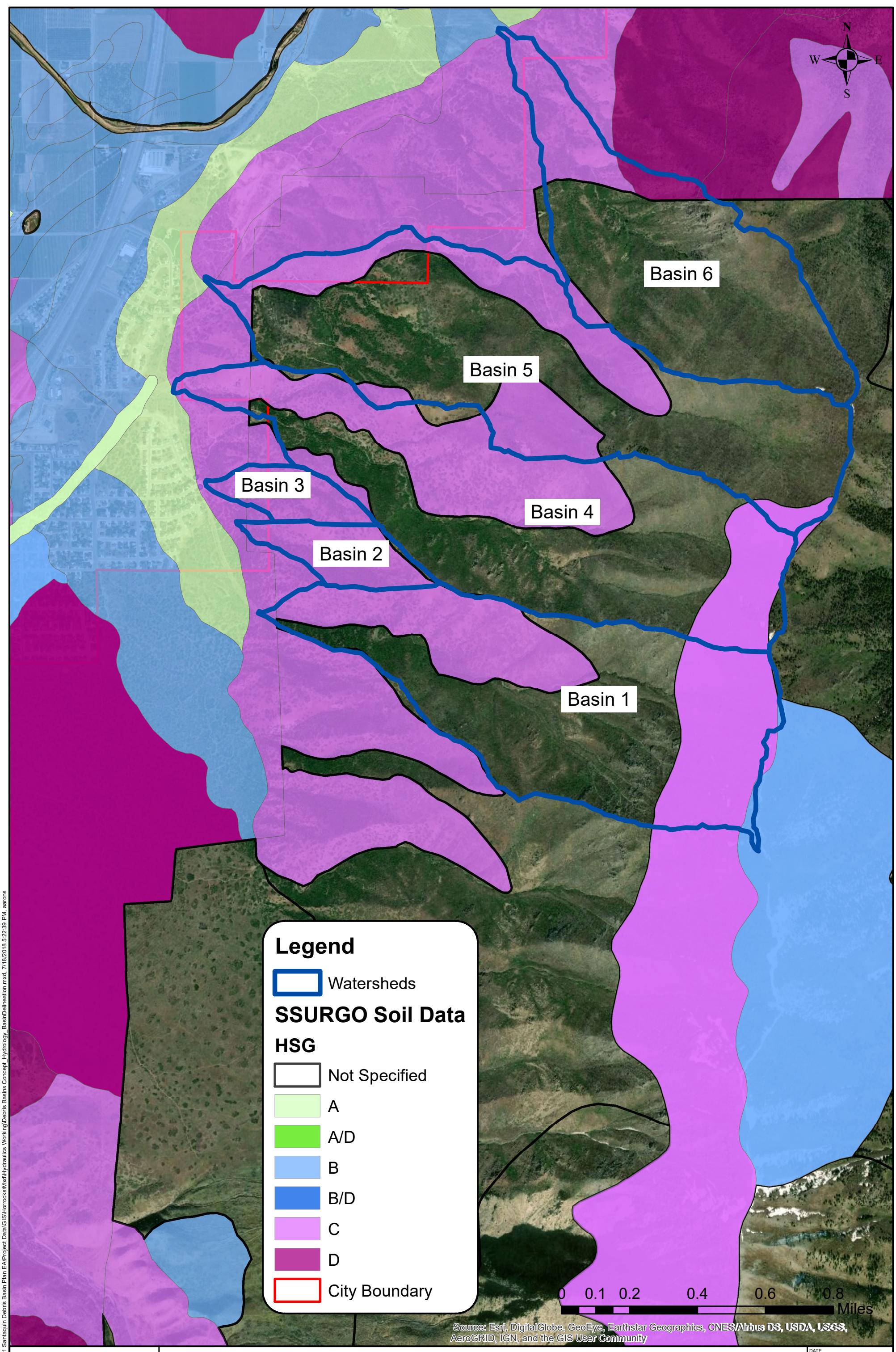
Santaquin Flood Control Plan-EA

Watershed Delineation

DATE 7/18/2018

DRAWN

Figure 1



Santaquin

Santaquin Flood Control Plan-EA

Soil Groups

DATE 7/18/2018

DRAWN

Figure 1

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Basin 6

Basin 5

Basin 4

Basin 3

Basin 2

Basin 1

N

S

E

W

Legend

Watersheds

City Boundary

NLCD Land Use

Class

11
21
22
23
24
31
41
42
43
52
71
81
82
90
95

0 0.075 0.15 0.3 0.45 0.6 Miles

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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Santaquin

Santaquin Flood Control Plan-EA

NLCD Land Use Classes

DATE 7/18/2018

DRAWN

Figure _

Mountain Watersheds Curve Number Table

National Land Cover Database (NLCD)		NRCS Land Use Equivalent		Hydrologic Soil Group				
Value	**Definition**	**NRCS Description Used**	**Condition**	**A**	**B**	**C**	**D**	**Notes**
1	Unknown	Impervious	NA	98	98	98	98	
11	Open Water - All areas of open water, generally with less than 25% cover or vegetation or soil	Open Water	NA	100	100	100	100	
12	Perennial Ice/Snow - All areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover.	Impervious	NA	98	98	98	98	
21	Developed, Open Space - Includes areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.	Open Space	Good	49	69	79	84	
22	Developed, Low Intensity -Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20-49 percent of total cover. These areas most commonly include single-family housing units.	Residential, 1 acre lots	NA	51	68	79	84	
23	Developed, Medium Intensity - Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50-79 percent of the total cover. These areas most commonly include single-family housing units.	Residential, 1/2 acre lots	NA	54	70	80	85	
24	Developed, High Intensity - Includes highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80 to 100 percent of the total cover.	Residential, 1/8 acre or less (townhouses)	NA	77	85	90	92	
31	Barren Land (Rock/Sand/Clay) - Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.	Fallow, Bare Soil	NA	77	86	91	94	
32	Unknown	Impervious	NA	98	98	98	98	
41	Deciduous Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species shed foliage simultaneously in response to seasonal change.	Woods	Fair	36	60	73	79	
42	Evergreen Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species maintain their leaves all year. Canopy is never without green foliage.	Woods	Fair	36	60	73	79	
43	Mixed Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75 percent of total tree cover.	Woods	Fair	36	60	73	79	
51	Dwarf Scrub - Alaska only areas dominated by shrubs less than 20 centimeters tall with shrub canopy typically greater than 20% of total vegetation. This type is often co-associated with grasses, sedges, herbs, and non-vascular vegetation.	NA	NA	0	0	0	0	
52	Shrub/Scrub - Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.	Desert Shrub	Good (minimal runoff reported)	49	68	79	84	
71	Grassland/Herbaceous - Areas dominated by grammanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.	Herbaceous	Good (minimal runoff reported)	39	62	74	85	No A type soil in described for semiarid herbaceous rangeland, agricultural pasture/grassland/range used to determine value for soil type A
72	Sedge/Herbaceous - Alaska only areas dominated by sedges and forbs, generally greater than 80% of total vegetation. This type can occur with significant other grasses or other grass like plants, and includes sedge tundra, and sedge tussock tundra.	NA						
73	Lichens - Alaska only areas dominated by fruticose or foliose lichens generally greater than 80% of total vegetation.	NA						
74	Moss - Alaska only areas dominated by mosses, generally greater than 80% of total vegetation.	NA						
81	Pasture/Hay - Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation.	Pasture, grassland, or range - forage for grazing	Fair	49	69	79	84	
82	Cultivated Crops - Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.	Small Grain, Straight row & Crop residue	Good	63	75	83	87	
90	Woody Wetlands - Areas where forest or shrub land vegetation accounts for greater than 20 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.	*Wetlands-Forested	NA	45	66	77	83	*Pineview Reservoir Utah DEQ Pineview Study (3/26/2002), https://deq.utah.gov/ProgramsServices/programs/water/watersheds/docs/2006/09Sep/Pineview_Res_Appendix_B.pdf
95	Emergent Herbaceous Wetlands - Areas where perennial herbaceous vegetation accounts for greater than 80 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.	*Wetlands-nonforested	NA	49	69	79	84	*Pineview Reservoir Utah DEQ Pineview Study (3/26/2002), https://deq.utah.gov/ProgramsServices/programs/water/watersheds/docs/2006/09Sep/Pineview_Res_Appendix_B.pdf

Mountain Watersheds Curve Number Table

Burned Conditions Adjustment

National Land Cover Database (NLCD)		NRCS Land Use Equivalent		Original Curve Number: Hydrologic Soil Group				**Burned Curve Number**									
Value	**Definition**	**NRCS Description Used**	**Condition**	**A**	**B**	**C**	**D**	Condition	A	B	C	D	A	B	C	D	
41	Deciduous Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species shed foliage simultaneously in response to seasonal change.	Woods	Fair	36	60	73	79	Poor	45	66	77	83	9	6	4	4	
42	Evergreen Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species maintain their leaves all year. Canopy is never without green foliage.	Woods	Fair	36	60	73	79	Poor	45	66	77	83	9	6	4	4	
43	Mixed Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75 percent of total tree cover.	Woods	Fair	36	60	73	79	Poor	45	66	77	83	9	6	4	4	
52	Shrub/Scrub - Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.	Desert Shrub	Good (minimal runoff reported)	49	68	79	84	Fair	55	72	81	86	6	4	2	2	
71	Grassland/Herbaceous - Areas dominated by grammanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.	Herbaceous	Good (minimal runoff reported)	39	62	74	85	Fair	49	71	81	89	10	9	7	4	
												Average Change	8.6	6.2	4.2	3.6	

3.9	Average of C and D soil types (predominant in mountain watersheds)

Time of Concentration Calculations - Mountain Watersheds

GIS Data | Identifier | Data Entry | Computation | Basins Not Part of Study

Normal Watershed Conditions

Velocity Checks

Gridcode	Shape_Leng	Shape_Length	Shape_Area	CN	Basin #	Hillside Location	Flow_Slope	Flow_Length	Sheet Flow Length	Sheet Flow Slope	2-yr, 24-hr rainfall	Roughness Coefficient, n	Sheet Flow Time	Shallow Concentrated Length	Shallow Concentrated Slope	Intercept Coeff, k	Shallow Concentrated Time	Channel Flow Length	Channel Slope	Roughness Coeff, n	Hydraulic Radius	Channel Flow Time	Total Time	Sheet Flow	Shallow Conc. Velocity	Channel Velcity	Overall Velocity Check
15	6676.9	6464.5	1625603.7	71.8	1	East	0.4	9003.2	100	0.4	1.59	0.4	0.16	2070.0	0.6	0.076	0.31	6833.2	0.3	0.035	0.7	0.10	0.572	0.174	1.867	18.205666	4.3730693
14	2187.8	2184.9	179203.9	69.2	2	East	0.4	3396.6	100	1.3	1.59	0.4	0.09	1230.0	0.7	0.076	0.16	2066.6	0.2	0.035	0.7	0.03	0.293	0.294	2.076	16.76437	3.21731104
34	2191.6	1834.8	137890.9	70.9	3	East	0.4	2883.3	100	0.8	1.59	0.4	0.12	665.0	0.4	0.076	0.12	2118.3	0.3	0.035	0.7	0.03	0.263	0.239	1.584	19.70847	3.04849893
0	7482.9	7381.5	1782638.8	70.9	4	East	0.3	11099.6	100	0.9	1.59	0.4	0.11	2070.0	0.5	0.076	0.34	8929.6	0.2	0.035	0.7	0.15	0.602	0.253	1.675	16.687007	5.12375763
1	7954.5	7736.1	1841030.9	67.3	5	East	0.3	12349.6	100	0.8	1.59	0.4	0.12	500.0	0.3	0.076	0.10	11749.6	0.3	0.035	0.7	0.19	0.406	0.236	1.425	17.098056	8.44522691
7	5722.2	5719.3	1168359.1	72.1	6	East	0.4	8552.7	100	0.6	1.59	0.4	0.13	940.0	0.4	0.076	0.17	7512.7	0.4	0.035	0.7	0.10	0.406	0.210	1.539	20.026381	5.85018751

QC Check - Normal Conditions

Time of Concentration Calculations - Mountain Watersheds GIS Data Identifier Data Entry Computation Basins Not Part of Study

TR-55 USDA-NRCS

Gridcode	Shape_Area	CN	CN Change	CN-Burned	Basin #	Hillside Location	Flow_Slope	Flow_Length	Start Elev	Sheet Flow Length	Sheet Flow Slope	2-yr, 24-hr rainfall	Roughness Coefficient, n	Sheet Flow Time	Mid Elev	Shallow Concentrated Length	Shallow Concentrated Slope	Flow Velocity	Shallow Concentrated Time	Low Elev	Channel Flow Length	Channel Slope	Roughness Coeff, n	Hydraulic Radius	Bottom Elev	Channel Flow Time	Total Time				
							feet/feet	feet	m	feet	ft/ft	in	Table 3-1 (TR-55)	hour	m	feet (Revised Values)	ft/ft (Revised)	Figure 15-4 NEH Ch. 15 (...and woodlands)	hour	m	feet (Revised Values)	ft/ft	FHWA-NHI-08-090, Table B-2	feet	m	hour	hour	Sheet Average	Shallow Average	Channel Average	Overall Average
15	1625603.7	71.8	6.0	77.8	1	East	0.4	9003.2	2638.0	100	0.4	1.59	0.40	0.16	2627.0	2584.0	0.4	3.000	0.24	2273.0	5760.0	0.4	0.070	0.8	1660	0.14	0.537	0.2	3.0	11.6	4.7
14	179203.9	69.2	6.0	75.2	2	East	0.4	3396.6	2039.7	100	1.3	1.59	0.40	0.09	1998.8	600.0	0.5	3.500	0.05	1738.8	2700.0	0.4	0.070	0.8	1581.6	0.06	0.207	0.3	3.5	11.6	4.6
34	137890.9	70.9	6.0	76.9	3	East	0.4	2883.3	1911.9	100	0.8	1.59	0.40	0.12	1887.6	550.0	0.6	3.750	0.04	1805.7	1900.0	0.3	0.070	0.8	1583	0.05	0.210	0.2	3.8	10.0	3.8
0	1782638.8	70.9	6.0	76.9	4	East	0.3	11099.6	2537.0	100	0.9	1.59	0.40	0.11	2509.0	1870.0	0.5	3.500	0.15	2224.0	9725.0	0.3	0.070	0.8	1551	0.27	0.527	0.3	3.5	10.0	5.8
1	1841030.9	67.3	6.0	73.3	5	East	0.3	12349.6	2511.0	100	0.8	1.59	0.40	0.12	2487.5	1725.0	0.4	3.000	0.16	2437.7	11500.0	0.2	0.070	0.8	1508	0.39	0.667	0.2	3.0	8.2	5.1
7	1168359.1	72.1	6.0	78.1	6	East	0.4	8552.7	2511.9	100	0.6	1.59	0.40	0.13	2494.3	1300.0	0.5	3.000	0.12	2385.0	7300.0	0.3	0.070	0.8	1569.5	0.20	0.454	0.2	3.0	10.0	5.2

Time of Concentration Calculations - Mountain Watersheds

GIS Data | Identifier | Data Entry | Computation | Basins Not Part of Study

Post-Burn Conditions

Gridcode	Shape_Area	CN	CN Change	CN-Burned	Basin #	Hillside Location	Flow_Slope	Flow_Length	Sheet Flow Length	Sheet Flow Slope	2-yr, 24-hr rainfall	Roughness Coefficient, n	Sheet Flow Time	Shallow Concentrated Length	Shallow Concentrated Slope	Intercept Coeff, k	Shallow Concentrated Time	Channel Flow Length	Channel Slope	Roughness Coeff, n	Hydraulic Radius	Channel Flow Time	Total Time
							feet/feet	feet	feet	ft/ft	in	Table 3-2 (HEC 22)	hour	feet	ft/ft	Table 3-3	hour	feet	ft/ft	Table 3-4	feet	hour	hour
15	1625603.7	71.8	6.0	77.8	1	East	0.4	9003.2	100	0.4	1.59	0.11	0.06	2070.0	0.6	0.076	0.31	6833.2	0.3	0.035	0.7	0.10	0.469
14	179203.9	69.2	6.0	75.2	2	East	0.4	3396.6	100	1.3	1.59	0.11	0.03	1230.0	0.7	0.076	0.16	2066.6	0.2	0.035	0.7	0.03	0.232
34	137890.9	70.9	6.0	76.9	3	East	0.4	2883.3	100	0.8	1.59	0.11	0.04	665.0	0.4	0.076	0.12	2118.3	0.3	0.035	0.7	0.03	0.188
0	1782638.8	70.9	6.0	76.9	4	East	0.3	11099.6	100	0.9	1.59	0.11	0.04	2070.0	0.5	0.076	0.34	8929.6	0.2	0.035	0.7	0.15	0.531
1	1841030.9	67.3	6.0	73.3	5	East	0.3	12349.6	100	0.8	1.59	0.11	0.04	500.0	0.3	0.076	0.10	11749.6	0.3	0.035	0.7	0.19	0.330
7	1168359.1	72.1	6.0	78.1	6	East	0.4	8552.7	100	0.6	1.59	0.11	0.05	940.0	0.4	0.076	0.17	7512.7	0.4	0.035	0.7	0.10	0.321

Santaquin Flood Control Plan-EA
Post Burn Analysis (10-yr 24-hr Event)

Bulking Calculations

$$BF = \frac{Q_w + Q_{sed}}{Q_w} = \frac{1}{1 + C_v}$$

C_v	20%	Sediment Concentration

Label	Hydrograph Volume (ac-ft)	Peak Flow (ft^3/s)	Bulking Factor (BF)	Bulked Peak Flow (cfs)	Volume Bulking Factor	Bulked Volume (ft^3)
1	19.6	174	1.25	218	1.20	23.52
2	1.8	19	1.25	24	1.20	2.16
3	1.4	21	1.25	26	1.20	1.68
4	19.5	157	1.25	196	1.20	23.4
5	15.3	147	1.25	184	1.20	18.36
6	13.7	154	1.25	193	1.20	16.44

Debris Flow Volumes

Santaquin City Storm Drain Master Plan

May-17

Cannon et al. (2010)

$$\ln V = 7.2 + 0.6(\ln A) + 0.7(B)^{1/2} + 0.2(T)^{1/2} + 0.3$$

R^2*	0.83
Std. Error*	0.9

*Based on basins used to develop the formula

Variable	Units	Description
A	km^2	Area of basin w/slopes 30% or greater
B	km^2	Area of basin burned at high and moderate Severity
T	mm	Rainfall Depth
V	m^3	Volume of Material

Assumptions:

(1) Entire Basin is burned

(2) Percentage burned at high to moderate severity matches percentage of Molley Fire that was moderate to high severity based on federal GIS Data (29.3%)

(3) 1-Hour, 5-Year Storm Depth Used - <2 to 10-Yr Recommended due to limited time burned area is in debris flow type conditions and history of debris flows occuring in higher recurrance interval storms.

Basin (Object ID)	Critical Watershed #	A (km^2)	Percentage of area over 30% Slope	Basin Area (ft^2)	B (km^2)	Rainfall Depth (in)	T (mm)	V (m^3)	V (ac-ft)	Notes
20	1	1.56	0.957940171	17,506,605	1.626417	0.729	18.5166	13621.18	11.04288	
15	2	0.17	0.959211787	1,929,894	0.179293	0.729	18.5166	1999.781	1.621251	
13	3	0.12	0.856360733	1,484,982	0.137959	0.729	18.5166	1539.33	1.247957	
16	4	1.64	0.920565032	19,197,765	1.783531	0.729	18.5166	14661.16	11.88601	
14	5	1.53	0.829957075	19,826,618	1.841953	0.729	18.5166	14261.45	11.56196	
12	6	1.04	0.891894829	12,582,443	1.168947	0.729	18.5166	9343.735	7.575097	

ATTACHMENT 2

HYDRAULICS REPORT

Santaquin City Flood Control Plan- EA Hydraulics Report

PREPARED FOR: RESOURCES CONVERVATION SERVICE (NRCS), USDA

DECEMBER 2018

Prepared by: Aaron Spencer, Jacob O'Bryant
HORROCKS ENGINEERS | 2162 W GROVE PARKWAY, PLEASANT GROVE, UT

2162 West Grove Parkway, Ste 400
Pleasant Grove, Utah 84062
801-763-5100
www.horrocks.com

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1.0 Introduction

This technical report documents the hydraulic aspects of the existing and proposed scenarios pertaining to the construction of debris basins along the east bench of Santaquin. The goal of this document and the hydrology report is to demonstrate compliance with State and Federal design guidelines for the purpose of establishing a footprint which can be evaluated for an environmental assessment.

The data from the hydrology, sedimentation, and other studies were brought together in the hydraulics analysis to determine volume and capacity requirements for the reservoir and the principal and auxiliary spillways for applicable alternatives. The resulting flows were then used to analyze the downstream effects of the various debris basin options for the purposes of determining the economic benefits from the potential structures, to verify effects on floodplains and potential induced flooding from spillways, and to determine downstream system capacities and requirements.

Additional analysis has also been performed to verify adequate freeboard for wave action, to meet spillway regulations, and to confirm the hazard rating of the basin.

In order to determine the most cost effective and appropriate option for control of floods and debris flow above the East Bench areas of Santaquin, several mitigation options were considered. Through a vetting process debris basins were determined to offer the highest level of protection from both flood and debris flows.

Two main approaches were taken with regard to how the debris basins would be built, function, and what level of protection they would provide. They will be referred to as “Approach A” and “Approach B” and are described below. Both approaches have been analyzed for economic purposes to see which provides the greatest net monetary benefit. The monetary benefit is based on capital and maintenance costs as well as protection from flood damages provided by each option. Both options will be discussed in this report so as to document the hydraulic methods used.

Approach A was the approach that was modeled first. As the design progressed and the plan-environmental assessment process advanced, several options became more desirable than others based on cost, grading, client preference, overall impacts, etc. For this reason, there are fewer combinations and types of debris basins modeled for Approach B. The less desirable options were purposely excluded from further study.

Approach A

Approach A consists of debris basins which would roughly contain the 25-year volume. It also has adequate volume for 50 years’ of sediment. The basins would be constructed with a spillway and outlet structure which would be connected to a pipe network that together with the basin, can safely convey the entire 100-year flows. The approach is based on the assumption that there is adequate capacity for the flows located several

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miles to the north in Spring Creek and under Red Bridge in western Payson. The pipe system for conveying the flows would need to go over or under (most likely under) the Strawberry-Highline Canal, and be piped or possibly kept in an open channel southward through private property, until it reaches Spring Creek. The pipe system would go under several overpass embankments, and be bored underneath I-15. In addition, several large diameter culverts downstream would need to be enlarged. Based on flow estimates and average slope, the downstream pipe system would be a 60 inch diameter pipe or equivalent from the Strawberry-Highline Canal and northward.

Approach B

Approach B consists of debris basins which would completely contain the 50-year volume. The basin also has volume for 25 years' worth of sediment. The basins would have a tower with an outlet pipe. The tower would have an orifice in the side of it to allow the basin to drain while restricting flows to a minimal flow rate. The tower would be open only at the top and would only be activated when water within the basin is deep. This approach would not include an extensive downstream pipe network. Flows for events larger than the 50-year event would first fill up the basin, and then exit through the tower and eventually overtop the emergency concrete spillway, as needed. The flows would be directed into their historic flow paths so as to not cause induced flooding. Although this approach does not provide full containment of the 100-year event, it significantly reduces flood damages associated with the 100-year event by reducing the peak flow rate to a non-threatening level.

Figure 1 on the following page shows the general location of the proposed basins along the east bench in Santaquin.

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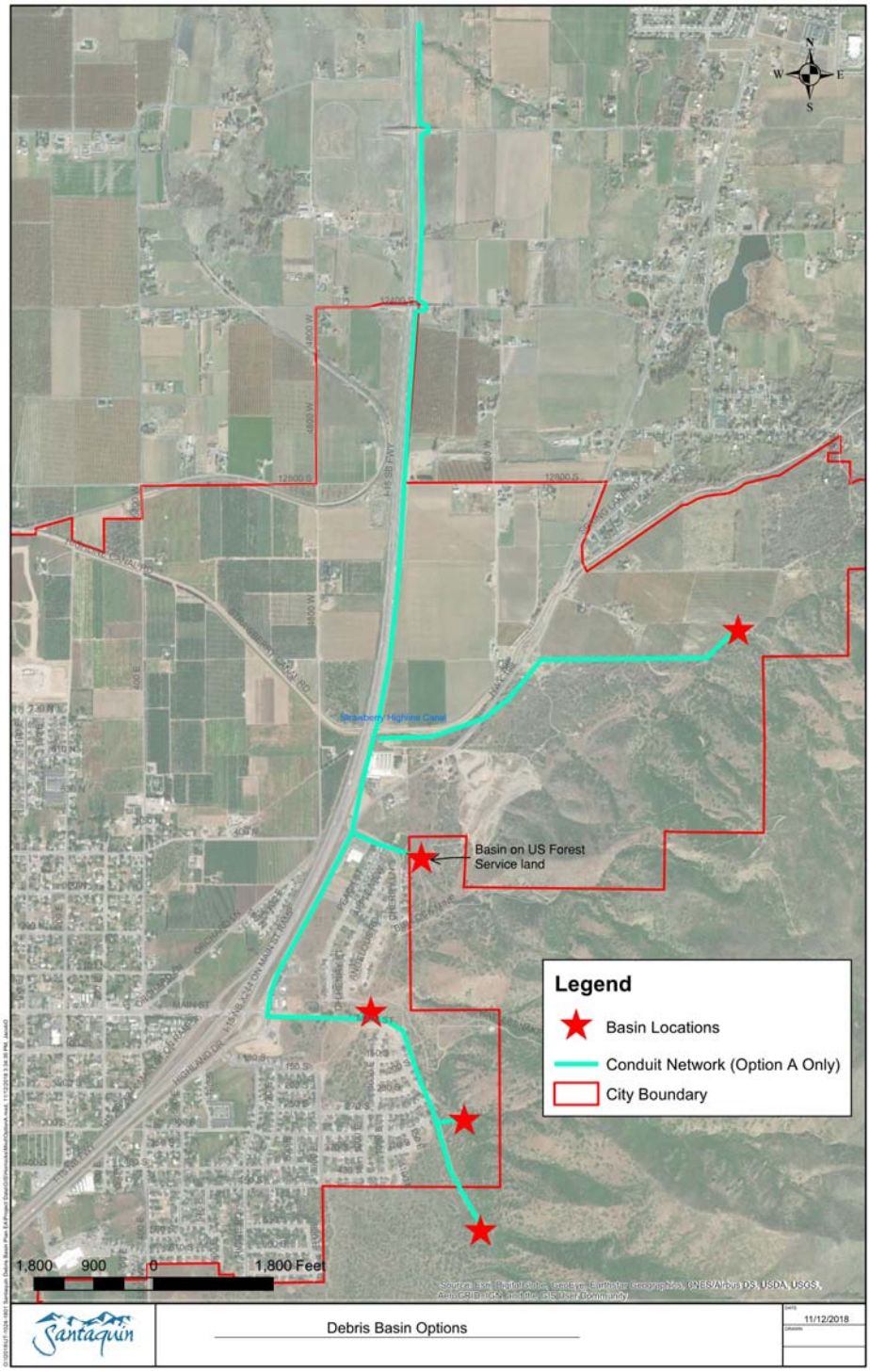

Figure 1 Debris Basin Options

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To better view the watersheds in relation to the debris basin locations, see Figure 2.

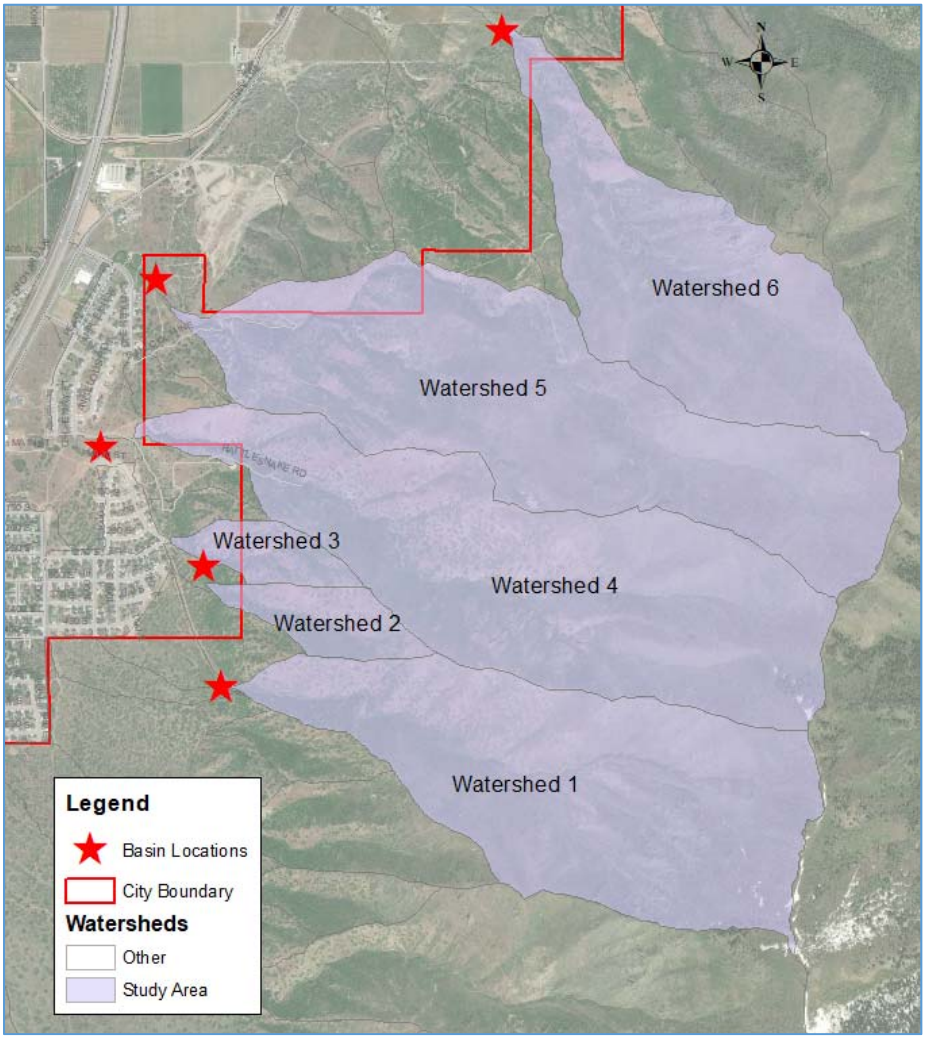

Figure 2. Watersheds

Debris basins may be constructed as earthen embankments or fully excavated basins. In the hydraulic analysis these were referred to as “above grade” and “below grade” options, respectively. In order to determine the nature, scale, and benefits of each type, reservoir routing for principal and auxiliary spillway capacity, freeboard and other criteria were evaluated to enable the geometric layout, comparison, and then selection of the preferred option. The analysis was done in accordance with the design criteria of both the NRCS Technical Release 60 (TR60) and the State of Utah dam safety rules and regulations (State Code) located in the Administrative Rules Title R-655, and Utah Code Title 73, Chapters 1-6, and 22. Although these basins could be low hazard and have a storage times height less than 3,000, TR-60 was still used for guidance.

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Sediment capacity is also highly critical in the design of any structure. Due to the compressed schedule we were attempting to meet, it was initially assumed that 20% of the volume in the basin was reserved for sediment and was assumed to be unavailable for reservoir routing, with the intent that any additional capacity required would be worked into the final design concept as the sediment yield study was completed. This volume was refined as the analysis progressed.

Determining the size, nature, and footprint of the potential structures is necessary for the environmental analysis process to proceed.

The hydrology and outflow data from the reservoir routing and sizing was used to model the change in flows in the downstream floodplain from the current conditions to the post-construction condition. This flood modeling enabled the determination of the changes in flood and debris flow impacts, enabling economic analysis of the project to be performed.

2.0 Design Goals and Criteria

As the project is in a Plan-EA phase at this time, the goals of the project are defined in the EA document as: prevent all flooding from the 50-year storm event and provide significant flood reduction from the 100-year storm event by reducing peak flow rates to a safe level.

The PL-566 program design goals were used in conjunction with NRCS specific design criteria. This required considering the 100-year, 10-day, and 24-hour storms using NRCS rainfall distributions. The principal design goals were as outlined below (not all-inclusive):

2.1 Standard Debris Basin Primary Design Concept and Goals (Approach A)

<u>High Hazard Structure ("Above Grade"):</u>
Description: Earth fill embankment with structural principal spillway and vegetated earth auxiliary spillway.
NRCS Criteria: Pass the 100-year 10-day Principal Spillway Hydrograph (PSH) through the principal spillway without activating the auxiliary spillway.
Design Goal: Pass the 100-year 24-hour event, and 50-year 24-hour event without activating the auxiliary spillway, for Approach A and Approach B, respectively.

<u>Low Hazard Structure ("Below Grade"):</u>
Description: Fully excavated basin with structural principal spillway and vegetated earth auxiliary spillway.
NRCS Criteria: Do not activate the auxiliary spillway until the 25-year PSH.
Design Goal: Pass the 50-year and/or 100-year 24-hour event without activating the auxiliary spillway.

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The auxiliary spillway design events and freeboard requirements dictated by the NRCS and Utah Dam Safety were also used to determine final auxiliary spillway elevation dimensions and dam crest elevations.

2.2 Alternative Debris Basin Design Concept and Goals (Approach B)

As the analysis process proceeded it became apparent that flows discharging from the principal spillway were smaller but still significant and had to be conveyed downstream even during more frequent events. Santaquin has no existing outflow channel, creek, or river in the vicinity to carry any discharge flows. Approach A would require a long conveyance system constructed up to Spring Creek approximately 2 miles to the north. In addition, several large culverts downstream of Spring Creek would need to be enlarged. To avoid having a piped system that would discharge the collective flow of all basins into a single location during all events regardless of return interval, a second option was studied.

The consideration of an alternative set of design criteria would allow the elimination of the extensive conveyance works, but still provide significant safety and economic benefits. In order to eliminate significant frequent principal spillway flows, and still meet NRCS criteria, a combined structural spillway was proposed, rather than a separate principal spillway and vegetated auxiliary spillway. Based on our correspondence with NRCS and our review of NRCS technical criteria, this approach negates most capacity and design regulations on the low level outlet, potentially permitting an outlet that passes much lower flows up to the design event. The basins in this approach would be sized to hold the entire 50-year event volume, with all larger storms passing excess flows over the combined spillway and flowing in historic paths. It is desirable to be able to drain the basin after runoff events without human intervention, so an ungated opening would be sized to drain the full volume of the basin within ten days, with an auxiliary gate as backup if deemed advisable. This alternative design criteria is summarized below:

Guidelines for All Structures:

NRCS Criteria: Pass all spillway design flows through a combined structural spillway while meeting freeboard requirements. Provide 10-day drawdown capacity through a restricted outlet pipe.

Design Goal: Fully contain all storms within the basin up to the 50-year event, reduce 100-year flows to safe level, limiting flows and volumes to amounts that could be handled within existing infrastructure without flooding. Excess from larger storms would pass over the spillway. The spillway will be located such that flows are directed in historic paths, thus eliminating induced flooding.

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3.0 Reservoir Routing and Sizing

The various design storms as outlined in the hydrology report were routed through each reservoir to verify and fine tune the reservoir volume, principal and auxiliary spillway and crest, and the size of the spillways and outlet pipes. This also allowed us to produce hydrographs to use in flood mapping for economic analysis.

3.1 Methodology

The methodologies inherent in the SITES program developed and distributed by the NRCS was utilized to route the storms through the reservoirs. Refer to the technical documentation for SITES available from the NRCS website or included with the program for further information on the methodologies used for performing hydraulic analysis by the program.

The program permits the designation of basic auxiliary spillway dimensions. Principal spillway combinations including low level outlets and upper weir crests, are all directed to an outlet pipe. Combined spillways and direct input of stage-discharge curves are also possible.

The program is designed to follow the general design criteria and approach of the NRCS, and can perform hydrology for specific events such as the PSH and Freeboard Hydrograph (FBH) based on TR-60 criteria as discussed in the Hydrology Memo. It can also accept direct input of hydrographs determined elsewhere. These features were used during the routing process for each event analyzed, as applicable. Further detail is provided in this report under the heading for each type of analysis.

3.2 Assumptions

Due to the number of analyses which had to be run, some initial assumptions had to be made and used in all scenarios to accelerate the modeling work. These assumptions were made to establish feasibility. Some were refined during the concept design, with the understanding that the rest will be fine-tuned where required during the final design. These initial assumptions included:

Reservoir Dimensions:

- Initial Volume: +/- 25-year 24-hour event volume at Auxiliary Spillway for Approach A; 50-year 24-hour event volume for Approach B
- 50 and 25-years' of sediment volume
- Initial Elevation of Auxiliary Spillway: 3 feet below crest/top of dam
- Internal Depth of Basin/Structural Height: 15 feet
- Cut and Fill Slopes: 3:1

Auxiliary Spillway Dimensions:

- Width: 50 feet
- Length of Flat Section (spillway crest): 40 feet

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Upstream Slope: 3:1
Downstream Slope: -2%
Side Slopes: 3:1

Principal Spillway:

Type: NRCS Standard Riser with Piped Outlet
Low Elevation Outlet: (2) 6”x12” openings (Approach A); Orifice as needed to meet 10-day draw down (Approach B)
Low Elevation Outlet Elevation: at +/- 20% Volume of Basin (Sediment Storage Elev.); Orifice as needed to meet 10-day draw down (Approach B)
Upper Weir Elevation: 1 foot below the auxiliary crest elevation
Upper Weir Length: 6 feet on each side of structure, total of 12 feet
Outlet Pipe Size: 30” (NRCS minimum size)

An existing open channel runs from some of the southern watersheds and would be used to collect the outflows from the basins. Based on measurements of the existing channel, the following approximation was used in the SITES models when routing these basins into a lower one:

Inter-Basin Channel Routing:

Slope: 0.013 ft/ft
Bottom Width: 5.74 feet
Channel Depth: 7 feet
Side Slopes: 2:1

The spillway widths, elevations, and pipe sizes were adjusted as required to meet the design goals and criteria as was determined during modeling. Final results will be provided below.

3.3 Modeling and Concept Design Process

The reservoir routing and basin concept design process was iterative in nature. In order to size the basins, several analysis steps were taken and adjustments were made throughout the process. Early in this study, basins were modeled in CAD. The basin volume was obtained from the draft Storm Drain Master Plan. These basins matched the concept design assumptions used in this study, except for overall volume. To develop the initial stage-storage curves to enter into SITES the stage-storage data from these initial basins were scaled in Excel to match the 25-year storm volumes used in this study (for Approach A). The modeling process then proceeded as illustrated below:

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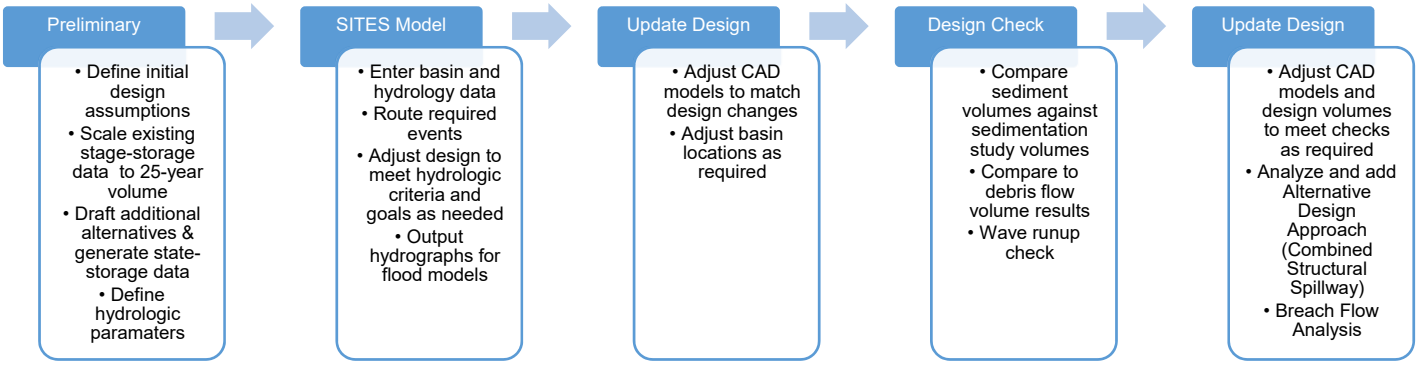

Figure 3. Modeling Process

It may be noted that the SITES models were not run again after the final design update. Since the sediment storage was assumed full initially, and any additional required volume could be accommodated by cutting the floor of the basins lower, and freeboard adjustments for wave run-up did not affect the routing, no adjustment to the SITES runs were required. In some cases, the relocation of the basins to better fit the adjusted designs to the topography does mean that the elevations in the SITES model may not match exactly with the elevation that the basin is shown at in the final CAD drawings, but the overall volume and relative spillway elevations were kept the same. Refinements to the calculations and drawings will be made in the final design process.

3.4 Options Modeled

Each site included the modeling of various options depending on the site conditions and to compare potential options. The main categories of options analyzed are as follows:

Option Types:

- "Above Grade" – Standard basin with earthen embankment, riser tower principal spillway, and vegetated earthen auxiliary spillway. Evaluated as high hazard structure based on observation, to be confirmed with flood modeling after completion of concept design.
- "Below Grade" – Fully excavated basin with riser tower principal spillway
- "Multi-Basin" – SITES model included all outflows from basins upstream of the basin being analyzed. To be conservative, whatever option for upstream basins produced the most outflow was used.
- "Watershed Only" – Options where flows from upstream basin are diverted around the basin being analyzed, and only the watershed directly associated with the basin is included.

A list of the options modeled for each site is provided below, with a basis of the justification for inclusion of the option in the analysis:

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Table 1. Modeling Scenarios

Watershed	Basin Option Title (Approach A)	Basin Option Title (Approach B)	Notes
1	Basin 1 Above Grade		
	Basin 1 Below Grade	Basin 1 Below Grade	Low Hazard Option
2	Basin 2 Above Grade		
	Basin 2 Below Grade		Low Hazard Option
3	Basin 3 Above Grade		
	Basin 3 Below Grade		Low Hazard Option
	Basin 3A Below Grade	Basin 3A Below Grade	Routes inflow from watershed 2 and 3 into a single low hazard basin.
4	Basin 4E Above Grade (Watershed Only)	Basin 4E Above Grade (Watershed Only)	Includes only inflows from the watershed associated with Basin 4 and not upstream basins.
	Basin 4E Above Grade (Multi-Basin)		Includes inputs from the watershed associated with Basin 4 as well as the outputs from the Below Grade alternatives in Basin 1, 2, and 3.
	Basin 4D Below Grade (Watershed Only)		Includes only inflows from the watershed associated with Basin 4 and not upstream basins.
	Basin 4D Below Grade (Multi-Basin)		Includes inputs from the watershed associated with Basin 4 as well as the outputs from the Below Grade alternatives in Basin 1, 2, and 3.
	Basin 4A-4B Below Grade (Watershed Only)		Includes only inflows from the watershed associated with Basin 4 and not upstream basins.
	Basin 4A-4B Below Grade (Multi-Basin)		Includes inputs from the watershed associated with Basin 4 as well as the outputs from the Below Grade alternatives in Basin 1, 2, and 3.
	Basin 4A-4B Above Grade (Multi-Basin)		Includes inputs from the watershed associated with Basin 4 as well as the outputs from the Below Grade alternatives in Basin 1, 2, and 3.
5	Basin 5 Below Grade	Basin 5 Below Grade	

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	Basin 5 Above Grade		
6	Basin 6A Above Grade		Offset from mouth of canyon to avoid orchards
	Basin 6A Below Grade		Offset from mouth of canyon to avoid orchards
	Basin 6B Below Grade		At mouth of canyon
	Basin 6B Above Grade	Basin 6B Above Grade	At mouth of canyon

3.4 Events Modeled

The routed storm events are listed below, along with the purpose for their inclusion in each model. An event was not included in a specific option where it did not apply. For further information on the development of the hydrographs for each of the events refer to the hydrology technical memo.

Table 2. Events Modeled

Category	Sub-Category	Notes/Reason For Inclusion
Principal Spillway Hydrograph	Curve Number Method Runoff Method (Governing Storm)	Principal Spillway Sizing per TR-60
Auxiliary Spillway Hydrograph (PMP)	6-Hour (Local Storm) (Governing Storm) 24-Hour (General Storm) 72-Hour (General Storm 6-Hour ARC III (for wave run-up analysis)	Auxiliary Spillway Sizing and Freeboard Design. Induced Flooding Analysis
Economic Analysis	5-year 24-hr storm 10-year 24-hr storm 25-year 24-hr storm 50-year 24-hr storm 100-year 24-hr storm (Design Criteria Storm) 200-year 24-hr storm 500-year 24-hr storm	Post-Construction Impact Analysis, Reservoir and for the 50 and 100-year events, Spillway Sizing for the 100-year event
Burned Conditions Hydrograph	10-year 100-year storm (Burned Conditions)	Verify containment of storm under burned conditions
Debris Flow	5-year 1-Hour precip. Depth	Not actually routed, total volume compared to volume of basin

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Principal Spillway Evaluation Events

The principal spillway evaluation events were routed to verify the principal spillway met the regulations for size and capacity as stated in TR-60. Given the required runoff and basin characteristics, SITES will route the principal spillway hydrograph (PSH) through the reservoir using standard NRCS methodology. The required input data were taken from hydrology study. Reference is made the Hydrology Report Memo for further details.

The principal spillway hydrograph (PSH) must be routed through the reservoir without activating the auxiliary spillway. Given specific data on the principal spillway design, and a stage-storage curve for the basin, SITES will determine the required elevation for the auxiliary spillway. In all cases the method from TR-60 utilizing stream gage results ("Runoff" or "Snowmelt" method) governed over the Curve Number Method. The final concept design met these requirements, and was in fact larger than required by these events since the 100-year 24-hour storm design criteria governed. SITES also confirmed during this analysis that the 10-day drawdown requirements have also been met. Key SITES input and output data can be reviewed in the table in Appendix A.

Approach B Drawdown Calculations

Per TR-60, all basins must be able to drain 85% of the total volume within 10 days. The drainage flows can be directed safely from the basins to historic flow paths, along local streets, etc. while the basins decrease the discharge rates and total volumes of larger events as they pass over the spillway.

The proposed basins will have a tower with a relatively small orifice located several feet above the bottom basin surface. To ensure that the basin can completely drain within 10 days, the orifice elevation was modeled 0.5 feet from the basin bottom as well as 3 feet from the bottom. Both approaches indicate a drawdown time which is less than 10 days. The top of the tower would be open to allow water to enter it to prevent the auxiliary spillway from functioning more frequently than is permissible.

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The table below shows the results of the drawdown calculations. Tables with full drawdown calculations are located in Appendix B.

Table 3. Drawdown Time

Basin	Peak Flow Out (cfs)	Drawdown Time (days)
1	2.5	7.9
2-3	1.3	2.3
4	2.3	8.3
5	1.8	8.3
6	1.7	8.1

Auxiliary Spillway Evaluation Events

Given some basic geometric and hydraulic criteria, SITES will route the Freeboard Hydrographs, Stability Design Hydrograph, or other required design hydrographs through the spillway in accordance with NRCS standard criteria and methods. For hydrologic input parameters reference is made to the Hydrology Report Memo. The auxiliary spillways were sized in accordance with the Assumptions section of this report. Events routed included the 6-hour SEF, 24-hour SEF, 72-hour SEF, and the 6-hour or 24-hour 100-year events on a saturated watershed to check State of Utah freeboard criteria, depending on which SEF event governed. In all cases the 6-hour SEF event governed, except for the Basin 5 Above-Grade Option, where the 24-hour event governed. In this case the 24-hour 100-year event was used to check State of Utah freeboard criteria, while a 6-hour 100-year event was used to check all other events. Spillway widths did not have to be changed from the assumed 50 feet except in the case of the Basin 4A-4B Multi-basin option, which uses two basins in series, and captures all flows from Basins 1, 2 and 3, which are located upstream. The spillway width and governing water depth over the spillway for each storm was as follows. Further data is available in Appendix C. More information regarding reservoir routing can be found in the hydrology report.

Table 4. Spillway Data

Watershed	Basin Option Title	Aux. Spillway Width (ft)	Water Height Above Spillway (ft)	Governing Storm
1	Basin 1 Above Grade	50	2.06	6-hr SEF
	Basin 1 Below Grade	50	0.72	6-Hr SEF

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Watershed	Basin Option Title	Aux. Spillway Width (ft)	Water Height Above Spillway (ft)	Governing Storm
2	Basin 2 Above Grade	50	0.15	6-Hr SEF
	Basin 2 Below Grade	50	-0.36	ARC III 6-Hr 100-year
3	Basin 3 Above Grade	50	0.15	6-Hr SEF
	Basin 3 Below Grade	50	-0.52	ARC III 6-Hr 100-year
	Basin 3A Below Grade	50	-0.87	
4	Basin 4E Above Grade (Watershed Only)	50	1.90	6-Hr SEF
	Basin 4E Above Grade (Multi-Basin)	50	2.35	6-Hr SEF
	Basin 4D Below Grade (Watershed Only)	50	0.92	ARC III 6-Hr 100-year
	Basin 4D Below Grade (Multi-Basin)	50	1.52	ARC III 6-Hr 100-year
	Basin 4A-4B Below Grade (Watershed Only)	60	0.64	ARC III 6-Hr 100-year
	Basin 4A-4B Below Grade (Multi-Basin)	60	1.69	6-Hr SEF
	Basin 4A-4B Above Grade (Multi-Basin)	50	2.26	6-Hr SEF
5	Basin 5 Below Grade	50	0.78	ARC III 6-Hr 100-year
	Basin 5 Above Grade	50	1.6	6-Hr SEF
6	Basin 6A Above Grade	50	1.79	6-Hr SEF
	Basin 6A Below Grade	50	1.31	6-Hr SEF
	Basin 6B Below Grade	50	0.62	6-Hr SEF
	Basin 6B Above Grade	50	1.96	6-Hr SEF

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Economic Analysis Events

The events listed previously were routed through the reservoir to provide hydrograph inputs to the post-construction flow model to allow evaluation of the change in flood and debris flow impact on the property located downstream of the watersheds being analyzed. The 100-year 24-hour storm was also used to size the reservoir and principal spillway elevation and size to prevent activation of the auxiliary spillway elevation up to the 100-year event for Approach A, and the 50-year event for Approach B. In this case, this turned out to be a more strict criteria than the NRCS criteria, which requires sizing the principal spillway to pass the PSH. Refer to Appendix A for peak discharges and water surface elevations, as well as final volumes, elevations, and sizes of the various components for each basin. Further discussion on the flood modeling and impact analysis will be provided later in this report. All of the basins generated similar results for the various return events.

The table below compares the some of the storms most critical in evaluating the effectiveness of the basins. The 2-, 200-, and 500-year event results can be seen in Appendix A. The table shows the inflow rates and volumes, and then compares them to the outflow rates for the various basin options modeled. Significant peak flow reductions were realized, but the outflows if considered together still represents a considerable flow rate to be accommodated downstream.

Table 5. Pre, Post Flows (Approach A)

		Peak Flow by Return Interval (Approach A)				
Watershed	**Data/Option**	**5-year**	**10-year**	**25-year**	**50-year**	**100-year**
1	Inflow (cfs)	41.8	79.6	149	217.1	300.6
	Inflow (ac-ft)	8.5	12.4	18.3	23.4	28.7
	Basin 1 Above Grade Outflow	6.6	9.1	12	18	60.5
	Basin 1 Below Grade Outflow	6.7	9.6	12.1	29.4	84.8
2	Inflow (cfs)	3.8	8.6	18.2	27.9	40.3
	Inflow (ac-ft)	0.5	1.0	1.6	2.1	2.6
	Basin 2 Above Grade Outflow	2.1	4.3	7.9	10	11.9
	Basin 2 Below Grade Outflow	2.1	4.5	8.3	10.3	12.4
3	Inflow (cfs)	4.2	8.7	17.1	25.7	36.4
	Inflow (ac-ft)	0.4	0.7	1.2	1.6	2.0
	Inflow (cfs) (2 & 3 Combined)	8	17.3	35.3	53.6	76.7
	Inflow (ac-ft) (2 & 3 Combined)	0.9	1.7	2.8	3.7	4.6

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		Peak Flow by Return Interval (Approach A)				
Watershed	**Data/Option**	**5-year**	**10-year**	**25-year**	**50-year**	**100-year**
	Basin 3 Above Grade Outflow	2.5	4.9	8.2	10.4	12.2
	Basin 3 Below Grade Outflow	2.4	2.4	9.1	11.6	21.8
	Basin 3A Below Grade Outflow (2 & 3 Combined)	3.2	6.5	9.9	12.2	27.7
4	Inflow (cfs) (Single Basin)	35.9	71.2	139.1	207.8	291.6
	Inflow (ac-ft) (Single Basin)	8.2	12.1	18.2	23.4	29.0
	Inflow (cfs) (Multi-Basin)	41.8	82.6	162.7	217.3	326.4
	Inflow (ac-ft) (Multi-Basin)	17.6	26.2	39.3	50.5	62.3
	Basin 4E Above Grade Outflow (Watershed Only)	6.7	9.5	12.3	30.7	71.8
	Basin 4E Above Grade Outflow (Multi-Basin)	10	13	27.9	84.2	189.5
	Basin 4D Below Grade Outflow (Watershed Only)	6.7	9.3	12	42.6	115.4
	Basin 4D Below Grade Outflow (Multi-Basin)	10.1	23	32.3	91.3	183.2
	Basin 4A-4B Above Grade (Multi-Basin)	9.9	24.9	47.6	95.2	213.8
	Basin 4A-4B Below Grade Outflow (Watershed Only)	6.8	9.3	12.7	42.3	115.2
	Basin 4A-4B Below Grade Outflow (Multi-Basin)	10.3	13.4	32.7	92.5	208.2
5	Inflow (cfs)	15.6	38.6	88.4	142.1	209.5
	Inflow (ac-ft)	5.6	8.8	14.2	18.8	23.8
	Basin 5 Above Grade Outflow	5	8.2	11.7	29.7	82.2
	Basin 5 Below Grade Outflow	4.9	8.2	11.7	19.9	68.3
6	Inflow (cfs)	35.3	67.9	127.8	188.8	262.5
	Inflow (ac-ft)	5.8	8.5	12.6	16.1	19.9
	Basin 6A Above Grade Outflow	5.7	8.7	11.6	19.4	57.4
	Basin 6A Below Grade Outflow	6.1	8.8	11.7	20.2	63.7
	Basin 6B Above Grade Outflow	6.1	8.9	12	18.6	63.2
	Basin 6B Below Grade Outflow	6.1	8.9	12	18.5	61.8

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Table 6 Pre, Post Flows (Approach B)

Watershed	Data/Option	Peak Flow* by Return Interval (Approach B)				
		5-year	10-year	25-year	50-year	100-year
1	Inflow (cfs)	41.8	79.6	149	217.1	300.6
	Inflow (ac-ft)	8.5	12.4	18.3	23.4	28.7
	Basin 1 Above Grade Outflow	1.2	1.6	2.1	2.5	15.2
2,3	Inflow (cfs) (2 & 3 Combined)	8	17.3	35.3	53.6	76.7
	Inflow (ac-ft) (2 & 3 Combined)	0.9	1.7	2.8	3.7	4.6
	Basin 3A Below Grade Outflow (2 & 3 Combined)	0.6	0.9	1.1	1.3	3.6
4	Inflow (cfs) (Single Basin)	35.9	71.2	139.1	207.8	291.6
	Inflow (ac-ft) (Single Basin)	8.2	12.1	18.2	23.4	29.0
	Basin 4E Above Grade (Watershed Only)	1.0	1.5	1.9	2.3	16.5
5	Inflow (cfs)	15.6	38.6	88.4	142.1	209.5
	Inflow (ac-ft)	5.6	8.8	14.2	18.8	23.8
	Basin 5 Below Grade Outflow	0.7	1.1	1.5	1.8	
6	Inflow (cfs)	35.3	67.9	127.8	188.8	262.5
	Inflow (ac-ft)	5.8	8.5	12.6	16.1	19.9
	Basin 6 Above Grade Outflow	0.8	1.1	1.4	1.7	14.5

*Outflows in 5, 10, 25 and 50-year are restricted drawdown flows through an orifice.

Burned Condition Event

Post-fire flows were routed using SITES to verify the basins had sufficient capacity to accommodate them. It was assumed that the sediment would settle out into the sediment basin, and the net effect on the spillways would be similar to passing the event without sediment loading. The additional volume determined from the bulking calculations in the hydrology report would therefore have to fit within the provided sediment pool. Table 9 in the Design Checks section of this report compares the extra bulked volume to the sediment volume available in each option modeled.

3.5 Adjusted Concept Designs

The size and elevation of spillways and pipes were adjusted in order to meet the NRCS design criteria and design goals. The key design data for each option modeled is shown in the following Table. Total Storage is measured at the auxiliary spillway crest. Options 4A and 4B are not included because the two-tier basin option was eliminated during the analysis process due to its obstructing access across the site, and anticipated additional

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cost with multiple sets of spillways and outlet works, and the lower basin was not significantly reducing the footprint of the upper basin. Approach A has a 50-year sediment volume. Approach B has a 25-year sediment volume.

Table 7. Basin Dimensions (Approach A)

Basin Option (Approach A)	Total Height (ft)	Height at Aux. Spillway (ft)	Height at Principal Spillway (ft)	Aux. Spillway Width (ft)	Principal Spillway Width (ft)	Outlet Pipe Diameter (in)	Total Storage (ac-ft)	Active Storage (ac-ft)	Sediment Storage (ac-ft)
Basin 1 Above Grade	16.5	13.5	12	50	14	42	20.35	16.92	5.63
Basin 1 Below Grade	16.5	13.5	11.9	50	12	30	20.47	16.76	5.63
Basin 2 Above Grade	15	12	11	50	12	30	1.77	1.51	0.35
Basin 2 Below Grade	14.68	11.68	10.68	50	12	30	1.62	1.34	0.35
Basin 3 Above Grade	15	12	11	50	12	30	1.31	1.12	0.35
Basin 3 Below Grade	16	13	12	50	12	30	1.25	1.02	0.35
Basin 3A Below Grade	17	14	13	50	12	30	2.98	2.43	0.35
Basin 4E Above Grade (Watershed 4 Only)	16	13	12	50	20	42	18.99	15.65	4.0
Basin 4E Above Grade (Multi-Basin)	17	14	12	50	20	42	20.97	17.63	4.0
Basin 4D Below Grade (Watershed 4 Only)	16.5	13.5	12	50	20	42	19.98	15.39	4.0
Basin 4D Below Grade (Multi-Basin)	17	14	12	50	20	42	20.96	16.37	4.0
Basin 5 Above Grade	15.5	12.5	11	50	12	42	14.64	11.75	3.16
Basin 5 Below Grade	16.3	13.3	12	50	12	42	15.88	12.79	3.16

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Basin Option (Approach A)	Total Height (ft)	Height at Aux. Spillway (ft)	Height at Principal Spillway (ft)	Aux. Spillway Width (ft)	Principal Spillway Width (ft)	Outlet Pipe Diameter (in)	Total Storage (ac-ft)	Active Storage (ac-ft)	Sediment Storage (ac-ft)
Basin 6A Above Grade	15.5	12.5	11	50	12	30	13.43	10.84	4.25
Basin 6A Below Grade	16.2	13.2	12	50	12	30	14.6	11.8	4.25
Basin 6B Above Grade	16.5	13.5	12	50	12	30	14.99	12.4	4.25
Basin 6B Below Grade	16.2	13.2	12	50	12	30	14.52	11.98	4.25

Table 8. Basin Dimensions (Approach B)

Basin Option (Approach B)	Total Height (ft)	Height at Aux. Spillway (ft)	Height at Principal Spillway (ft)	Aux. Spillway Width (ft)	Outlet Pipe Diameter (in)	Total Storage (ac-ft)	Active Storage (ac-ft)	Sediment Storage (ac-ft)
Basin 1 Below Grade	16	13	12	50	30	27.15	23.4	3.75
Basin 3A Below Grade	16	13	12	50	30	4.25	3.7	0.55
Basin 4E Above Grade (Watershed 4 Only)	16	13	12	50	30	25.9	23.4	2.5
Basin 5 Below Grade	16	13	12	50	30	20.8	18.8	2.0

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Basin Option (Approach B)	Total Height (ft)	Height at Aux. Spillway (ft)	Height at Principal Spillway (ft)	Aux. Spillway Width (ft)	Outlet Pipe Diameter (in)	Total Storage (ac-ft)	Active Storage (ac-ft)	Sediment Storage (ac-ft)
Basin 6A Above Grade	16	13	12	50	30	18.6	16.1	2.5

3.6 Design Checks

In order to ensure the concept designs resulting from the storm routing in SITES met all design goals and criteria, the resulting volumes were compared to the debris flow volumes and sediment volumes. Further detail is provided below.

Debris Flow Events

The debris flow volumes determined in the hydrology report and in the geotechnical report must be considered in the final sizing of the reservoir. The final volumes determined through the reservoir routing process are compared below to the debris flow volumes. The basin volumes are measured at the auxiliary crest elevation. The values are compared in the table below:

Table 9. Debris Flow Volumes

Basin Option	Total Volume (ac-ft)	Active Volume (ac-ft)	Watershed(s) Contributing Debris Flow	Empirical Debris Flow Volume (ac-ft)	Geotech Report Estimated Debris Flow (ac-ft)
Basin 1 Above Grade	20.35	16.92	1	11.08	23.6
Basin 1 Below Grade	20.47	16.76	1	11.08	23.6
Basin 1 Below Grade (Approach B)	27.15	23.4	1	11.08	23.6
Basin 2 Above Grade	1.77	1.51	2	1.62	3.6

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Basin Option	Total Volume (ac-ft)	Active Volume (ac-ft)	Watershed(s) Contributing Debris Flow	Empirical Debris Flow Volume (ac-ft)	Geotech Report Estimated Debris Flow (ac-ft)
Basin 2 Below Grade	1.62	1.34	2	1.62	3.6
Basin 3 Above Grade	1.31	1.12	3	1.25	1.0
Basin 3 Below Grade	1.25	1.02	3	1.25	1.0
Basin 3A Below Grade	2.98	2.43	2 and 3	2.87	4.6
Basin 3A Below Grade (Approach B)	4.25	3.7	2 and 3	2.87	4.6
Basin 4E Above Grade (Watershed 4 Only)	18.99	15.65	4	11.88	12.6
Basin 4E Above Grade (Watershed 4 Only) (Approach B)	25.9	23.4	4	11.88	12.6
Basin 4E Above Grade (Multi-Basin)	20.97	17.63	4	11.88	12.6
Basin 4D Below Grade (Watershed 4 Only)	19.98	15.39	4	11.88	12.6
Basin 4D Below Grade (Multi-Basin)	20.96	16.37	4	11.88	12.6
Basin 5 Above Grade	14.64	11.75	5	11.56	14.6
Basin 5 Below Grade	15.88	12.79	5	11.56	14.6
Basin 5 Below Grade (Approach B)	20.8	18.8	5	11.56	14.6
Basin 6A Above Grade	13.43	10.84	6	7.57	17.4
Basin 6A Below Grade	14.6	11.8	6	7.57	17.4
Basin 6B Above Grade	14.99	12.4	6	7.57	17.4
Basin 6B Above Grade (Approach B)	18.6	16.1	6	7.57	17.4
Basin 6B Below Grade	14.52	11.98	6	7.57	17.4

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Sedimentation

In order to expedite analysis, it was initially assumed that 20% of the initial storage was reserved as a sediment pool. To ensure that the sediment pool had sufficient volume, the sediment volumes from the Sedimentation Analysis Technical Memo are compared below to the initial assumptions. The sediment load from post-fire flows as discussed in this report are also compared. The sediment volumes in Table 10 are based on an annual sedimentation rate multiplied by the number of years listed.

Table 10. Sediment Volumes

Basin Option	Total Volume (ac-ft)	Concept Sediment Volume (ac-ft)	25-year Sedimentation (ac-ft)	50-year Sedimentation (ac-ft)	Bulked Post-Fire Runoff (ac-ft)	Direct Post-Fire Runoff (ac-ft)	Post-Fire Event Sediment (ac-ft)
Basin 1 Above Grade	20.35	3.43	2.7	5.63	23.5	19.6	3.9
Basin 1 Below Grade	20.47	3.71	2.7	5.63	23.5	19.6	3.9
Basin 1 Below Grade (Approach B)	27.15	3.71	3.75	5.63	23.5	19.6	3.9
Basin 2 Above Grade	1.77	0.26	0.16	0.35	2.2	1.8	0.4
Basin 2 Below Grade	1.62	0.28	0.16	0.35	2.2	1.8	0.4
Basin 3 Above Grade	1.31	0.19	0.16	0.35	1.7	1.4	0.3
Basin 3 Below Grade	1.25	0.23	0.16	0.35	1.7	1.4	0.3
Basin 3A Below Grade (2 and 3 combined)	2.98	0.55	0.32	0.7	3.9	3.5	0.4
Basin 3A Below Grade (2 and 3 combined) (Approach B)	4.25	0.55	0.55	0.7	3.9	3.5	0.4
Basin 4E Above Grade (Watershed 4 Only)	18.99	3.34	1.98	4.0	23.4	19.5	3.9
Basin 4E Above Grade (Watershed 4	25.9	3.34	2.5	4.0	23.4	19.5	3.9

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Basin Option	Total Volume (ac-ft)	Concept Sediment Volume (ac-ft)	25-year Sedimentation (ac-ft)	50-year Sedimentation (ac-ft)	Bulked Post-Fire Runoff (ac-ft)	Direct Post-Fire Runoff (ac-ft)	Post-Fire Event Sediment (ac-ft)
Only) (Approach B)							
Basin 4E Above Grade (Multi-Basin)	20.97	3.34	1.98	4.0	23.4	19.5	3.9
Basin 4D Below Grade (Watershed 4 Only)	19.98	4.59	1.98	4.0	23.4	19.5	3.9
Basin 4D Below Grade (Multi-Basin)	20.96	4.59	1.98	4.0	23.4	19.5	3.9
Basin 5 Above Grade	14.64	2.89	1.50	3.16	18.4	15.3	3.1
Basin 5 Below Grade	15.88	3.09	1.50	3.16	18.4	15.3	3.1
Basin 5 Below Grade (Approach B)	20.8	3.09	2.0	3.16	18.4	15.3	3.1
Basin 6A Above Grade	13.43	2.59	2.05	4.25	16.4	13.7	2.7
Basin 6A Below Grade	14.6	2.8	2.05	4.25	16.4	13.7	2.7
Basin 6B Above Grade	14.99	2.59	2.05	4.25	16.4	13.7	2.7
Basin 6B Above Grade (Approach B)	18.6	2.59	2.5	4.25	16.4	13.7	2.7
Basin 6B Below Grade	14.52	2.54	2.05	4.25	16.4	13.7	2.7

All of the methods used to determine sediment loads are highly subjective, and subject to significant error. No reliable method of calibration is readily available. Therefore, a sediment storage volume must be selected which the Owner is comfortable with given the uncertainty, with the knowledge of roughly how often they may have to perform maintenance. 50 to 100-year design life is typical NRCS standard. 50-year sediment load is recommended due to site and cost constraints. Less volume may also be acceptable if the Owner is willing and able to perform the maintenance as needed.

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4.0 Economic Analysis Flood Modeling

2-D Model

FLO-2D software was used to determine the effects on the downstream floodplain that would result from constructing debris basins. FLO-2D has been approved by multiple government agencies including FEMA. A pre and post-construction model was created and ran for each return event. The use of a two-dimensional model provides better results than a one-dimensional model as the flow directions are calculated, rather than assumed. The model is based on the best available GIS data and topographic data including LiDAR survey, field measurements and reconnaissance. It should be noted that the model output is useful for determining general effects of flooding and provides a good understanding of what is likely to occur. However, exact depths at specific locations should not be considered absolute.

Model Input

Model input includes elevation data, topographic data for homes, buildings and street locations, as well as for channels. Various sources were used for the east bench elevation data. Two-foot contour data is available form Utah's Automated Geographic Reference Center (AGCR). In addition, detailed topographic/elevation data was supplied by Santaquin City for the development in the 1030 East and 200 South vicinity.

The elevation data is converted into an elevation grid to represent the ground surface within the 2-D model. A ten foot grid element size was used in the model.

The model limits extend from Watershed 1 all the way north into Spring Lake, and include I-15 and the Highline-Strawberry Canal.

For the existing condition models, inflow nodes are located at the mouth of each watershed being analyzed. In the proposed condition, the inflow nodes are located where the spillway would be. A hydrograph is applied at each inflow node. The hydrographs were developed for existing conditions as well as for proposed conditions. The proposed condition hydrographs represent the flows being routed through the basins and associated outlet structures. The proposed condition hydrographs were developed using SITES. Also, proposed hydrographs for the basins which hold the 50-year volume were developed using the existing flow hydrograph and modifying it such that the 50-year volume is contained within the basin. Flow which exceed that volume would spill over the spillway into their historic flow path.

The model was set to run for at least as long as the storm duration (24 hours). In some cases it was run longer to make sure the full effects of the flooding had been propagated downstream. Generally, the peak flows occur early in the model. However, the full area of inundation is better understood by running the simulation for a longer period of time.

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The channel at the base of Watershed 1 was not clearly represented in the 2-foot contours obtained from AGRC. This channel has a significant enough impact on the flows coming from Watershed 1 that this issue needed to be corrected. To mitigate this lack of data, field measurements were taken at approximately 200-300 foot intervals to determine bottom width, bank slopes, top width, etc. Other smaller channels which may exist, such as curb and gutter were not captured within the model.

The grid elements along the northern and western edges of the model were made outflow nodes. This allows water to flow off the model domain at a normal depth.

Floodplain roughness coefficients within the model are 0.04 for typical floodplain and 0.015 for streets and paved areas. The model also adjusts the roughness coefficient for very shallow flows to be as rough as 0.2.

A pipe network was developed for the proposed model in the alternative that includes an extensive pipe network downstream. The pipe inflow and outflow nodes were assigned a rating table of flow to depth based on average slope between the points, and the estimated pipe size. The outfall of the combined pipe network cannot extend beyond the model boundaries to determine its ultimate effects on the entire downstream system in Payson and to Utah Lake. However, because this model was proven to have a very low benefit to cost ratio, and for other reasons, this alternative is not recommended as the preferred alternative.

Model Output

FLO-2D model output for maximum depths, water surface elevations, and velocity are exported as shapefiles. The FLO-2D shapefiles were then superimposed with aerial imagery and other shapefiles for existing infrastructure such as homes, buildings, roads, etc. This data was used to quantify where flood flows of varying depths intersected with homes and roads. The velocity multiplied by the depth was also provided for the economic analysis. This information is included on maps in Appendix D.

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Economic Analysis

An economic analysis was conducted by an NRCS certified economist using the results of the FLO-2D model as well as cost estimates for the projects, and projected maintenance costs. The results of the economic analysis indicate a benefit cost ratio as follows:

Table 11. Benefit Cost Ratio

Approach	Benefit/Cost Ratio
A	1.24
B	1.88

The full economic analysis is contained in a separate document.

Induced Flooding Analysis

Induced flooding is causing flooding to occur where it did not previously/historically occur. In order to prevent induced flooding, proposed debris basins will be constructed at or adjacent to the historic flow paths. The outlet and spillway works will be constructed such that the flows are directed to the historic flow path. Induced flooding has thus been greatly minimized. The spillway channels will be areas of induced flooding for either option. However, property for these areas will be acquired for the project. As the water reaches the end of the spillway channel, it enters its historic flow path. Induced flooding maps are included in Appendix E.

Outflow System Analysis

In order to ensure that the recommended measures did not increase flooding hazards at any point downstream of the lower limits of the project area, the flows were measured in the flood model at several locations where the water flows out of the study area and to the north. These flows were then compared to the post-construction flood models to check the potential impacts.

Maps showing the flood extents, depths, and peak flows both under existing conditions and post-project conditions are included in Appendix F. Table 12 provides a summary of the flow results.

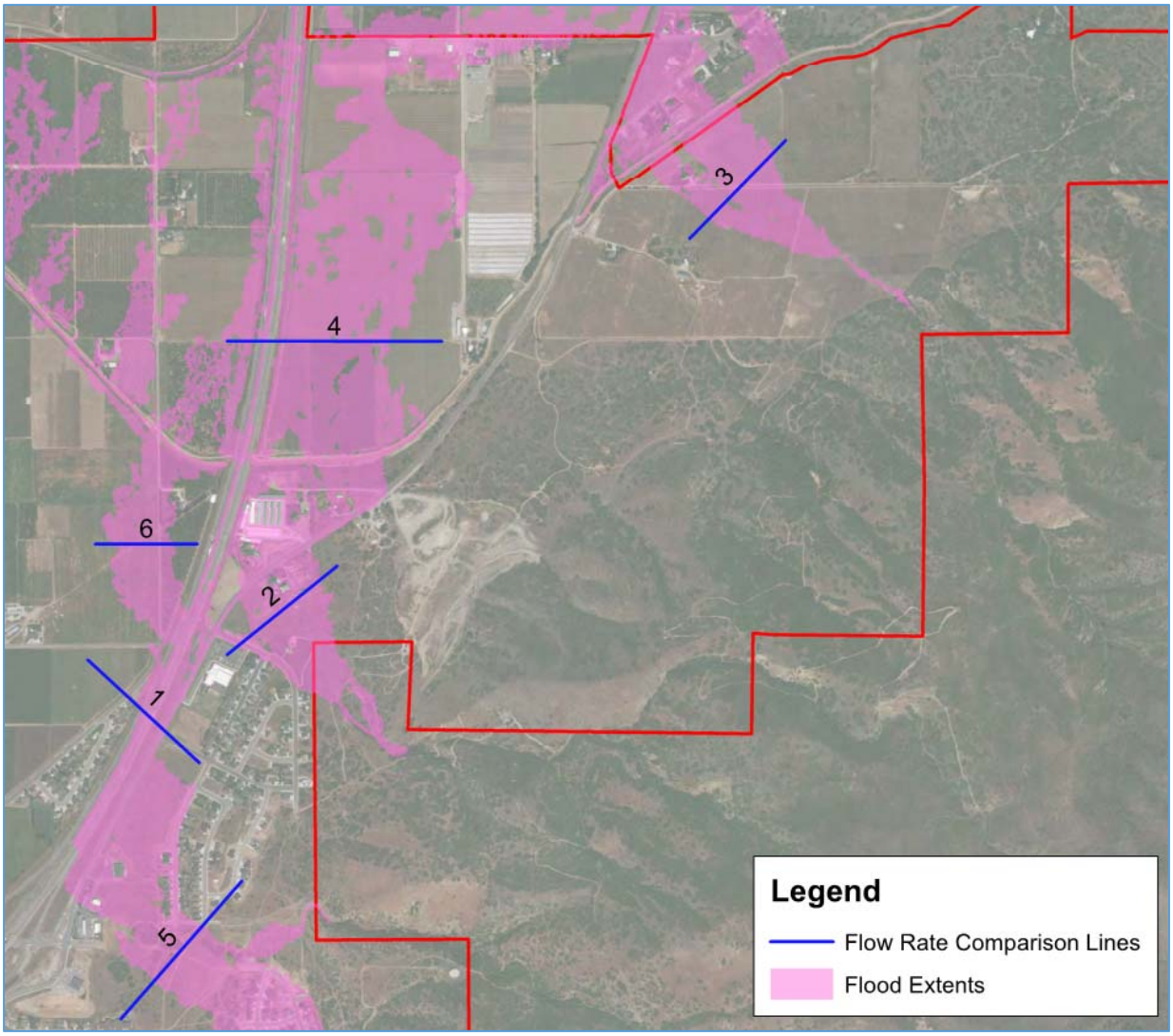

Figure 4. Floodplain Comparison Lines

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Table 12. Flow Comparisons

2-Year (cfs)			
Section	**Existing**	**Proposed A**	**Proposed B**
1	11.3	0	0
2	6.2	0	0
3	12.1	0	0
4	10	0	0
5	13.3	0	0
6	0	0	0
5-Year (cfs)			
Section	**Existing**	**Proposed A**	**Proposed B**
1	158	0	0
2	9.1	0	0
3	38.6	0	0
4	134.1	0	0
5	187.2	0	0
6	1.7	0	0
25-Year (cfs)			
Section	**Existing**	**Proposed A**	**Proposed B**
1	315.2	0	0
2	71.8	0	0
3	118.7	0	0
4	277.4	0	0
5	373.7	0	0
6	20	0	0
50-Year (cfs)			
Section	**Existing**	**Proposed A**	**Proposed B**
1	445.6	0	0
2	130.6	0	0
3	167.6	0	0
4	385.9	0	0
5	489.7	0	0
6	50	0	0

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100-Year (cfs)			
Section	**Existing**	**Proposed A**	**Proposed B**
1	576.7	0	28.4
2	200.4	0	10.2
3	246.7	0	15.2
4	495.8	0	19.2
5	622.5	0	33.6
6	80.6	0	0
200-Year (cfs)			
Section	**Existing**	**Proposed A**	**Proposed B**
1	774.5	174.4	216.2
2	284.7	0	51.8
3	341.6	84.1	85.2
4	639.4	139.3	199.6
5	831.5	94.9	244.8
6	156.1	0	8.3
500-Year (cfs)			
Section	**Existing**	**Proposed A**	**Proposed B**
1	1107.1	505.5	657.7
2	414.6	116.3	223.5
3	499	228.8	218.1
4	929.2	444.4	475.5
5	1155.7	461.0	928.8
6	334.9	52.4	90.1

Hazard Rating and Dam Breach Analysis

Breach Flow Analysis

Peak flow rates and hydrographs were developed using criteria outlined in TR-60 and using a spreadsheet titled “Dambreach Hydrographs via TRs 60 & 66 NRCS Guidance” obtained from the NRCS website.

A dam breach analysis was conducted for Basin 4 and Basin 6 as they are the basins which are proposed as being partly constructed above grade.

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Breach Flood Inundation Analysis

The breach hydrograph values were input into FLO-2D to determine the downstream effects of a breach. Velocity and depth information was extracted from the model and maps were created using ArcMap. Breach hydrographs and breach maps are included in Appendix G.

Hazard Rating

Dam classification guidance is found in NEM Part 520C:
(1) Low Hazard Potential—Dams in rural or agricultural areas where failure may damage farm buildings, agricultural land, or township and country roads.

(2) Significant Hazard Potential— Dams in predominantly rural or agricultural areas where failure may damage isolated homes, main highways, or minor railroads or interrupt service of relatively important public utilities.

(3) High Hazard Potential— Dams where failure may cause loss of life or serious damage to homes, industrial and commercial buildings, important public utilities, main highways, or railroads.

Breach flows from Basin 4 would have high velocities combined with moderate depths. There is some residential and commercial development downstream, as well as SR-198 and I-15 which would be impacted by a breach. For these reasons, and based on the criteria established in NEM Part 520, this would be a High Hazard dam.

Breach flows from Basin 6 indicate velocities in excess of 15 ft/s with typical depths ranging from 1-3 feet and maximum depths at about 5 feet.

See the breach flow maps in Appendix G for more information.

Debris basins that are constructed above grade with an embankment holding the debris or water volume back have been found to be high hazard per NRCS and Utah Dam Safety guidelines. These basins will require additional inspections, maintenance, embankment, design, etc.

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Conclusion

Two similar options for handling flooding along the east bench have been analyzed for the purpose of understanding the footprint that will be required for an environmental assessment. It can be seen by the flow comparison maps that both options clearly provide significant reductions in flow rates and in flood damages. Multiple options for each basin were modeled for reservoir routing, floodplain analysis and breach analysis.

Both options have a reasonable limit in how far the impacts have been studied. Further downstream analysis is possible but would impact schedule, analysis budget and would have a diminished return value.

Option A's extensive pipe network would be constructed to a downstream point where it appears there is adequate capacity for these flows. However, the discharge location down to Utah Lake has not been modeled.

Option B does not completely contain the 100-year flows but it does reduce them to a much safer level.

While this report was being finalized, Santaquin City Council made the decision to continue with Approach B instead of Approach A. The reasons for making this selection include: greater monetary benefit, less pipe maintenance requirements and potentially more overall protection from typical debris flows by having a larger basin.

A full geotechnical analysis will be needed when the projects are fully designed. When further funding for the basins is procured, it may only cover a portion of the overall 5-basin project. If that is the case, coordination with NRCS and Santaquin City must occur to determine which basin is the most critical at that time.