APPENDIX E

SUPPORTING INFORMATION

1958 Watershed Work Plan American Fork – Dry Creek Watershed
1963 Supplemental Watershed Work Plan Agreement #4 American Fork – Dry Creek Watershed
Wetland and Stream Delineation Report
Botanical and Wildlife Survey Report
Cultural Resources Letter Report
UDWRt Seepage Monitoring Letter

WORK PLAN SECTION
FILE

WATERSHED WORK PLAN
AMERICAN FORK - DRY CREEK WATERSHED
UTAH COUNTY, UTAH

June, 1958

Prepared under the authority of the Watershed Protection & Flood Prevention Act.
(Public law 566, 83rd. Congress, 68 Stat. 666) as amended by the Act of Aug.7, 1956
(Public law 1018, 84th. Congress, 70 Stat. 1088)

WATERSHED WORK PLAN

AMERICAN FORK-DRY CREEK WATERSHED

Utah County, Utah

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress, 68 Stat. 666) as amended by the Act of August 7, 1956 (Public Law 1018, 84th Congress, 70 Stat. 1088).

Prepared by:

Alpine Soil Conservation District
Pleasant Grove City
American Fork City
Alpine City
Lehi City
Pleasant Grove Irrigation Company
American Fork Irrigation Company
Alpine Irrigation Company
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With assistance by:

U. S. Department of Agriculture, Soil Conservation Service
U. S. Department of Agriculture, State Office of the Agricultural Stabilization And Conservation Committee
U. S. Department of Agriculture, Forest Service
U. S. Department of Interior, Bureau of Land Management
U. S. Department of Interior, Fish and Wild Life Service
U. S. Department of Interior, National Park Service
Utah State Fish and Game Department
Utah State Land Board
Utah State Department of Forestry and Fire Control
Utah State Road Commission
Utah Cooperative Extension Service

November 1958

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SECTION 1

THE WATERSHED WORK PLAN

AMERICAN FORK-DRY CREEK WATERSHED

Utah County, Utah

November 1958

SUMMARY OF PLAN

The Watershed Work Plan for the American Fork-Dry Creek Watershed was prepared by the Alpine Soil Conservation District, the cities of American Fork, Pleasant Grove, Lehi, and Alpine, the American Fork, Pleasant Grove, Lehi, and Alpine Irrigation Companies, and Utah County. Technical assistance was provided by the Soil Conservation Service, Forest Service, and the State Office of the Agricultural Stabilization and Conservation Committee, United States Department of Agriculture; the Bureau of Land Management, National Park Service, the Fish and Wild Life Service, United States Department of Interior; the Utah State Fish and Game Department, Utah State Land Board, Utah State Department of Forestry and Fire Control, the Utah State Road Commission, and the Utah Cooperative Extension Service.

This work plan covers an area of approximately 118,710 acres in northern Utah County, Utah.

Measures to be Installed

The plan was developed to reduce sediment and floodwater damages to urban property, irrigation systems, farmland, recreational facilities, and roads and bridges within the watershed; reduce water losses in canals and ditches; improve irrigation efficiencies on the farms; and to provide additional late season irrigation water. It includes a combination of land treatment measures and debris basins to reduce sediment yields and summer flood flows, an irrigation storage reservoir, and improvements to canal systems and farm irrigation facilities. The estimated cost of installation for the works of improvement included in the work plan is $3,791,285. The Federal (P.L. 566) share of this will be $1,677,855. The share from other funds will be $2,113,430.

Land Treatment Measures

The restoration of vegetative cover on approximately 74,200 acres of upper watershed land involves terracing, seeding, management, increased fire protection, and other works to stabilize critical floodwater and sediment source areas. The measures will be installed on both public and private lands. Land treatment for the improvement of irrigation efficiencies and the conservation of soil and water will be accelerated and will include such measures as land leveling, canal lining, drainage, grassed waterways, strip cropping, and others. The total installation cost of these measures is estimated to be $1,944,610 of which $480,460 or 25% will be Federal (P.L. 566) cost and $1,464,150 or 75% from other funds. Cost of the treat-

ment on federal lands is estimated to be $353,780. Cost on non-federal lands is estimated to be $1,590,830.

Structural Measures

The structural measures to be installed consist of four debris basins, an irrigation storage reservoir, ditch lining, pipe lines, overnight storage ponds, ditch construction, drop spillways, desilting basins, and a diversion dam. Estimated total installation cost of the structural measures is $1,846,675 of which $1,197,395 or 65% will be federal (P.L. 566) cost and $649,280 or 35% will be from other funds. The installation cost includes the cost of lands, easements, and rights-of-way for the structural sites, relocation of existing facilities, and contract administration, all of which will be borne entirely by non-federal interests.

Damages and Benefits

The project will reduce or eliminate sediment and floodwater damages from summer floods of up to and including 100-year frequency events. It will provide an adequate irrigation water supply for irrigated lands now only partially supplied. Average annual flood prevention benefits will be $52,835, agricultural water management primary benefits $56,150. Average annual cost of the measures for flood prevention and agricultural water management will be $80,550. The ratio of average annual benefits to average annual costs is 1.4 to 1.

Provisions for Accomplishing and Financing Construction

Sponsoring organizations will acquire necessary land, easements, and rights-of-way, execute agreements with owners of private lands for installation of the land treatment measures, provide the non-federal share of the installation costs of structural and land treatment measures, cooperate with the Forest Service and Bureau of Land Management for installation of the program on federal lands within the watershed and other local, state, and federal agencies concerned with the project. Water rights affecting works of improvement have already been acquired. Local sponsoring organizations will contract for the construction of the structural measures in the work plan.

Operation and Maintenance

Annual operation and maintenance costs are estimated to be $5,575.

Land treatment measures on private land will be maintained by owners and operators of the land or by local sponsoring organizations under agreement with the landowners. Maintenance costs for land treatment measures on federal land during the project installation period will be borne by project funds. After the project installation period, maintenance of land treatment measures on federal lands will be financed from regular appropriations of the respective federal agencies.

All structural measures will be maintained by the local sponsoring organizations. Specific responsibilities are detailed under "Provisions for Operation and Maintenance."

DESCRIPTION OF THE WATERSHED

The American Fork-Dry Creek Watershed is located in Utah County, North Central Utah. It includes approximately 118,710 acres in the northeast part of the county. The watershed is composed of two major topographic units. They are: (1) the Mountainous area and (2) the Valley area.

Mountainous Area

About 74,200 acres, or 62%, of watershed lands are included in the precipitous western section of the Wasatch Plateau, which is a massive physiographic feature of Utah terrain extending south from the Utah-Idaho border for over 200 miles. The wall-like mountain front which forms the western edge of the plateau was formed as a result of displacement along the Wasatch fault and is called the Wasatch Front. In the watershed, the "Front" includes several peaks which rise to elevations of over 12,000 feet, and many short and minor canyons are cut back into the face of the escarpment. Larger canyon systems have been developed by Dry Creek, Box Elder Creek, Grove Creek, Battle Creek, and Dry Canyon. American Fork Creek, the largest of all, has extended its drainage area well back into the plateau and the upper watershed of this stream covers about 41,000 acres or 55% of the mountainous part of the watershed.

Vegetal cover of the lower elevations in this section of the watershed includes low density stands of sagebrush, mountain brush, pinon-juniper, and the associated grasses and weeds. The density and the variety of the cover, including a large aspen zone, increases through the intermediate elevations. The vegetation at the highest elevations includes both open and dense stands of coniferous timber and open stands of brush, grasses, or forbs. Most of the mountain area has been heavily grazed in past years by domestic livestock and by big game. In general, the area falls in the very poor to fair range condition classes.

Mountain soils fall mostly in medium textured groups and are mainly residual in origin. Nearly 26% of the mountain area is rock outcrop or coarse rock material over bedrock. Shallow soils with relatively impervious subsoils derived chiefly from limestones are the most susceptible to erosion, and many areas of these soils around Box Elder Peak and at the head of American Fork Creek are in advanced stages of deterioration. Soils developed from glacial moraine deposits above 6,500 feet in elevation in American Fork Canyon and at the mouth of Dry Creek Canyon are the source of substantial amounts of sediment. All of the known flood source area is located in the mountain section of the watershed.

The mountain areas are the principal source of the water supply, domestic and agricultural, for the valley below. The aggregate average annual yield of water from the watershed is about 82,000 acre feet. An additional 16,000 acre feet of water for domestic, agricultural, and industrial use comes into the watershed from the Provo River drainage.

Valley Area

The balance of the watershed, 44,510 acres, is situated in the northeast part of Utah Lake Valley. The valley lands cover an area of benches and

terraces formed by ancient Lake Bonneville, and the valley terrain drops in successive benches from the mountain front down to Utah Lake. Both Dry Creek and American Fork Creek have cut relatively shallow channels through the valley alluvium in their course to the lake. By contrast, Box Elder, Grove, and Battle Creeks have built prominent alluvial fans at their mouths and many commercial and residential developments have been established on flood-vulnerable fan areas. Elevations of valley lands range from 4,200 feet to about 5,200 feet. The three principal towns, Lehi, American Fork, and Pleasant Grove, are situated in the valley and lie along U. S. Highway #89-91.

There are 23,720 acres of irrigated farmland and 4,260 acres of dry land in the valley area. Valley soils are almost entirely lacustrine in origin and range in texture from gravelly loam to silty clay. Clay loams and loams are the dominent textures. Little, if any, of the valley area is considered a flood source area.

To facilitate the planning and treatment of the watershed, three major physical segments are recognized. They include (1) all the drainage of Dry Creek, (2) all the drainage of American Fork Creek, and (3) a group of drainages of small and intermediate size on the south part of the watershed, including Grove and Battle Creeks, which have cut back into the face of the Wasatch Fault escarpment. For purposes of description and discussion in this plan, the latter area has been named the "Timpanogos Face."

Tabulated below are data showing other relationships between the three major segments of the watershed.

		Segment of Watershed		
Item	Watershed	Dry Creek	American Fork	Timpanogos Face
Mountain area	74,200 ac.	23,640 ac.	40,960 ac.	9,600 ac.
Valley area	44,510 ac.	15,710 ac.	14,200 ac.	14,600 ac.
Irrigated area	23,720 ac.	9,950 ac.	6,720 ac.	7,050 ac.
Dryland area	4,260 ac.	3,300 ac.	210 ac.	750 ac.

The distribution of improvements and the varying physical conditions along the stream channels produce differences in the nature and magnitude of watershed problems in each segment. Further description of physical features which have a bearing on watershed problems is given below.

Dry Creek Segment

Dry Creek flows through the towns of Alpine and Lehi and crosses a network of county roads in its course to Utah Lake. It intersects the main line of the Denver and Rio Grande Western Railroad and a branch line of the Union Pacific. The Utah Power and Light Company has a hydroelectric plant in the mouth of Dry Creek Canyon. Irrigated farmlands, dryland pasture, and meadow lands are located all along the 10-mile distance from the mouth of Dry Creek Canyon to Utah Lake. In addition, four irrigation diversions are located

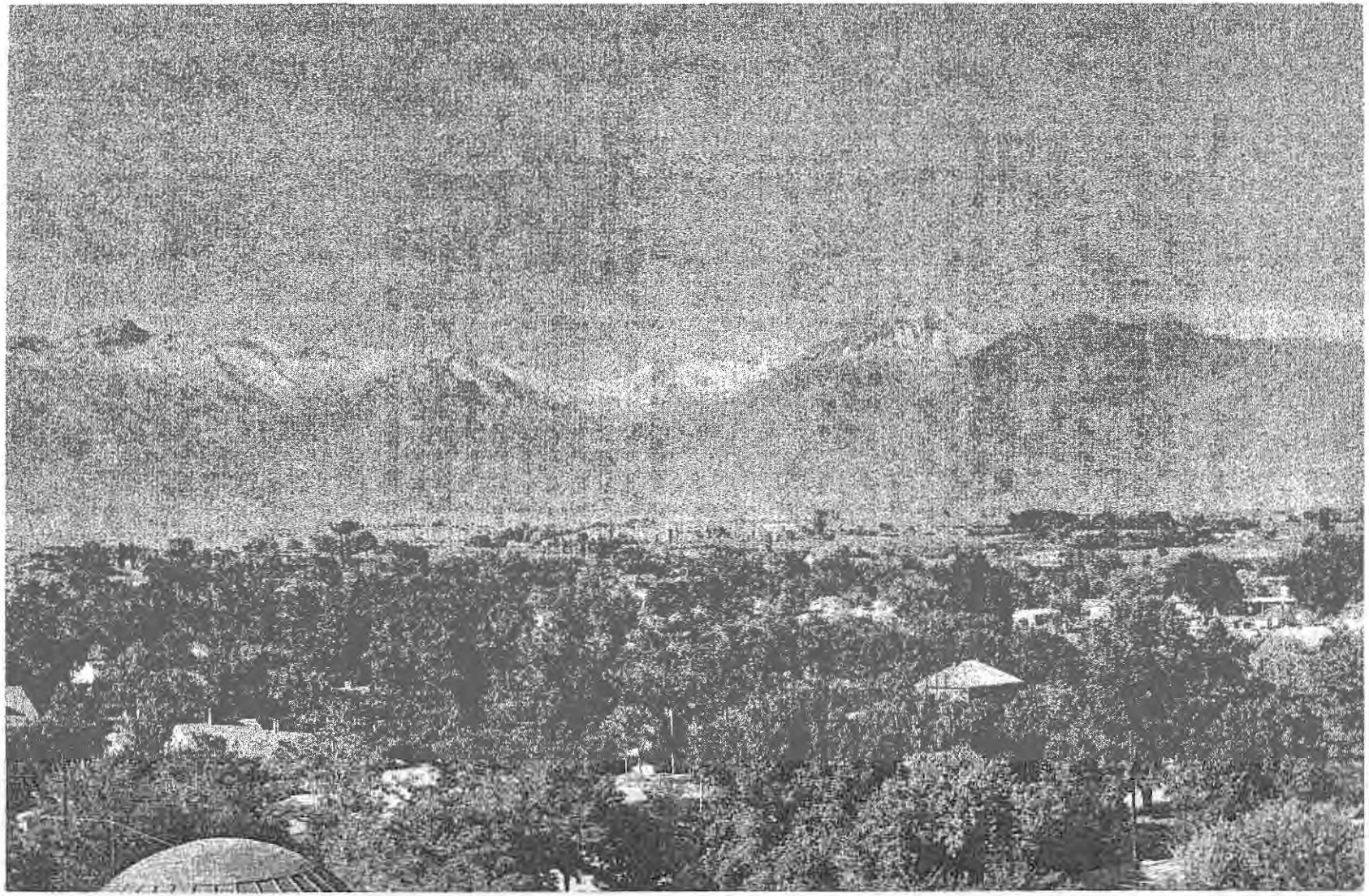
along the channel and a major highway--U.S. Highway #89-91--crosses the channel at Lehi. State Highway #80 crosses Dry Creek four miles above Lehi.

American Fork Segment

American Fork Creek occupies the central segment of the watershed and the channel traverses a section of valuable recreation, power, irrigation, and urban developments. In the mountainous section, extensive recreational facilities have been established including improved access roads and bridges. Lower in the canyon, the recreational and living facilities at the headquarters of the Timpanogos National Monument and a hydroelectric plant of the Utah Power and Light Company are situated adjacent to the channel. The intake and the pipe line for the American Fork City water supply is also located in and immediately adjacent to the channel in the reach extending two miles upstream from the canyon mouth and is highly susceptible to damage. Both improved and unimproved roads are situated in the bottom of the canyon close to the stream channels. The irrigation diversion serving the three major irrigation companies is located in the mouth of the canyon. The stream intersects numerous county roads, passes through American Fork City, and is crossed by State Highway #80 and U. S. Highway #89-91 in its course to Utah Lake. Pasture land and irrigated farmland is situated along the channel from the mouth of the canyon down to Utah Lake.

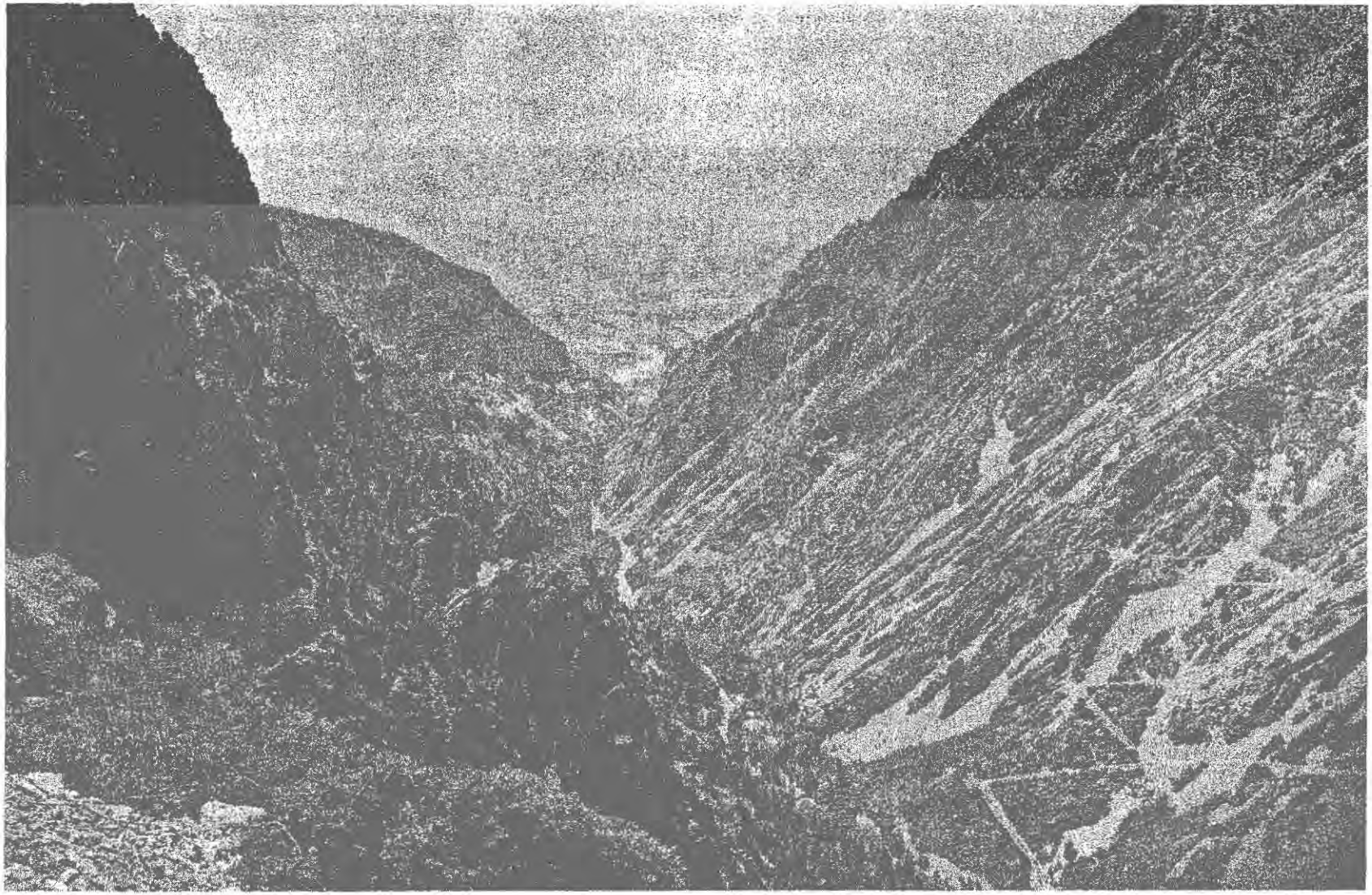
Timpanogos Face Segment

The Timpanogos Face segment in the south section of the watershed includes a complex of physical conditions and rural and urban improvements which produce a varied aggregate of watershed problems. Farmlands and rural residences are on the benches and the fans which lie below the small drainages of Rondavu, Heisetts, Sumac, and Dry Canyons. Utah State Highway #80 and the main Provo Reservoir Canal skirt the fringes of the fans and Grove Creek and Battle Creek both discharge flows on a common fan occupied by the city of Pleasant Grove. The fragmentary channel of both Grove and Battle Creeks can be traced through Pleasant Grove City and across U. S. Highway #89-91. The Provo Reservoir Canal traverses the Grove and Battle Creek fan in the higher part of Pleasant Grove City.



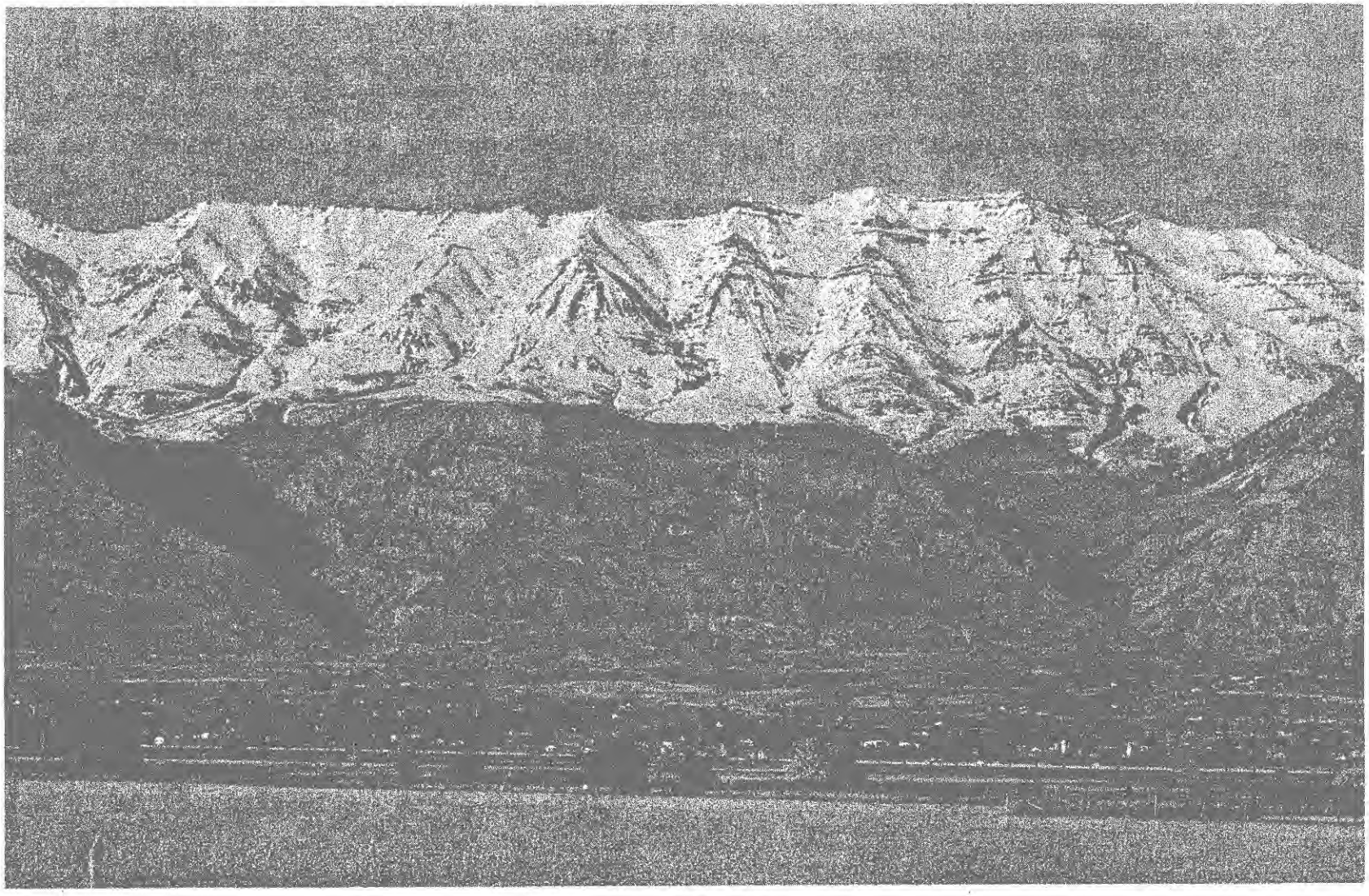
The Dry Creek Segment

Dry Creek heads in the high mountains in the background and flows through Alpine, out of sight at the foot of the mountains, and Lehi, in the foreground. The near side of Box Elder Peak, just right of center, drains into Dry Creek; the far side, into American Fork Creek. Deteriorated areas on Box Elder Peak are the source of floodwater and sediment for flash summer floods in both Dry Creek and American Fork Creek.



American Fork Segment

Lower American Fork Canyon shows the narrow and steep profile typical of most of the major canyons cut through the Wasatch Front. Roads, pipe lines, power facilities, and improved recreation areas are concentrated in the narrow canyon bottoms and all of these developments are highly susceptible to damage from floods. Deposits of sand and gravel carried down from the gullied upper watershed are framed as a light colored area in the notch of the canyon mouth.



The Timpanogos Face Segment

Grove Creek, left, and Battle Creek, right, have cut deep, steep canyons into the Wasatch Fruit escarpment toward Mt. Timpanogos. These drainages discharge flood flows into the city of Pleasant Grove, situated on a fan common to both streams, and the urban developments extending toward the mouths of the canyons have largely erased the old creek channels.

Climate

Elevations of valley land range from 4,500 to about 5,180 feet above sea level. Average annual precipitation in the valley area ranges from 12 inches at lower elevations to about 16 inches on the Bonneville Terrace at approximate elevation 5,135 feet. Precipitation increases rapidly with elevation in the mountainous portion of the unit, most of which falls as snow during the winter months. Recorded data from the 8,700 foot level indicates that average annual precipitation in the highest elevations exceeds 40 inches with about 75% of the total accumulating as snow.

Maximum and minimum temperatures in the valley have ranged from -28° F to 106° F. At Lehi, average January temperature is 25° and the average for July is 72°. Winds are mainly gentle to moderate, with the occasional strong winds which are common to most desert regions. The maximum average frost-free period for the watershed extends from May 13 to September 25, a period of 135 days.

During the hot summer months, convective type thunderstorms occur frequently in the watershed. The U. S. Weather Bureau indicates that the principal source of this moisture is the Atlantic Ocean. Warm, moist air originates over the Atlantic, swings across the warm waters of the Caribbean Sea and the Gulf of Mexico and thence up the Rio Grande Valley and over Northern Mexico into the southwestern plateau region.

The orographic effect of the steep mountains rising abruptly from the valley floor, in conjunction with the convective type storm, produces the intense rainfall which is the principal cause of flood damages in this watershed.

Land Ownership

Almost all of the mountainous area lies within the boundaries of the Uinta National Forest and the bulk of these lands are under Federal ownership. Approximately 4,000 acres of patented mining claims are principally concentrated in the Mary Ellen, Major Evans, and Mineral Basin drainages of American Fork Canyon. The Timpanogs National Monument is also located in lower American Fork Canyon and includes 260 acres.

Valley lands are almost entirely under private ownership. The American Fork Training School, a State agency, operates 400 acres of farmland north of American Fork City.

The present ownership of the land is as follows:

Mountainous Area	Acres	Percent of total
Private (Including 4,000 acres mining claims)	14,880	12.5
State	660	0.6
BLM	560	0.5
National Forest	57,840	48.7
National Park	260	0.2
Subtotal	74,200	62.5
Valley Area		
Private	43,820	36.9
State	610	0.5
Federal (BLM)	80	0.1
Subtotal	44,510	37.5
GRAND TOTAL	118,710	100.0

Economy of the Watershed

The watershed economy typically represents the rapidly developing portion of the State which is characterized by a shift from a dominantly agricultural economy toward a dominantly industrial economy. The Geneva and Ironton plants of the United States Steel Corporation, located adjacent to the watershed, presently comprise the chief unit of heavy industry for the county. Many smaller manufacturing and fabrication industries have been and are now being established near the steel plant. However, during the evaluation period, it can be anticipated that agriculture will continue to be a substantial factor in the economy of the watershed.

One of the strong indicators of the changing economic base is the past and current pattern of population growth. Utah County population has increased 24.5% during the period 1950 to 1957, as compared to an increase of 20.4% for the State. Since 1920, the county has advanced from a position of 9.1% of the State population to 12.3% as of January 1, 1957.

Urban population is increasing at a much faster rate than rural population in both Utah County and the State. The same situation exists within the watershed area. This points to urban properties as becoming an increasingly important factor in determining future damages and benefits.

The urban population of the watershed centers in four towns. Population of these towns, as of January 1, 1957, is listed below.

Lehi	4,495
American Fork	6,355
Pleasant Grove	3,960
Alpine	710

Poultry products and field crops are the chief item of agricultural production in the watershed, followed closely by beef, fruit, and dairy products. There is a trend toward decrease in size of farms and an increase in specialty farming. Under conditions of a growing population and an expanding industrial economy, it may be predicted that these trends will continue for some time. In some parts of the watershed, especially the Lehi and Alpine areas, production is hampered by a short supply of late season irrigation water. It is anticipated that the shortage in the Lehi area will be somewhat relieved by water scheduled to come into the Bonneville Basin under the Central Utah Project some years hence. Higher areas such as Alpine are not expected to share in this improvement.

Transportation

The watershed is served by two railroads and by an extensive system of State, County, and Forest Service roads. The main line of the Denver and Rio Grande Western Railroad traverses the area and the Union Pacific Railroad Central Utah Branch line gives local service. Combined U. S. Highways #89, 91, and 50 pass through the lower watershed area and a network of county and local roads connect the four towns and provide access to the mountainous area and to the farming sections. All major highways and a good percentage of the local roads are improved and maintained in good condition. Interstate Highway #15 will roughly parallel U. S. #89-91 through the area. Construction is scheduled to begin in 1959.

The location of the watershed on U. S. Highway #89-91 and U. S. #50 adds to the support of service stations, cafes, and motels along the highway. The tourist trade presently makes a small contribution to the local economy.

Recreation

Current and future development of recreational facilities in the mountainous area of the watershed is rapidly growing into an important factor in the local economy. American Fork Canyon is one of the more favorably situated areas for picnicing,hiking, skiing, hunting, fishing, and as a site for summer homes and organization camps. Surveys of potential recreation sites in mountain areas indicate that accessible and suitable terrain for recreation is limited. However, parts of American Fork, Dry Creek, and Fort Creek Canyons are particularly suited for recreational use.

American Fork Canyon also gives access to the Timpanogos Cave National Monument, which is attracting increasing numbers of visitors. One leg of the Alpine Loop, a scenic highway which traverses the crest of the Wasatch escarpment to Provo Canyon, originates in the South Fork of American Fork Canyon. It appears probable that present plans for the expansion of

recreational facilities in American Fork Canyon and for another scenic road from Fort Creek Canyon into Salt Lake Valley will be given impetus by the rapid increase in population predicted for the next 25 years.

The expected increase in the establishment of additional recreational facilities has an important relation to future flood damages. Many new recreational facilities will be added to those now susceptible to flood damage and the values of existing facilities, all of them more or less subject to flood damage, will be augmented by future improvement.

WATERSHED PROBLEMS

The watershed includes a number of independent drainages with combined flood source and flood damage areas ranging from 785 acres to over 55,000 acres in size. Damaging summer floods of various magnitudes have occurred in the major tributaries of the watershed on the average of once every five years since 1860. On smaller tributaries within the upper watershed, summer flash floods may occur nearly every year.

The critical floodwater and sediment source areas are primarily located in two range sites--high mountain aspen and high mountain park--and on Land Capability Class VIII lands. Critical areas also occur to a limited extent in the intermediate mountain and intermediate mountain timber sites. Detailed descriptions of the range site may be found in Section 2.

Newspaper and other accounts detail summer floods which occurred in various parts of the watershed in 1869, 1876, 1878, 1880, 1881, 1885, 1896, 1901, 1910, 1919, 1921, 1923, 1930, 1934, 1935, 1938, 1946, 1951, and 1953. Many of these floods were small and damage was light. Some floods, such as the events of 1881 and 1900 on Dry Creek and the flood of 1921 on American Fork Creek, caused significant damage even though the population was sparse and damageable values were low. Specific data on damages from older floods are not available, but the general magnitude and the nature of damages from many of these events can be reconstructed from old newspaper accounts, diaries, and other records.

More accurate data are available for flood events occurring in recent years. The American Fork summer flood of 1953 caused direct damage in excess of $61,000. The Dry Creek summer flood of 1951 caused at least $55,000 in total damages. The total of direct floodwater and sediment damages from the summer flash flood of 1951, the sediment damages occurring in the snowmelt flood of 1952, and the summer flash flood of 1953 in American Fork Creek, was over $123,000. Major items of damage included flooding of yards and basements in Alpine, Lehi, and American Fork, blocking of irrigation diversions in Dry Creek and American Fork Creek, and the undermining of roads, bridges, and sidewalks. Recreation facilities were buried in mud and debris, power diversions blocked, and traffic delayed and detoured on U. S. Highway #91.

The greater part of damages from historic floods are from relatively infrequent summer flash floods. The high peak flows from this type of flood transport large masses of sediment and debris from the upstream sediment source areas into the main channels and cause extensive bank

cutting and channel erosion as well. In the ensuing years after each flood, natural streamflow and snowmelt floods move sediment deposited by summer floods down to irrigation and power diversions or reduce channel capacities and clog bridges and culverts.

Thus, the initial expense of cleaning up flood debris or in making repairs to damaged structures and other facilities represents only a portion of the damages which must be assigned to each flood event. Sediment movement by spring snowmelt flows, therefore, becomes an item of significance in determining the full extent of summer flash flood damages. Expense of handling sediment moved by snowmelt flows have been given appropriate weight in the determination of the damage base set forth in this report.

Flood damages to roads, bridges, and to recreational facilities in the canyon areas occur chiefly from flash floods rather than snowmelt floods. Most of the canyons are narrow and deep and the flood channels must be restricted to make room for the roads, the pipe lines, or the diversions. Where room will permit, picnic units and camp grounds have been established, chiefly on spots next to the creek. Such spots are highly susceptible to damages and damage occurrence is frequent. Such facilities are being expanded, in the upper watershed, along with additional roads, trails, bridges, and summer home areas. All of these are subject to some degree of damage.

Sediment Damage

Nearly two thirds of the damages caused by floods are from sediment. Sediments transported by both snowmelt and summer flash floods are distributed widely throughout the irrigated area.

The removal of debris and sediment carried by the floodwater from summer flash floods and deposited in the streets, on lawns, and in buildings and basements are important items of sediment damages. In addition, annually recurring problems of handling and disposing of gravel and sand at irrigation and power diversions and in the stream channels through Alpine, Lehi, and American Fork are causing an increase in operation and maintenance costs. Irrigation and power diversions must be flushed several times a day during snowmelt runoff to get rid of gravel; the task of moving gravel accumulations in the channel below the diversions is getting bigger each year. Water losses incident to the periodic flushing of gravel through the diversions are sizeable. Further, gravel passing through the irrigation diversions moves down to clog other diversions or to fill the channels through the towns. This causes continual expense in keeping the channels open or reduces the capacity so that overflow onto streets or into yards and basements occurs with greater frequency.

Crop production losses are brought about through periodic blocking of the diversions by flood debris and sediment. The August, 1951, flood brought about crop losses of over $15,000 in the vicinity of Alpine and Lehi when the Dry Creek diversion was blocked for 10 days by flood debris and sediment. The movement of sediment into canals and ditches and onto the land is an item of increasing expense. This is an especially important problem in canals diverting irrigation water from Dry Creek, and, to a lesser degree, in American Fork Creek. Other items are costs of clearing

roads and trails, removing sediment from camp grounds and picnic areas, annual cleaning of channels through Lehi, Alpine, and American Fork, and clearing other restricted points in the channels. Sediment has also had a detrimental effect on the fish habitat in the streams of the watershed.

Floodwater Damage

Floodwater damage included in the damage base involves those items where the damage has been the result of direct contact by water. Scour in streets and roads, undermining of sidewalks, foundations, and retaining walls, destruction of bridges, damage to crops and gardens, inundation damage in basements to appliances, heating units, walls, painted surfaces, food, fixtures, floor covering, furniture,and miscellaneous articles and supplies are items of floodwater damage. Cost of pumping floodwater from basements is also included. Repair expense due to settlement of backfill of sewer, water, and gas lines is also assigned to floodwater damage.

Erosion Damage

Erosion damage is serious in many parts of the upper watershed. Badly gullied areas are concentrated in the Mary Ellen, Major Evans, Dry Fork, Mineral Basin, and Deer Creek areas of American Fork Canyon. Smaller spots lie near the head of Tank and Swinging Bridge Canyon. Erosion is severe in the area around Box Elder Peak, which drains into both American Fork and Dry Creek, and in the heads of Grove Creek and Battle Creek. In addition to the offsite effects of erosion, there has been a steady decline in grazing capacity of the land in recent years. The wild life habitat has also been adversely effected. No monetary evaluation of erosion damage has been made.

Indirect Damage

Indirect damages are those damages which are not the direct result of contact by floodwater and sediment but which arise in association with floodwater and sediment. Such damages include the rerouting of traffic and the interruption to business and local activities during the clean-up period. Interruptions to travel are an important indirect item in this watershed. Dry Creek, American Fork Creek, Grove Creek, and Battle Creek all intercept U. S. Highway #89-91 and both interstate and local traffic make heavy use of this road.

Problems Relating to Agricultural Water Management

The principal problems of water management center around the conservation of available irrigation water supplies. Problems in this category include (1) on-farm conservation of water, (2) canal seepage losses, (3) seasonal distribution of irrigation supplies, (4) drainage problems, (5) diurnal fluctuation of streams during snowmelt flow, and (6) operation and maintenance problems from sediment moving into the canal system.

The items of on-farm water conservation, seasonal distribution of streamflow and canal seepage losses are the most important of the problems listed. Measures aimed at raising farm irrigation efficiencies, the storage of snowmelt flow for late season use and the reduction of seepage losses from

canals offer the chief opportunities for improvement. Farm irrigation efficiencies are generally low with an average seasonal range of from 25% to 40%. In eight out of ten years, twenty-nine percent of the lands served by American Fork and Dry Creek have an inadequate supply of late season water. In two years out of ten, the deficiency is even greater.

The gravelly soils of the alluvial valley fills contribute to high canal losses. In one half mile section, the measured water loss was seven cubic feet per second out of twenty. In another three-fourths mile canal, the loss was five cubic feet per second, out of twenty-five. The combined effects of canal seepage losses, ditch bank vegetation, and leaky headgates impair the efficient delivery of irrigation water to the users. It is calculated that the loss of water from canal and ditch seepage ranges from 16% to 23% of volumes carried.

Water loss from the network of canals and water loss from deep percolation on irrigated lands results in a drainage problem at lower levels. Thus, one of the major practical solutions to the drainage problem lies in reducing seepage losses from canals and ditches along with improvement of on-the-farm irrigation efficiencies.

Diurnal fluctuations of some of the streams of the watershed during snowmelt periods reduces farm irrigation efficiencies and complicates the equitable distribution of available flow. Dry Creek shows wide differences between day and night flow. American Fork Creek has a more stable flow but diurnal fluctuation has some adverse effect on the management of water diverted into the canal system.

The effect of sediment movement at diversion points and throughout the irrigation system has been discussed in a previous paragraph.

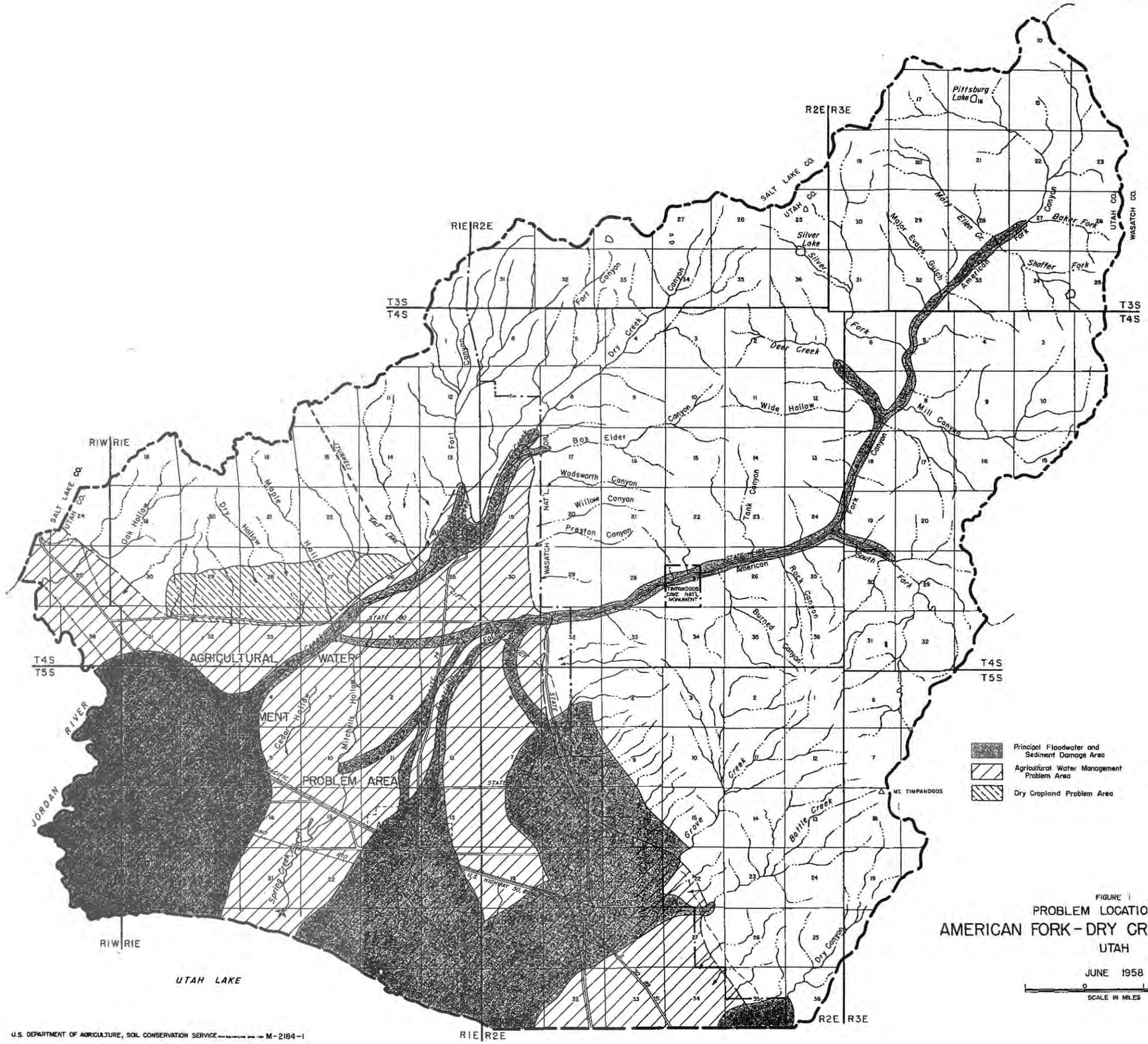


FIGURE 1

PROBLEM LOCATION MAP

AMERICAN FORK - DRY CREEK WATERSHED

UTAH

JUNE 1958

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE M-2184-1

7-R-19395-N

EXISTING OR PROPOSED WORKS OF IMPROVEMENT

Management programs are in existence for all land and water resources within the watershed. Private lands are included in the regular conservation programs of the Alpine Soil Conservation District and Agricultural Conservation Program Service. Publicly owned National Forest, National Monument, Federal Range, and State of Utah lands are managed under legal authorities applying to them. Accomplishments under these programs in the past 10 years are summarized in Table 1a. The Utah State Fish and Game Department and the U. S. Fish and Wild Life Service have management programs for the wild life resources. The Utah State Department of Forestry and Fire Control participates in forestry and fire control on private and state lands.

The Bureau of Reclamation Deer Creek project furnishes some water to the area through the Provo Reservoir Canal and the Salt Lake Aqueduct. These facilities will be protected from flood hazards by the works of improvement to be installed under the watershed project. The Bureau of Reclamation is currently planning the Central Utah Project which, when constructed, will furnish supplementary water to areas within the watershed. The irrigation storage facilities proposed in this plan will not serve any areas currently scheduled to receive supplemental water under the proposed Central Utah Project.

WORKS OF IMPROVEMENT TO BE INSTALLED

The works of improvement to be installed constitute an effective and feasible combination of land treatment and structural measures needed to stabilize and improve watershed resources. The works of improvement will reduce damages from recurring floods, improve irrigation water management, reduce water loss, provide additional water for late season use, reduce operation and maintenance costs on irrigation systems, and insure the economic stability of the agricultural enterprise. These measures are summarized in Table 1.

Land Treatment Measures

The land treatment measures to be installed include only those measures that have measurable effect in reducing runoff and erosion, will bring about more efficient use of the improved water supply resulting from the proposed structural measures for agricultural water management, and provide for the use of the land within its capabilities. In addition, the land treatment measures will provide significant returns to the land owners or operators. These measures include those to be installed under going federal, state, and local programs and measures needed to accelerate the going programs.

The measures planned will accomplish these objectives through the improvement of plant cover, augmented by mechanical treatment of the critical floodwater and sediment source areas, and by more efficient control of irrigation water on the irrigated crop land.

The full effect of the upstream land treatment measures in reducing summer flood peaks and sediment yield from critical areas will not be realized immediately. Structural measures are required to store and retard

floodwater sediment during and subsequent to the installation period.

The downstream land treatment measures will have a substantial effect in reducing irrigation water deficiencies. Structural measures will further reduce these deficiencies by increasing the water supply by storage, reducing losses from seepage and non-beneficial use by riparian vegetation, and regulation of streamflow for better utilization of the water supply.

Land Treatment Measures for Watershed Protection

These measures are an important part of this plan. Those to be installed on range land include proper use, stockwater developments, seeding, contour furrowing, fencing, and pitting. These will reduce sediment yields and flood peaks, increase the efficiency of the land treatment measures for flood prevention, and increase forage production. After the land treatment measures have become effective, livestock and big game use of the area will be managed to insure continued stabilization of the critical areas. Road and trail construction and maintenance, logging operations, recreation, and other land uses will be planned and coordinated with soil and water management needs.

Measures to be installed on dry cropland include stubble mulching, grassed waterways, across-slope farming, and fall tillage. These will reduce erosion and increase crop production.

Measures to be installed on irrigated cropland include improved water management, land leveling, drainage, canal lining (on-farm), and minor structures. They are an acceleration of the going program of the Alpine Soil Conservation District. They will provide for better use of the land and water resource.

Acceleration of conservation planning and application is feasible within the project period both on private and federally owned lands. Costs and quantities of measures to be installed for watershed protection are listed on Table 1. Cost of technical assistance for the installation of the accelerated portion of the land treatment program on non-federal lands, estimated to be $166,840, and the total cost of the accelerated portion of the program on National Forest and Federal Range lands, estimated to be $51,260, will be borne from P. L. 566 funds. Cost of technical assistance for the installation of going program measures on non-federal lands, estimated to be $123,100, will be borne from regular appropriations of the Soil Conservation Service. Total installation cost of the going program measures, on National Forest lands, including technical assistance, estimated to be $75,200, will be borne from regular appropriations of the Forest Service. Installation costs other than technical assistance on non-federal lands, estimated to be $1,248,450, will be from other funds.

Land Treatment Measures for Flood Prevention

The measures planned for installation on the critical floodwater and sediment source areas will reduce sediment production and summer flood peaks, chiefly through the improvement of plant cover but also through the installation of mechanical treatment such as special purpose terraces, gully control, drop spillways at headcuts, and road and trail erosion control. Practices such

as increased fire protection, tree planting, and contour furrowing will assist in the revegetation of the area. Increased fire protection will be secured by the purchase and operation of additional fire control equipment such as pumper trucks, hand tool outfits, tanks, etc. Quantities of land treatment measures for flood prevention are listed in Table 1.

The cost of installing these measures is estimated to be $279,760. Cost from P.L. 566 funds will be $262,360; from other funds $17,400. Cost of these measures on federal lands is $227,320.

Structural Measures for Flood Prevention

Four debris basins will be installed, on Dry Creek, Grove Creek, Battle Creek, and American Fork Creek. These structures will be earth-fill dams, at locations shown on Figure 2. Each structure will be provided with a principal spillway and a reinforced concrete emergency spillway. All principal and emergency spillways will discharge into existing channels. Borrow areas will be graded to prevent dead storage.

Principal features of the structures are shown on the Preliminary Plans, and capacities, sizes, areas, and other details on Table 3.

Each debris basin will have capacity for the expected sediment accumulation for the next 50 years, and floodwater retarding capacity to reduce summer flood peaks. It will be provided with an ungated principal spillway with ported riser to drain the basin after summer floods and pass ordinary streamflows. Summer flood peaks of 100-year frequency size will be reduced from 360 cfs to 100 cfs by the Dry Creek basin, from 1500 cfs to 206 cfs by the Tibble Fork basin, from 655 cfs to 32 cfs by the Grove Creek basin, and from 411 cfs to 32 cfs by the Battle Creek basin. The debris basins will have little or no effect in reducing snowmelt flood peaks. The Dry Creek debris basin will incidentally reduce the differential between day and night flows during parts of the snowmelt runoff period.

The estimated total installation cost of these measures is $786,895. Distribution of costs for each structure is shown in Table 2. Approximately 70% of the critical sediment and floodwater source areas will be upstream from these structures.

Structural Measures for Agricultural Water Management

These measures will increase irrigation efficiency, reduce water losses and erosion of ditches, and provide additional water for late season use. They are that part of the going conservation plans of the irrigation companies that will be accelerated to complement the land treatment and flood prevention phases of this plan.

Silver Lake Flat Irrigation Reservoir. This structure will be located on Silver Fork, a tributary of American Fork Creek, approximately 4-1/2 miles above Tibble Fork debris basin. It will store water for late season use on lands served by the Lehi, American Fork, and Pleasant Grove Irrigation Companies. Principal features of the structure are shown on the Preliminary Plans, figures 16 and 17, and capacities, etc. on Table 3.

Estimated installation cost is $462,230. Share from P.L. 566 funds is $205,690; from other funds $256,540. See Table 2 for distribution of costs.

The Lehi, Pleasant Grove, and American Fork Irrigation Companies have an approved right to develop water storage at this site.

Other Irrigation Measures. The Lehi Irrigation Company will install 49,600 lined feet of concrete canal lining, on the First North, Second North, Field, Gess Gurney, Fox, Buchanan, Smith, Cedar Hollow, Upper South Club, New Survey, and Fort Canyon Cutoff canals. These canals have capacities varying from 8 to 70 cfs. The lining will be Portland cement concrete, with a bottom width of 12 inches, 30 inches, or 48 inches depending on the quantity of water to be handled. Thickness of the lining will be 2-1/2 inches. The lining is designed for installation by slipform machines. Cost of this work, including technical assistance and contract administration, is estimated to be $155,000.

The American Fork Irrigation Company will install 39,730 lineal feet of concrete lining on the McArthur, Cemetery, West Fields, Mitchell, East, Mitchell Main, Wagstaff, and Mott canals. These canals have capacities varying from 15 to 90 cfs. Lining will be of the type described for the Lehi Irrigation Company canals. Total cost of the lining is estimated to be $126,235. Two concrete drop spillways will be installed on the Mitchell Main canal and at the West Division, at a cost of $3,750; and two desilting basins, approximately 10 acre feet capacity each, on the Mitchell Main canal at a cost of $3,750. Total cost on this irrigation system is estimated to be $133,735.

The Pleasant Grove Irrigation Company will install 76,556 lineal feet of concrete lining on the Meredith, Gardner, Mill, Center, Bishop, Jorgensen, 80-Rod, and Main canals. These canals have capacities varying from 8 to 20 cfs. Lining will be of the type described for the Lehi Irrigation Company canals. Total cost of the lining is estimated to be $181,205. Seven Thousand nine hundred twenty lineal feet of pipe line, with a capacity of 15 cfs, will be installed in Battle Creek to bring irrigation water from Big Spring to existing facilities of the irrigation company at the mouth of the canyon. This pipe line will be 14-inch steel pipe. Total cost of the pipe line is estimated at $44,550. Total cost on the Pleasant Grove Irrigation Company system is estimated to be $225,755.

The Alpine Irrigation Company will install 8,700 lineal feet of concrete canal lining on the Chipman Creek--Alpine, and Fort Canyon--Hog Hollow canals. These canals have capacities of 18 cfs and 20 cfs respectively. Lining will be of the type described for the Lehi Irrigation Company canals. Total cost is estimated at $26,185. A 6-inch concrete pipe line to carry 1 cfs from Box Elder Creek to Grove Spring, 4,000 lineal feet, will be installed at a total cost of $6,250. A reinforced concrete diversion dam on Dry Creek will be constructed at a total cost of $3,125. Eight overnight storage ponds with small earth fill dams will be installed at a total cost of $27,500. Three and one-tenth miles of new ditch with capacities of 8 to 10 cfs will be constructed at a total cost of $20,000. Total cost on this system is estimated to be $83,060.

These measures are to be installed on existing company-owned rights-of-way. Total installation cost of the measures for agricultural water management

is estimated to be $1,059,780, shown in Table 1 and 2. Federal share is $471,600, non-federal share is $588,180. Locations are shown in Figure 2.

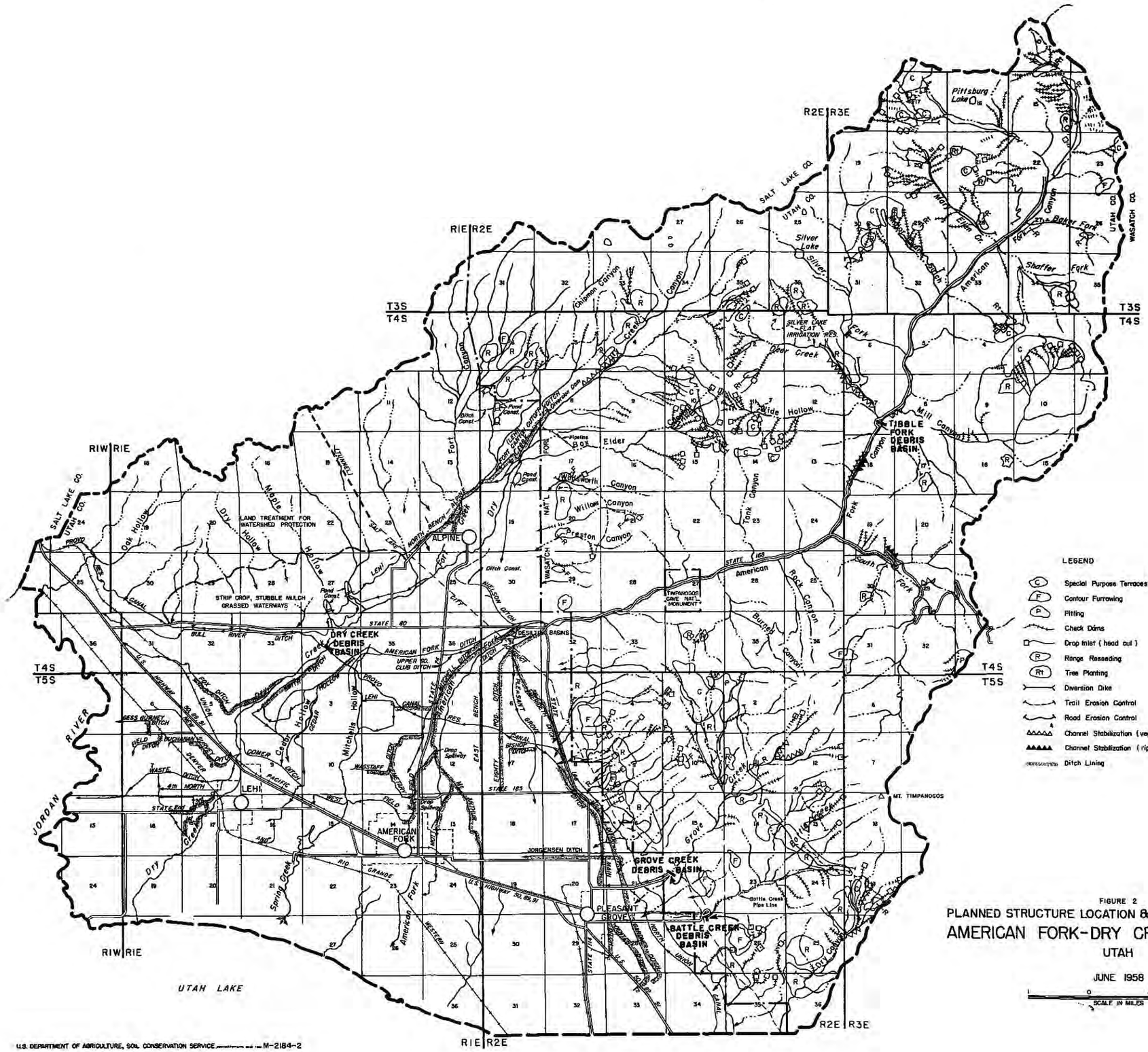


FIGURE 2
PLANNED STRUCTURE LOCATION & LAND TREATMENT MAP
AMERICAN FORK-DRY CREEK WATERSHED
UTAH

JUNE 1958

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE M-2184-2

7-R-19396-N

TABLE 1 - ESTIMATED PROJECT INSTALLATION COSTS

Sheet 1 of 2

American Fork-Dry Creek Watershed, Utah

For Total

ITEMS (1)	UNIT (2)	NO. TO BE APPLIED Federal Land (3)	Non-Fed. Land (4)	Total (5)	ESTIMATED COST (DOLLARS) 1/ P.L. 566 FUNDS Federal Land (6)	Non-Fed. Land (7)	Total (8)	OTHER Federal Land (9)	Non-Fed. Land (10)	Total (11)	TOTAL (12)
LAND TREATMENT FOR											
Watershed Protection											
Soil Conservation Service											
Cross Slope Strip Cropping	acre		2,000	2,000					16,000	16,000	16,000
Stubble Mulching	acre		2,000	2,000					7,000	7,000	7,000
Fall Tillage	acre		2,000	2,000					5,000	5,000	5,000
Grassed Waterways	acre		20	20					800	800	800
Irrigation Structures	No.		9,000	9,000					135,000	135,000	135,000
Land Leveling	acre		6,000	6,000					390,000	390,000	390,000
Canal Lining	L.F.		300,000	300,000					450,000	450,000	450,000
Drainage	acre		1,500	1,500					187,500	187,500	187,500
Range Improvement											
Range Seeding	acre		2,490 2/	2,490					24,030	24,030	24,030
Pond Construction (Stockwater)	No.		18	18					3,150	3,150	3,150
Well Construction (Stockwater)	No.		1	1					2,400	2,400	2,400
Check Dams	No.		11	11					825	825	825
Stock Trails	mile		3.25	3.25					325	325	325
Fencing	mile		5.75	5.75					5,320	5,320	5,320
Deferred Grazing	AUM		820	820					4,100	4,100	4,100
Limited Use	acre		4,000	4,000					17,000 3/	17,000	17,000
Technical Assistance						166,840	166,840		123,100	123,100	289,940
SCS Subtotal						166,840	166,840		1,371,550	1,371,550	1,538,390
Forest Service											
Range Improvement											
Contour Furrowing	acre	38		38	2,105		2,105				2,105
Range Seeding	acre	1,903		1,903	21,295		21,295				21,295
Fencing	mile	12.75		12.75	14,120		14,120				14,120
Tree Planting	acre	45		45	2,490		2,490				2,490
Access Road Construction					6,520		6,520	10,000		10,000	16,520
Fire Control Measures								12,000		12,000	12,000
Resource Management								53,200		53,200	53,200
Maintenance (Installation Period)					1,925		1,925				1,925
FS Subtotal					48,455		48,455	75,200		75,200	123,655
Bureau of Land Management											
Range Improvement											
Range Seeding	acre	80		80	705		705				705
Fencing	mile	1.5		1.5	2,100		2,100				2,100
BLM Subtotal					2,805		2,805				2,805
Subtotal - Watershed Protection					51,260	166,840	218,100	75,200	1,371,550	1,446,750	1,664,850
Flood Prevention 4/											
Soil Conservation Service											
Stabilization of Critical Areas											
Special Purpose Terraces	acre		195	195		11,190	11,190		4,800	4,800	15,990
Contour Furrowing	acre		17	17		425	425		425	425	850
Gully Control	mile		16	16		10,700	10,700		4,580	4,580	15,280
Range Seeding	acre		35	35		175	175		175	175	350
Drop Spillway Construction (Headcut)	No.		12	12		600	600		600	600	1,200
Road Erosion Control	mile		5.25	5.25		265	265		265	265	530
Technical Assistance						5,130	5,130				5,130
SCS Subtotal						28,485	28,485		10,845	10,845	39,330
Forest Service											
Stabilization of Critical Areas											
Special Purpose Terraces	acre	879		879	80,860		80,860				80,860
Contour Furrowing	acre	187		187	9,455		9,455				9,455
Pitting	acre	160		160	8,330		8,330				8,330
Gully Control	mile	47.5		47.5	50,275		50,275				50,275
Seeding	acre	708		708	7,840		7,840				7,840
Drop Spillway Construction (Headcut)	No.	95		95	10,530		10,530				10,530
Trail Erosion Control	mile	28		28	1,750		1,750				1,750
Road Erosion Control	mile	31.75		31.75	5,760		5,760				5,760
Channel Stabilization (vegetative)	L.F.	33,000		33,000	1,040		1,040				1,040
Channel Stabilization (riprap)	L.F.	2,200		2,200	12,980		12,980				12,980
Access Road Construction					29,725		29,725				29,725
Fire Control Equipment						6,555	6,555		6,555	6,555	13,110
Maintenance (Installation Period)					8,775		8,775				8,775
FS Subtotal					227,320	6,555	233,875		6,555	6,555	240,430
Subtotal - Flood Prevention					227,320	35,040	262,360		17,400	17,400	279,760
TOTAL LAND TREATMENT					278,580	201,880	480,460	75,200	1,388,950	1,464,150	1,944,610

1/ Price Base 1958

Date: November 1958

2/ Includes 925 acres plowed and seeded at $12.00 per acre, 800 acres broadcast seeding at $6.60 per acre, and 765 acres broadcast seeding (in American Fork Canyon) at $10.00 per acre.

3/ Assistance to operators on mining claims in American Fork Canyon by sponsors.

4/ Cost sharing based on ACP rates.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COSTS

Sheet 2 of 2

American Fork-Dry Creek Watershed

For Total

ITEMS (1)	UNIT (2)	NO. TO BE APPLIED Federal Land (3)	Non-Fed. Land (4)	Total (5)	ESTIMATED COST (DOLLARS) 1/ P.L. 566 FUNDS Federal Land (6)	Non-Fed. Land (7)	Total (8)	OTHER Federal Land (9)	Non-Fed. Land (10)	Total (11)	TOTAL (12)
Brought Forward - TOTAL LAND TREATMENT					278,580	201,880	480,460	75,200	1,388,950	1,464,150	1,944,610
STRUCTURAL MEASURES											
Soil Conservation Service											
Debris Basins	No.	1	3	4	156,935	419,700	576,635				576,635
Irrigation Storage Reservoir	No.	1		1	101,645		101,645	254,540		254,540	356,185
Canal Lining	L.F.		174,586	~~176,586~~ 4		139,260	139,260		251,640	251,640	390,900
Drop Spillway Construction	No.		2	2		1,070	1,070		1,930	1,930	3,000
Desilting Basins	No.		2	2		1,070	1,070		1,930	1,930	3,000
Pipe Lines	L.F.		11,920	11,920		14,475	14,475		26,165	26,165	40,640
Diversion Dam	No.		1	1		890	890		1,610	1,610	2,500
Pond Construction	No.		8	8		7,835	7,835		14,165	14,165	22,000
Ditch Construction	mile		3.1	3.1		5,700	5,700		10,300	10,300	16,000
SCS Subtotal					258,580	590,000	848,580	254,540	307,740	562,280	1,410,860
Subtotal - Construction					258,580	590,000	848,580	254,540	307,740	562,280	1,410,860
Installation Services											
Soil Conservation Service											
Engineering Services					97,430	136,895	234,325				234,325
Other					45,850	68,640	114,490				114,490
SCS, Subtotal					143,280	205,535	348,815				348,815
Subtotal - Installation Services					143,280	205,535	348,815				348,815
Other Costs											
Lands, Easements, and Rights-of-way								25,000	32,100	57,100	57,100
Administration of Contracts								3,000	26,900	29,900	29,900
Subtotal - Other								28,000	59,000	87,000	87,000
TOTAL STRUCTURAL MEASURES					401,860	795,535	1,197,395	282,540	366,740	649,280	1,846,675
TOTAL PROJECT					680,440	997,415	1,677,855	357,740	1,755,690	2,113,430	3,791,285
SUMMARY											
Subtotal SCS					401,860	990,860	1,392,720	282,540	1,749,135	2,031,675	3,424,395
Subtotal FS					275,775	6,555	282,330	75,200	6,555	81,755	364,085
Subtotal BLM					2,805		2,805				2,805
TOTAL PROJECT					680,440	997,415	1,677,855	357,740	1,755,690	2,113,430	3,791,285

1/ Price Base 1958

Date: November 1958

BENEFITS FROM WORKS OF IMPROVEMENT

Physical Effects

The structural and land treatment measures proposed in this plan will have significant physical effects on water and soil resources of the watershed. In the upper watershed, the land treatment measures will (1) reduce sediment yield and surface runoff from principal sediment and flood source areas, (2) reduce sheet and gully erosion and accelerate the revegetation of eroded and gullied areas, (3) bring about a general overall improvement of the vegetal cover of the upper watershed, (4) provide an effective means of suppressing forest or brush fires and for reducing the extent of damage from such fires, (5) decrease the discharge of sediment and debris into the main channels; and, (6) generally improve the area for recreation, grazing, or other use.

In the lower watershed and along the major channels, the land treatment and structural measures will (1) decrease the magnitude of summer flash flood flows in the main channels and reduce the frequency of overbank flooding, (2) reduce the task of maintaining adequate channel capacities through American Fork and Lehi, (3) decrease the quantity of sediment which must be handled through irrigation and power diversions or in canals and ditches, (4) reduce the frequency by which floods damage roads, bridges, culverts, railroads, or diversions; and (5) minimize indirect damages which result from interruptions to travel, to commercial activity, or to irrigation.

The major structures, particularly those on Dry Creek and American Fork Creek, will also have the effect of smoothing diurnal fluctuations in streamflow during periods of snowmelt runoff, and permit increased efficiency in the use of irrigation water during this period.

The maximum efficient utilization of the land and water resources in the irrigated portion of the watershed will be facilitated by the combination of agricultural water management measures and on-farm land treatment measures installed under this plan. Further, the full accomplishment of the benefits calculated for this group of measures is based on the interdependent effect of the various measures and calls for the establishment of all of the measures during the ten year installation period.

On-farm measures included in this plan will improve irrigation efficiencies so that the gross irrigation needs of crops will be reduced. This will have the immediate effect of insuring the greatest possible benefits from the added available mid-season water developed through lining, piping, and storage. In the long run, it will also effectively add to the mid and late season water supply on the remaining short supply lands by virtue of the reduced gross volume of irrigation water required for full production.

The lining of canals and ditches will have the effect of adding to the full season irrigation water supply but, more important, it will add to the critical mid-season supply. Further, lining will also reduce the accretion of seepage water to the water table in poorly drained areas below the canals. The piping of springs into the main irrigation canals will have essentially the same effect as lining.

The storage of irrigation water for mid-season use is an essential factor

in achieving a stabilized full season supply for a maximum acreage of irrigated crop land. The development of a full season supply for the greatest possible acreage has an important influence on the successful application of improved on-farm irrigation management measures and on other improved farm management measures. The maximum productive effect of fertilizer, for instance, cannot be realized without a full water supply.

Floodwater and Sediment Damage Reduction Benefits

The benefits outlined below include reductions in floodwater and sediment damages from summer floods and reductions in sediment damages from snowmelt floods. No reduction in damages from snowmelt floodwaters is claimed, and these damages are not included in the damage base.

Combined monetary benefits of $52,835 from floodwater and sediment damage reductions throughout the entire watershed amount to 48% of all benefits claimed for the project. The combination of land treatment and structural measures for flood prevention will bring about damage reductions of 88% on Dry Creek, 77% on American Fork Creek, and 89% in the Timpanogos Face area. Initial reductions in 100-year flood peaks (within the installation period) affected by land treatment measures for flood prevention will range from 6% to 25% in the various treatment areas of the watershed. When the land treatment becomes fully effective (30-40 years hence) reductions of up to 75% in flood peaks will be attained in some of the treatment areas. Reduction in sediment rates will range from 40% to 50% in the lower reaches of the three major segments of the watershed, and reductions of sheet erosion--principally in the upper watershed--will range from 55% to 70%.

The downward trend in the production of range forage in the upper watershed will be arrested and a small increase in available forage will be attained when deteriorated range sites have been fully revegetated.

The nature and magnitude of benefits from the project are shown in Table 7.

Agricultural Water Management Benefits

The primary monetary benefits, $56,150, from agricultural water management measures comprise 52% of all primary benefits. Additional secondary benefits, stemming from the increased value of agricultural production will accrue and are set forth in Table 7.

One of the principal benefits of the agricultural water management measures will be the effective increase in the irrigation water supply brought about by the on-farm treatment and the irrigation system improvements. It is calculated that 4,093 acres of land with a present partial supply of irrigation water will be raised to a full supply position with project measures installed. This increase will be principally accomplished by the conservation of water from lining and by the increased irrigation efficiencies brought about by the on-farm measures. Water storage in Silver Lake Flat Reservoir will also make a significant contribution to this improvement.

With all agricultural water management measures in full effect, the acres of irrigated land in the entire watershed with a full supply will be increased by 35%. With a full supply, the increased acreage will be

shifted to higher net return crops which will more nearly fill the needs of a growing local population.

An additional, but unevaluated benefit will come from an effective increase in the "early" (May - June) water supply. This water has value, but has not been considered in this analysis.

Recreational Benefits - Unevaluated

The overall effect of project measures on recreational activity will have a number of aspects. (1) Water impounded in Silver Lake Flat Reservoir will produce a habitat for fish and a place for boating, swimming, and camping. (2) The reduction in runoff and sediment production from present flood source areas and the protection from floods afforded by the debris basins will also improve fish habitat and will allow for maximum use of the suitable picnic and summer home sites along the channels. (3) The overall improvement of the vegetal cover through land treatment measures will improve big game habitat and generally enhance the value of the mountainous portion of the watershed for recreation use. These benefits have not been evaluated monetarily, but it is felt that these values must be given full recognition.

COMPARISON OF BENEFITS AND COSTS

Flood Prevention Measures

Total annual benefits from all project measures will be $108,985 and annual cost of installing these measures will be $80,550. The benefit-cost ratio is 1.4 to 1. Unit comparisons of benefit and cost are set forth in Table 8.

ACCOMPLISHING THE PLAN

The execution of this plan will be a joint undertaking of private, local, State, and Federal interests. Non-federal interests include individual farmers and ranchers, the towns of Lehi, Alpine, American Fork, and Pleasant Grove, the Lehi Irrigation Company, Alpine Irrigation Company, American Fork Irrigation Company, Pleasant Grove Irrigation Company, Alpine Soil Conservation District, Utah County, Utah State Fish and Game Department, Utah State Road Commission, Utah State Land Board, Utah State Department of Forestry and Fire Control, State and County Agricultural Stabilization and Conservation Committees, and the North Utah County Water Conservancy District, now being formed by the sponsoring organizations of the watershed project under appropriate laws of the State of Utah. The Water Conservancy District will be a sponsor of this project upon completion of the legal formation of the District. Federal agencies involved in the project include the Soil Conservation Service, Forest Service, Bureau of Land Management, and National Park Service. Cost sharing arrangements between federal and non-federal interests are matters of mutual agreement and are set forth in detail in Tables 1 and 9.

Responsibilities for Installation

In order to carry out a coordinated acceleration of the land treatment measures with structural measures for flood prevention and agricultural water management and the going conservation programs within the watershed, close cooperation and specific responsibilities are required of private interests, the sponsors, and local, state, and federal agencies assisting in this project.

The Alpine Soil Conservation District will:

1. Provide local leadership and direction which will continue the going conservation program of the District at the rate existing prior to the development of this work plan.

2. Provide local leadership to insure the scheduled installation of the accelerated land treatment measures for watershed protection and flood prevention on private lands.

The North Utah County Water Conservancy District will:

1. Negotiate agreements with owners and operators for installation of land treatment measures for flood prevention on the non-federal lands in upper American Fork Canyon, install the measures, and assume the non-federal share of the cost of installation of these measures.

2. Furnish funds necessary to assist livestock operators on the private lands in upper American Fork Canyon to relocate elsewhere, to assure limited use of the area.

The District plans to use the loan provisions of the Act and has asked for a loan in the amount of $27,845 to carry out these responsibilities.

3. Survey, acquire, and record all necessary lands, easements, and rights-of-way for the Tibble Fork, Dry Creek, Battle Creek, and Grove Creek debris basins. The Conservancy District will secure a special use permit from the Forest Service for the Tibble Fork structure.

4. Act as the contracting local organization for the construction of the Dry Creek, Tibble Fork, Grove Creek, and Battle Creek debris basins.

5. Assume the cost of relocating pipe lines at the Grove Creek and Battle Creek debris basins and the power line at the Battle Creek debris basin.

The District will use the loan provisions available under the Act, as amended, to cover the costs allocated to it as above. A loan has been asked for in the amount of $36,100.

6. Act as the contracting local organization for the construction of the Silver Lake Flat Reservoir and assume the non-federal share of the construction cost. The Conservancy District will secure a special use permit from the Forest Service for the structure. Funds will be provided through use of the loan provisions of the Act. A loan has been asked for in the amount of $256,540.

The loans described above will be repaid from funds available to the District through its taxing authority.

Pleasant Grove, American Fork, Alpine, and Lehi Irrigation Companies will:

1. Assist the Alpine Soil Conservation District to accelerate the land treatment program for watershed protection on irrigated lands by helping in education and information activities designed to stimulate private farm operators and owners.

2. The Pleasant Grove Irrigation Company will act as contracting local organization and will furnish funds for costs allocated to them for the installation of the measures proposed for their system. Funds will be provided through use of the loan provisions of the Act, as amended. A loan will be asked for in the amount of $125,295. The loan will be repaid from funds obtained from annual assessments of stockholders.

3. The American Fork Irrigation Company will act as contracting local organization and will furnish funds for costs allocated to them for the installation of the measures proposed for their system. Funds will be provided through use of the loan provisions of the Act, as amended. A loan will be asked for in the amount of $74,220. The loan will be repaid from funds obtained from annual assessment of stockholders.

4. The Alpine Irrigation Company will act as contracting local organization for the installation of the measures proposed for their system. Funds will be furnished jointly by the Alpine Irrigation Company and the North Utah County Water Conservancy District, and provided through use of the loan provisions of the Act, as amended. A loan will be asked for in the amount of $46,100. The loan will be repaid from funds available to the District through its taxing authority and from assessments of stockholders of the irrigation company.

5. The Lehi Irrigation Company will act as contracting local organization and will furnish funds for costs allocated to them for the installation of the measures proposed for their system. Funds will be provided through use of the loan provisions of the Act, as amended. A loan will be asked for in the amount of $86,025. The loan will be repaid from funds obtained from annual assessment of stockholders.

The measures in items 2, 3, 4, and 5 will be installed on existing rights-of-way of the companies.

All of these companies have developed a conservation plan with the Alpine Soil Conservation District for their systems.

The Soil Conservation Service will:

1. Furnish necessary technical assistance through the Alpine Soil Conservation District to private land owners in installing land treatment measures scheduled for non-federal lands.

2. Allot monies for the federal share of the installation of land treatment measures for flood prevention on the non-federal lands in upper American Fork Canyon, in accordance with the cost sharing and time schedule set forth herein.

3. Furnish the necessary installation services for engineering surveys, designs, construction plans and specifications, and construction supervision for the structural measures for flood prevention and for agricultural water management.

4. Allot construction money to the project in accordance with the cost sharing and time schedule set forth herein or as revised by mutual agreement and in accordance with national priorities and availability of appropriations at the time of installation.

5. Maintain liaison with sponsor, state, and federal agencies involved in the project to the end that unified effort and coordinated action will produce the most effective results. Consult with and assist the sponsoring organizations, and local, state, and federal agencies in making desirable revisions on the plan if and when circumstances dictate.

The Forest Service will:

1. Carry out the land treatment measures on National Forest lands in accordance with the program outlined in Table 1.

2. Adjust grazing and other uses on National Forest land to facilitate the installation of the planned works of improvement.

3. Furnish technical assistance in planning and application of practices under its departmental responsibility for technical adequacy for woodland planning. This will be done in cooperation with the State Department of Forestry and Fire Control.

4. Review and approve plans and specifications for the Tibble Fork debris basin and the Silver Lake Flat reservoir, both to be constructed on National Forest lands; issue special use permits for the structures, borrow areas, construction camp, and other necessary land occupancy; inspect the construction of all structures and land occupancy in accordance with the stipulations of the special use permits; issue a timber sale contract or permit for the timber to be removed from the structure sites; and survey and design the new section of the American Fork-Snake Creek road around the Tibble Fork debris basin, and the new Tibble Fork summer home spur road.

5. Maintain close liaison with sponsors, individual permittees, and local, state, and federal agencies involved in the project and assist in necessary revisions of the work plan.

The Bureau of Land Management will:

1. Carry out the land treatment measures on the Federal Range lands in accordance with the program outlined in Table 1.

2. Enter into formal non-use agreements, when needed, with the permittees affected by this plan. Upon termination of these agreements, grazing use will be based on annual utilization checks.

3. Maintain close liaison with sponsors, individual permittees, and local, state, and federal agencies involved in the project and assist in necessary revisions of the work plan.

The National Park Service will:

Continue to administer the lands within the Timpanogos Cave National Monument for maximum watershed effectiveness. No measures are proposed for installation under authority of P.L. 566.

Utah County will:

Assume responsibility for relocation of American Fork-Snake Creek road and the summer home spur at the Tibble Fork debris basin as necessary.

The Sponsoring Organizations concerned have given the Service adequate assurance that their share of project costs allocated to them will be available at the time and in the amounts required.

The following State agencies, by agreement with the Sponsors, will participate as shown:

The Utah Fish and Game Department will:

1. Recommend as needed to the Board of Big Game Control game management programs which will bring about and maintain herd size in balance with proper use of game forage.

2. Maintain the 5 browse utilization transects which are set up along the deer winter range of this herd unit. Additional range surveys, deer pellet group counts, and other management information will also be collected and expanded. Utilization and trend studies will be continued on the two acre big game-livestock enclosure established by the Forest Service and the Department.

3. Cooperate with local, state, and federal agencies in making range and vegetative surveys,utilization checks, or other studies involving forage utilization and maintenance.

4. Take such measures on the Department-owned land within the watershed as are necessary to insure and maintain proper range management and watershed conditions.

5. Participate to the maximum extent feasible in establishing a sports fishery in the Silver Lake Flat Reservoir and suitable streams.

6. Maintain close liaison with sponsors and federal agencies involved on the project and assist in appropriate revisions of the work plan as necessary.

The chief objective in big game management on the American Fork-Dry Creek Watershed is to manage the deer herd consistent with the carrying capacity of the winter range. This involves areas outside the watershed as well. The chief objective in fisheries management on the watershed is to provide the maximum amount of sports fishing. The above committments are made with the view to making the maximum possible contributions to the solution of the American Fork-Dry Creek Watershed flood problem and to promote a program of range rehabilitation and improved sports fishing in the watershed.

The Utah State Land Board will:

Participate with permittees and the Alpine Soil Conservation District in the proper management of the grazing resources on the 160 acres of State Land Board land in the area.

The Utah State Department of Forestry and Fire Control will:

Assume the non-federal share of the cost of fire control equipment.

The Utah Water and Power Board will:

To the extent permitted by State law, availability of funds, and Utah Water and Power Board regulations, make financial assistance available to the irrigation companies for installation of works of improvement.

The Utah Agricultural Extension Service will:

Give high priority in carrying out an effective education and information program in cooperation with the sponsors of this project.

The Utah State Road Commission will:

Assume responsibility for any work found necessary in future years on State Highway #80 at the Dry Creek retarding structure.

The Agricultural Stabilization and Conservation Committees, State and County, will:

Give high priority to scheduling ACP funds to expedite the land treatment on private and state lands.

Schedules for Installation

The installation of accelerated land treatment measures for watershed protection and flood prevention which have measurable effects in flood prevention will begin during the first year of the program and be completed during a five-year installation period. Treatment and adjustments in use will be scheduled in accordance with the schedule for the installation of the mechanical and structural measures. The effect on normal farm and ranch operations was considered in developing the schedules for installation and will be considered in any adjustments in schedules during the installation period.

The installation of the accelerated land treatment measures for watershed protection which have a measurable effect in reducing irrigation water losses and will bring about greater efficiencies in water use on the farm will begin in the first year of the project and be completed during a ten-year installation period. The systematic installation of the on-farm measures concurrently with the structural agricultural water management measures is essential to the successful application of the provisions of this plan. Accordingly, the scheduled assistance for the installation of structural agricultural water management measures will depend on substantial year by year progress in the installation of the on-farm measures.

The going conservation programs of the Alpine Soil Conservation District and federal and state agencies cooperating in this project are an integral part of this plan and will continue at least at the same rate that existed prior to the development of the watershed work plan.

The installation of the structural program for flood prevention is scheduled concurrently with or after the installation of the required land treatment above the structures. The installation of the structural measures for agricultural water management is scheduled concurrently with the installation of the on-farm irrigation measures, the improvements on the irrigation companies' systems, and the Silver Lake Flat Reservoir. The proposed schedule is as follows:

First year - Install the Battle Creek and Grove Creek debris basins; do the core drilling on the Dry Creek debris basin and Silver Lake Flat Reservoir. Install 8,700 lineal feet of ditch lining on the Lehi Irrigation Company system, 11,000 lineal feet of lining and one drop spillway on the American Fork Irrigation Company system, 7,920 lineal feet of pipe line in Battle Creek and 26,924 lineal feet of lining on the Pleasant Grove Irrigation Company system, and 4,000 lineal feet of pipe line, 4,700 lineal feet of lining, and a diversion on the Alpine system.

Second year - Construct the Dry Creek debris basin. Install 9,700 lineal feet of lining on the Lehi Irrigation Company system, 3,300 lineal feet of lining, one drop spillway, and two desilting basins on the American Fork Irrigation Company system, 23,760 lineal feet of lining on the Pleasant Grove Irrigation Company system, and construct one pond and 8,000 lineal feet of ditch on the Alpine Irrigation Company system.

Third year - Construct the Silver Lake Flat Reservoir. Install 10,500 lineal feet of lining on the Lehi Irrigation Company system, 6,950 lineal feet of lining on the American Fork Irrigation system, 8,448 lineal feet of lining on the Pleasant Grove Irrigation system, and 4,000 lineal feet of lining and one pond on the Alpine Irrigation system.

Fourth year - Construct the Tibble Fork debris basin. Install 5,000 lineal feet of lining on the Lehi Irrigation Company system, 8,300 lineal feet of lining on the American Fork Irrigation system, 17,424 lineal feet of lining on the Pleasant Grove Irrigation Company system, and 4 ponds on the Alpine Irrigation Company system.

Fifth year - Install 15,700 lineal feet of lining on the Lehi Irrigation Company system, 10,180 lineal feet of lining on the American Fork Irrigation Company system, and two ponds on the Alpine Irrigation Company system.

Schedule for Expenditure of Funds

Estimated expenditure of funds by years is as follows:

	P.L. 566 funds	Other	Total
First year	560,470	309,355	869,825
Second year	337,320	234,240	571,560
Third year	302,530	481,245	783,775
Fourth year	306,765	254,310	561,075
Fifth year	109,880	258,730	368,610
Sixth year	19,130	161,210	180,340
Seventh year	13,110	130,710	143,820
Eighth year	10,660	102,210	112,870
Ninth year	9,980	91,460	101,440
Tenth year	8,010	89,960	97,970
Total	1,677,855	2,113,430	3,791,285

Federal assistance for carrying out the works of improvement on non-federal land and the federal funds for installing the works of improvement on federal land, as described in this work plan, will be provided under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress; 68 Stat. 666), as amended by the Act of August 7, 1956, (Public Law 1018, 84th Congress; 70 Stat. 1088).

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Land treatment measures for flood prevention installed on the private lands in upper American Fork Canyon will be operated and maintained by the North Utah County Water Conservancy District, under agreements with the land owners.

Other land treatment measures installed on non-federal lands will be operated and maintained by the landowner or operator in accordance with cooperative agreements between the owners and the Alpine Soil Conservation District.

Fire control equipment to be acquired as part of this project will be stationed at Alpine, American Fork, and Pleasant Grove. The equipment will be operated by the community fire departments at these locations, under existing agreements between the communities, Utah County, and the State of Utah, Department of Forestry and Fire Control, which specify the areas of use and fix the sharing of costs. Cost of maintenance of the equipment will be shared by Utah County and the State of Utah under the same agreements.

Land treatment measures on federally-owned land will be operated and maintained after the period of installation by the agency administering such land from regular funds. Maintenance during the period of installation will be from project funds as shown in Table 1.

Structural Measures

The North Utah County Water Conservancy District will maintain the Silver Lake Flat Reservoir, using funds available to the District through its taxing authority. The Lehi, American Fork, and Pleasant Grove Irrigation Companies will jointly operate the structure as an irrigation storage reservoir, releasing the stored water to augment natural streamflow during mid season and late season irrigation period, under existing agreements for joint operation of the irrigation facilities on American Fork Creek. Total annual operation and maintenance cost of the structure is estimated at $1,000

The North Utah County Water Conservancy District will operate and maintain the Dry Creek, Tibble Fork, Grove Creek, and Battle Creek debris basins, using funds available to it through its taxing authority. Total annual operation and maintenance cost of the structures is estimated at $2,600.

The respective irrigation companies will operate and maintain the agricultural water management measures installed on their system, using funds available from assessment of stockholders.

Inspections of all works of improvement will be made at least annually and after all floods, by representatives of the Alpine Soil Conservation District, Soil Conservation Service, and the sponsoring organizations responsible for operation and maintenance. The responsible organizations will perform the maintenance work as needed.

Specific operation and maintenance agreements between the sponsoring local organizations and the Service covering all phases of operation and maintenance will be executed prior to making funds available to local organizations for the installation of the works of improvement.

COST SHARING

Project costs estimated at $3,791,285 will be shared as follows:

P.L. 566 Funds	$1,677,855	(44%)
Other Funds	$2,113,430	(56%)

The following costs will be borne by P.L. 566 funds:

1. Accelerating technical assistance for installation of land treatment measures on federal and non-federal land, $199,185.

2. Accelerating application of land treatment measures on federal land, $251,365.

3. The cost-sharing assistance that will be available for application of land treatment measures for flood prevention on non-federal land, $29,910. Sharing of costs is based on rates currently authorized under other programs. Cost-sharing on fire suppression equipment is based on Clark-McNary equivalents.

4. Installation services for installation of structural measures for flood prevention, $149,160.

5. Installation services for installing structural measures for agricultural water management, $199,655.

6. All construction costs of the four debris basins, single purpose structural measures for flood prevention, $576,635.

7. The cost sharing assistance that will be available for sharing of the construction cost of the structural measures for agricultural water management to be installed on the irrigation companies' systems (canal lining, etc.), $170,300, or 35.6% of the total construction cost.

8. The cost sharing assistance that will be available for sharing of the construction cost of the Silver Lake Flat Reservoir, $101,645, or 28.6% of the total construction cost.

Cost sharing in items 7 and 8 is based on P.L. 566 funds bearing that part of the installation cost which is allocated to other than direct identifiable benefits, limited to 44½% of the installation cost. The installation cost includes construction cost, installation services, contract administration, and lands, easements, and rights-of-way.

The following costs will be borne from other funds:

1. The cost of application of land treatment measures for watershed protection on non-federal lands, $1,248,450.

2. The cost of technical assistance for existing programs for land treatment for watershed protection on non-federal lands, $123,100.

3. The installation cost of land treatment measures for watershed protection on federal lands, under existing programs, $75,200.

4. The non-federal share of the cost of applying land treatment measures for flood prevention on non-federal lands, $17,400, or 33% of the total cost, $52,440, of these measures.

5. The non-federal share of construction costs in the Silver Lake Flat Reservoir, $254,540, or 71.4% of the total construction cost.

6. The non-federal share of the construction costs of the structural measures for agricultural water management to be installed on the irrigation companies' systems, $307,740, or 64.4% of the total construction cost.

7. The cost of lands, easements, and rights-of-way, and for relocating existing facilities for structural measures, $57,100.

8. The cost of administering contracts for project installation, $29,900.

CONFORMANCE OF PLAN TO FEDERAL LAWS AND REGULATIONS

The American Fork-Dry Creek Watershed Project is not in conflict with any proposed developments of the area. Existing and proposed projects of the Bureau of Reclamation will be complemented and protected by the measures to be installed under this plan.

There will be no new land brought into the production of crops as a result of work done under this plan.

WATERSHED WORK PLAN

AMERICAN FORK-DRY CREEK WATERSHED

SECTION 2

INVESTIGATIONS AND ANALYSES

SUPPORTING TABLES AND FIGURES

SECTION 2

INVESTIGATIONS AND ANALYSES

PROJECT FORMULATION

Guiding principles followed in formulation of the project have been to accomplish the objectives of the sponsoring organizations with maximum net benefits. These objectives are watershed protection and flood prevention, increased productivity of range, increased productivity of cropland, increased irrigation water supply, and reduction in soil erosion. Many alternatives have been compared, involving kinds of measures, types and locations of structures, and levels of protection. Within the limits of SCS standards, the selections have been made that gave the maximum net benefits without regard to relative federal and non-federal costs.

Needed land treatment measures for protection of the watershed grazing lands, and for the full utilization of the benefits accruing to the farm lands from other measures in the plan, were determined from analysis of the needs and capabilities of the lands. Technical assistance will be furnished from project funds to accelerate the going program to meet these objectives.

Needed land treatment measures for stabilization of critical floodwater and sediment source areas which contribute directly to flood prevention were determined and evaluated. The hydrologic, sedimentation, and economic investigations provided data on the effects of these measures in terms of the reduction in damages. Although significant benefits result from application of these needed land treatment measures, other flood prevention measures were required to attain the degree of flood protection and sediment damage reduction desired.

Land Treatment Measures

Watershed Protection. Accelerated land treatment for watershed protection in the flood source area was based upon the combination of practices for each range site and/or condition class and soil group that is expected to yield material offsite benefits by reducing flood flows and erosion. Deferred grazing on National Forest lands is not included as a measure in this plan, as it is part of the existing management program of the Forest Service.

Accelerated land treatment in the irrigated area was limited to those measures which will bring about the maximum efficient use of the improved water supply resulting from the proposed agricultural water management measures. Greatest benefits will be realized from the acceleration of technical assistance to assist farmers in applying their water in accordance with crop requirements and soil characteristics. Supplemental measures such as land leveling, drainage, and canal lining, on individual farms, will be accelerated to the extent necessary to apply irrigation water efficiently in the areas served by the proposed agricultural water management measures. Going programs of the Alpine Soil Conservation District will be accelerated about 130%.

Flood Prevention. Land treatment for flood prevention is limited to critical flood and sediment source areas and benefits are primarily offsite. This treatment generally consists of special purpose terraces, reseeding with grass,

gully stabilization, and increased fire protection. Terracing is needed to stabilize the site so that vegetation can be established. Gully stabilization consists of drop inlets where they are headcutting, bank stabilization by vegetation and rock riprap, and check dams. This treatment is within areas of Class VIII capability and on range sites in poor and very poor range condition.

Feasibility and expected improvements were determined from range sites. Rate of improvement and needed intensity were determined both from range site and range condition.

Structural Measures

Structural measures considered for flood prevention included control by debris basins in each of the principal subwatersheds. All probable sites for structures were investigated, together with possible variations in design features and functions. Sufficient analyses were made to determine that the proposal presented herein is the most practical combination of structural measures to accomplish the flood prevention objectives.

This work plan includes those structural measures for agricultural water management which give the maximum water conservation benefits and need to be accelerated to increase irrigation efficiencies. These measures were based on long range conservation plans that the several irrigation companies had previously developed in cooperation with the Alpine Soil Conservation District.

INVENTORY OF SOIL CONDITION AND PLANT COVER

Range Sites

Range sites and range condition class determinations were based upon existing information and from field examinations by the SCS and the Forest Service.

The term "range site" is used to describe an area which has the potential ability to produce a definite kind and amount of vegetation. The forage producing potential of a specific range site is determined by the climate, soils, topography, precipitation, elevation, and other environmental factors.

The range sites have been classified into range condition classes. Range condition is the present state of the vegetation on the site as compared to the vegetation which would prevail under climax conditions. The factors used to determine range condition classes are: (1) Plant composition, (2) Vegetative density, (3) Plant litter and residue, and (4) Amount of soil erosion.

The following range sites and range consition classes are found in the watershed. Locations are shown on the range site and range condition class map, Figure 3.

A. Range Sites

1. Foothill (Upper) Site

This site is found at the lower elevations of the range portion of the watershed area. Elevation is generally from 5,000 to 5,500 feet. Precipitation usually averages from 12 to 16 inches annually. This site covers the less steep areas of the range lands in the watershed and includes benches, lake-formed terraces, and alluvial fans. The water holding capacity of the soils is limited and permeability is moderate to rapid.

Most of this site is in poor and very poor range condition class. Because of the relative position in the watershed and rapidly permeable soil, this range site contributes small amounts of runoff to flood flows during intense storms.

2. Intermediate Mountain Site (Browse and Parks)

This range site generally occupies a middle elevation on benches, ridges, and basins. The site occurs generally from 5,500 to 7,500 feet elevation--on south exposures it may be found up to 8,500 feet elevation. Annual precipitation ranges from 16 to 30 inches.

Soils are variable and range from shallow to deep and from sandy loam to clay loams in texture. Soils are moderately permeable to rapidly permeable, depending on the nature of the parent material.

Most of this site is in poor and very poor range condition class; a small amount is in fair range condition class. Areas of poor and very poor condition class contribute a large amount of floodwater runoff during intense storms. In the areas of dense oak with a heavy litter cover, runoff does not occur. However, in the openings between the oak thickets, runoff does take place.

3. Shallow Stony Hills Site

This range site is found adjacent to the intermediate mountain site and the high mountain site and includes stony ridges and canyon slopes. Elevations range from 6,000 to 8,500 feet and precipitation from 18 to 30 inches annually. Slopes are steep to very steep.

Soils are shallow and underlain by bedrock. Rocky ledges and out-croppings are common. Soils are generally medium textured and permeability is from moderately rapid to rapid.

The potential forage production on this site is limited more than on adjacent range sites because of the shallow soils. The site is now in fair and poor range condition class.

Areas in poor range condition class where cover density and plant litter are low produce runoff during high intensity rainstorms.

4. High Mountain Site (Aspen and Park)

This site constitutes most of the watershed from elevations of 7,000 to 11,000 feet. North exposures are not common to this site. Annual precipitation varies from 18 to 40 inches. Topography varies from gentle slopes in the aspen and parks to very steep on the canyon sides.

Most of this range site is now in poor and very poor range condition class. Areas in poor and very poor range condition class, especially the open weedy areas, contribute a large amount of floodwater runoff from storms of high intensity.

B. Non-Grazing Sites

1. Inaccessible Sites (Class VIII)

This area is comprised of rocky faces, which are scattered over much of the watershed and at all elevations. They consist of rock out-crops on moderate to precipitous slopes. Talus slopes commonly occur at the base of these rock faces. Scattered areas of shrubs and trees are found in most of the area, even on the steepest slopes. Elevation varies from 5,500 to 11,500 feet.

This land has little commercial value but is very important from a watershed standpoint.

2. High Mountain Timber Sites

These areas are usually found on north and northwest facing slopes. Elevation varies from 6,500 to 11,000 feet.

This site does not materially contribute to floods because of the high absorbing capacity of the soil mantle. However, depleted slopes above the timber have created gullies through the timber in some instances.

Soils

The valley area of the watershed includes most of the land in capability classes I, II, III, and IV, and a fringe of wetland in class VI around Utah Lake. Most of the irrigated lands are composed of classes II and III. Capability class II also includes the 4,260 acres of dryland.

Class IV soils include steep, shallow or deep gravelly soils on 6-10% slopes and deep and shallow wetlands of 1% slopes.

The mountain area is a composite of classes VI, VII and VIII. Class VI includes mountain soils with slopes of from 10% to 30%. Class VII land has slopes of from 30% to 60% and Class VIII steep base rock areas or rock materials over bedrock.

Most of the soils are medium textured and are moderately permeable. The wetlands are generally finer textured and more slowly permeable. The benchlands and terrace slopes around the perimeter of the valley are dominated by gravelly soils. Mountain soils are a composite of medium textured, moderately to rapidly permeable soils.

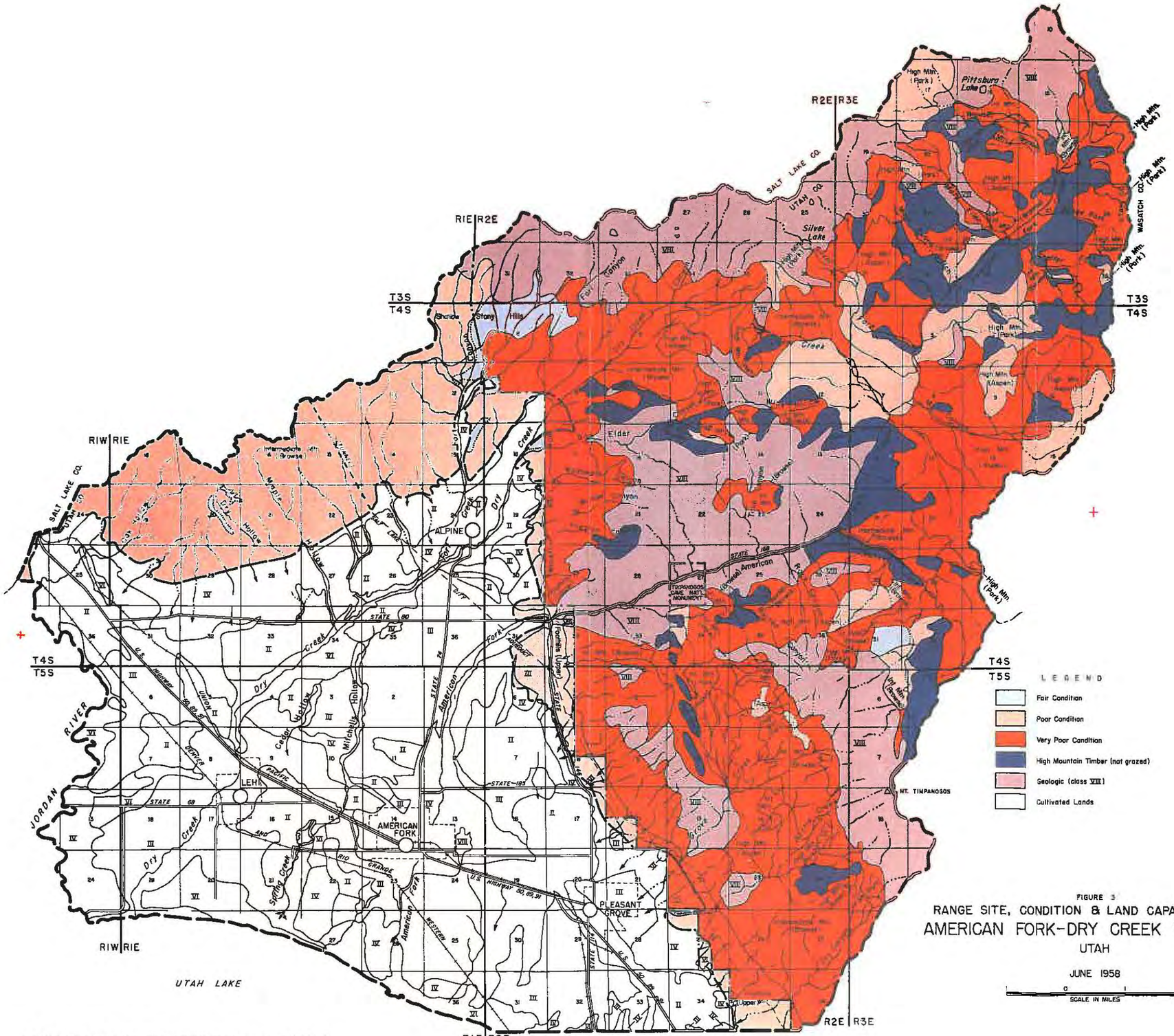


FIGURE 3

RANGE SITE, CONDITION & LAND CAPABILITY MAP

AMERICAN FORK-DRY CREEK WATERSHED

UTAH

JUNE 1958

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE M-2184-3

7-S-19397-N

HYDROLOGY

Historical records show that the most damaging floods along the valley reaches of the main streams are caused by the summer convective-type thunderstorms. These larger summer storms, while occurring infrequently, cause the major proportion of all downstream flood damages.

Local thunderstorms also cause flooding on one or more of the headwater tributaries virtually every summer. These local floods often develop into mud-rock flows which load the main channels with sediment and debris. This is the source of much of the sediment which is moved downstream during subsequent snowmelt flows.

Hydrologic investigations were required to furnish data for calculation of average annual damages and average annual benefits resulting from the various combinations of land treatment and structural measures, and for use in the design of proposed structures. Determination of peak-frequency relationships at locations subject to flood damages were made for two separate conditions: (1) floodwater and sediment damages caused by summer rainstorms; and (2) sediment damages occurring during the annual spring snowmelt runoff.

Basic Data Available

Streamflow Records

Records are available from three U. S. Geological Survey gaging-stations in the watershed. The gage on American Fork Creek, located approximately 4 miles above the mouth of the canyon, is the only one now operating. Daily records are available since 1927. There are 8 years of record for Dry Creek and Fort Creek (1948-1955). A few scattered measurements are available for several other perennial streams in the watershed.

Precipitation Data

There are five Weather Bureau standard rain gaging stations within the watershed, located primarily in the valley, with lengths of record ranging from 11 to 45 years. Elevations of these stations range from 4,497 at Utah Lake-Lehi to 5,523 at Timpanogos Cave. Recording rain gages nearest the watershed are at Salt Lake City Airport, Silver-Lake-Brighton (elevation 8,700), and Provo. Five cooperative snow survey courses are maintained in the watershed by the Soil Conservation Service and the Utah State Engineer's Office. Mean annual precipitation ranges from 12 inches in the valley to 45 inches or more at elevations above 10,000 feet. Point rainfall amounts are available from Weather Bureau Technical Paper No. 28.

Local Flood Records and Reports

Local residents and irrigation companies were interviewed; newspaper files and official reports of the Forest Service, Weather Bureau, Geological Survey, and the National Park Service were available which gave information on damaging floods. A detailed study was available for the August 1951 flood on both American Fork and Dry Creeks, and for the July 1953 flood on American Fork Creek.

Local records of flooding date back to 1876. However, in recent years, the severity and frequency of damaging summer floods has increased on both Dry Creek and American Fork Creek. The August 3, 1951 flood on Dry Creek and the July 31, 1953 flood on American Fork Creek were the largest and most damaging floods on the respective streams within the memory of local residents, which covers a period in excess of 50 years. Each of these floods destroyed the respective stream gages. These floods were characterized by the movement of large quantities of debris and sediment, much of which was deposited and lodged in the main-stem stream channels. Figure 6 shows the hydrograph recorded at the American Fork Creek gage for the August 3, 1951 runoff. This was one of the largest summer floods recorded at the gage for the period of record (since 1927).

Watershed Hydrologic Condition Data

Results of infiltrometer and rainfall-runoff plot studies made by the Forest Service and Range Experiment Station, on similar watershed soil-cover types, were available for use in checking calculations.

Hydrologic Investigations

Summer Storm Floods:

Determination of Rainfall and Flood Frequencies. Weather Bureau Technical Paper No. 28 and local station precipitation data were used to determine depth-frequency relationships for short duration rains within the watershed. Figure 4 shows a rainfall-frequency curve representative of this watershed. Flood frequencies were based upon rainfall frequencies.

Development of Flood Volumes. All sub-areas of the watershed were classified by hydrologic condition as part of the plant-cover-soils survey made on National Forest land and the range site and condition survey made for private lands. Typical storm rainfall patterns, having a range of frequencies, were placed over different combinations of hydrologic sub-areas in order to determine the critical runoff-producing areas above each proposed structure site. Flood volumes originating from these areas were computed by methods given in Supplement A - Section 4, SCS National Engineering Handbook.

Development of Flood Hydrographs. Cross-sections of the channel and adjacent floodplain were made through each damage reach. Times of concentration, velocities, and bankfull capacities for the principal tributaries and main-stems were computed from field hydraulic data. Hydrographs were developed for all main tributaries using methods outlined in Supplement A - Section 4, SCS National Engineering Handbook.

Flood Routing and Peak-Frequency Relationships. Flood routings, using the storage indication method, were made through all damage reaches of the major streams. Peak-frequency relationships, for both present and future conditions with and without effects of land treatment and structural measures, were determined for those locations where major damageable values are concentrated.

Instantaneous peak-frequency curves for the sites of the proposed structures are shown on Figure 5. These curves are for the one-hour duration summer storm with the watershed in present condition.

Effect of Land Treatment Measures. Since high intensity, short duration summer rainstorms cause the majority of damaging floods, land treatment measures which will improve the infiltration capacity of the soil and decrease the volume of surface runoff will be effective in reducing peak flows and flood damages. Special purpose terraces (contour trenches) which are designed to contain the runoff from a 100-year rainstorm for the area treated, will have an immediate effect in reducing runoff. On those sub-areas where the proposed land treatment measures will have an immediate effect in reducing peak flows (within the 5-year installation period), reductions will range from 6% to 25%.

When all land treatment measures, including the expected improvement due to proper management, are fully effective, reductions in peak flows from the various sub-areas will range from a very slight effect up to about 75%. Improvement due to range-use adjustments and proper management may require periods of up to 40 years in some areas.

Spring Snowmelt Floods:

Local Flood Records. Snowmelt runoff does not usually produce damaging floods except in years of abnormal snowpack and/or high melting temperature sequences. Flooding is usually restricted to the low-gradient sections of the main streams through the valley, where channel capacities are low. Maximum snowmelt runoff for the period 1927-57 occurred in 1952, from all perennial streams in the watershed. Peak flows recorded in 1952 were: American Fork - 531 cfs; Dry Creek - 292 cfs; and Fort Creek - 134 cfs.

Snowmelt Runoff Characteristics. On American Fork Creek and Dry Creek, during the peak of the snowmelt runoff when daily mean discharges are quite high, the proposed structures will reduce peak flows only slightly. They will, however, trap practically all of the bed-load sediment. These two streams have pronounced fluctuations in flow (during the day) for most of the snowmelt season.

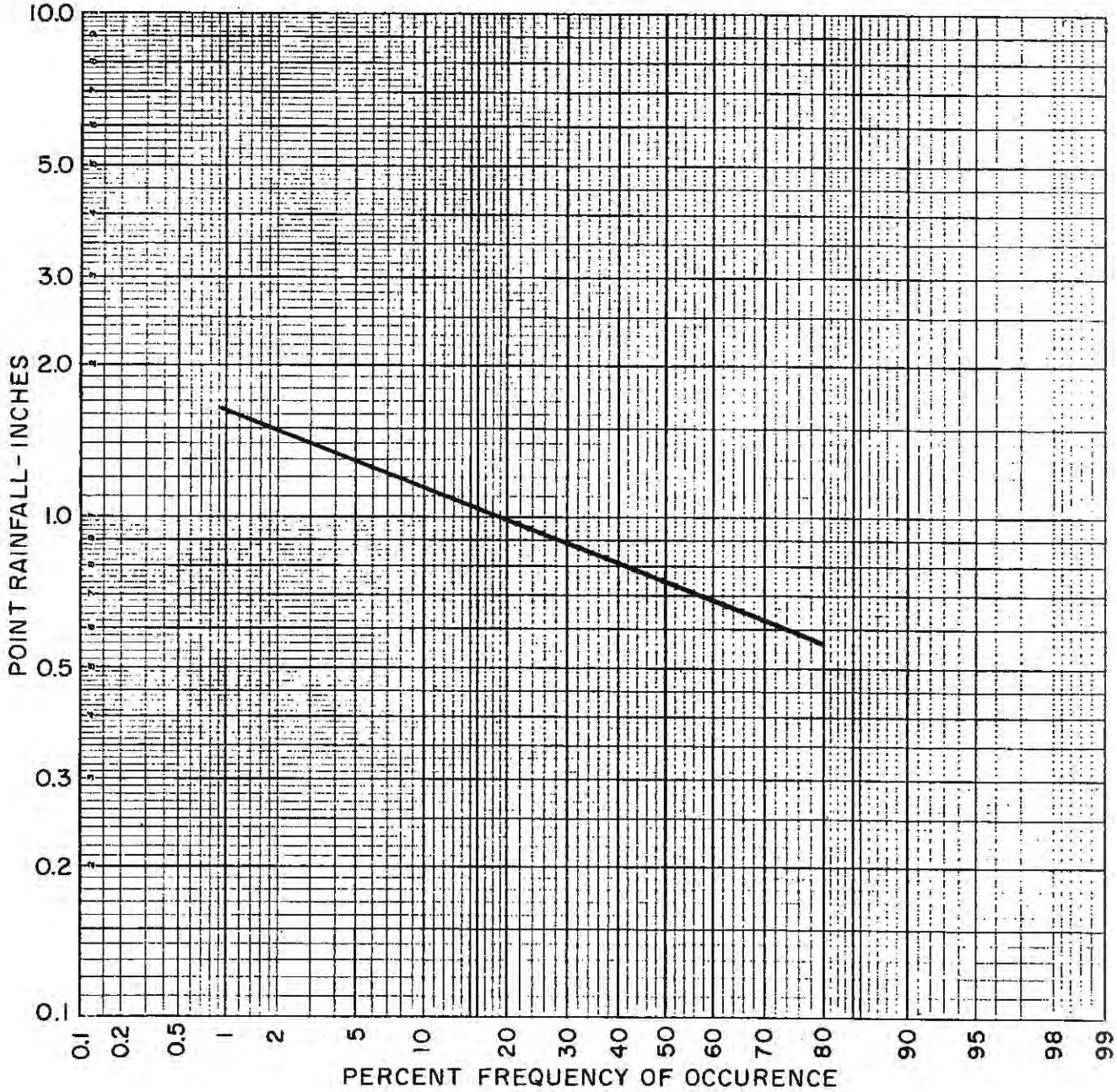


FIGURE 4: Point Rainfall – 1 hour duration

USDA-SCS-PORTLAND, OREG 1958 M-2184-15

7-L-19404

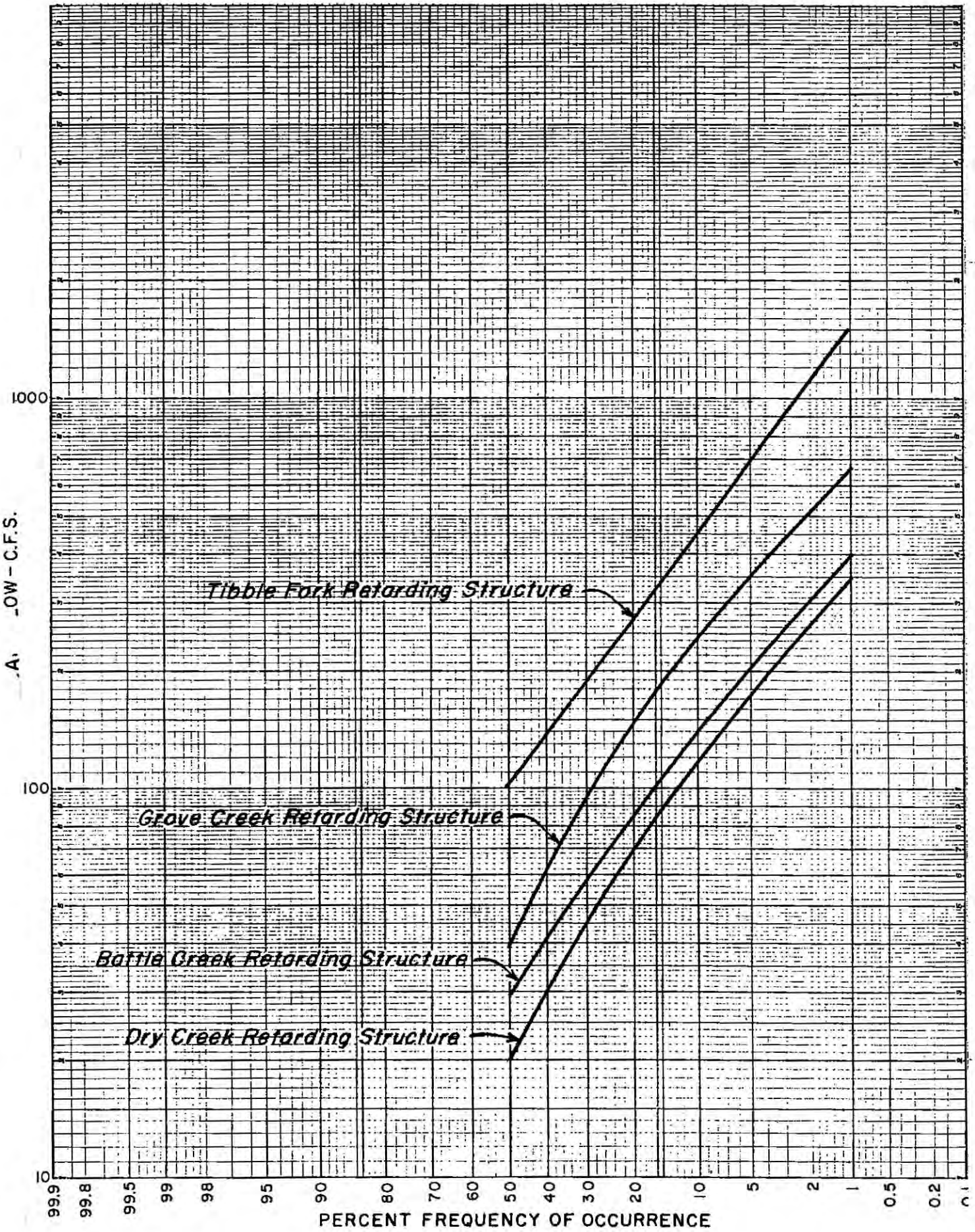


FIGURE 5. Summer flood peak - frequency curves.

USDA-SCS-PORTLAND, OREG. 1958 M-2184-16

7-L-19404

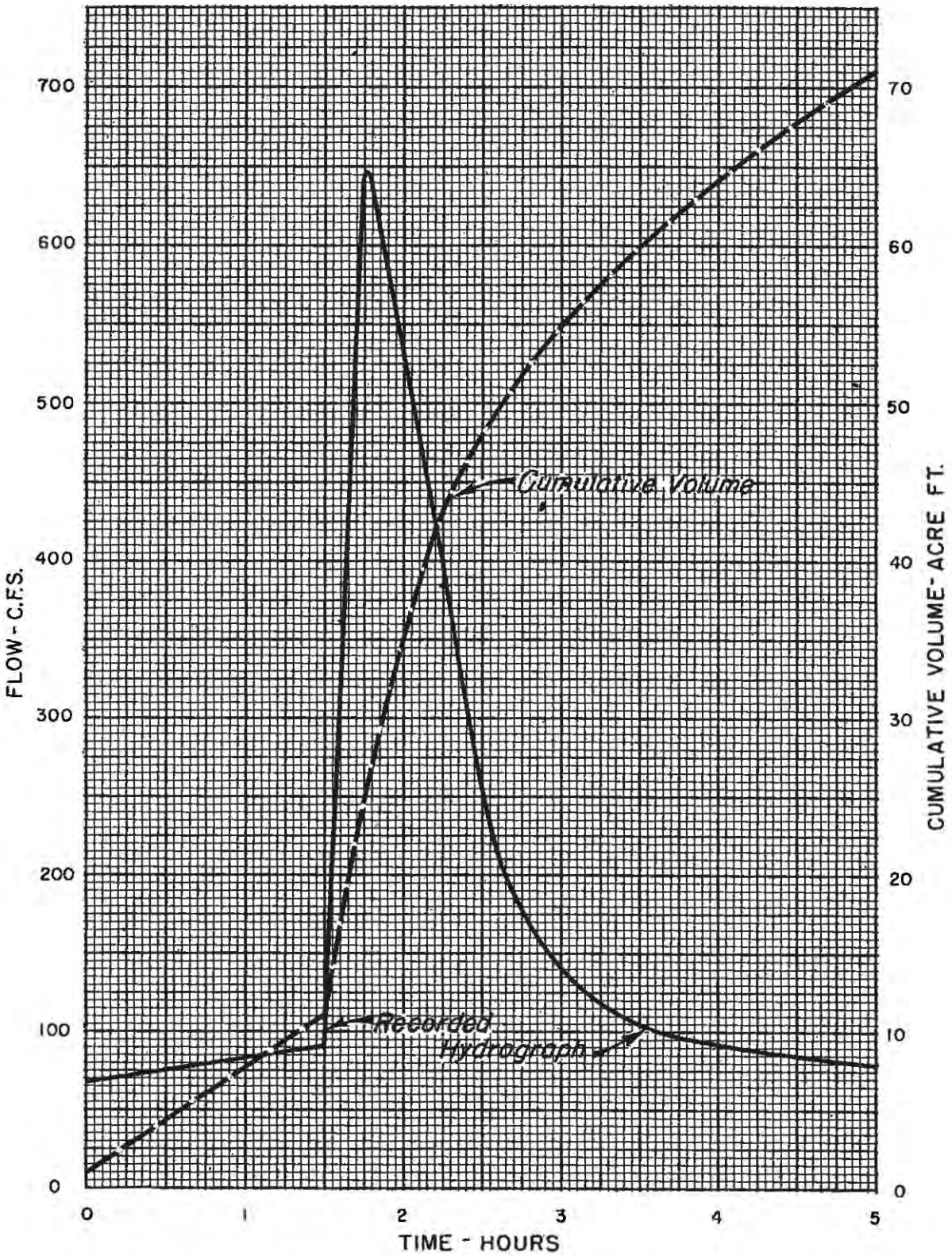


FIGURE 6: Typical summer flood hydrograph, flood of Aug. 3, 1951. American Fork, above upper power plant near American Fork, Utah. Drainage Area 55 Sq. mi.

GEOLOGY

Dry Creek Segment

General:

Granitic intrusive rocks are exposed throughout most of the north half of the mountainous upper watershed, but south of Dry Creek the surface consists of northward dipping, highly disturbed sedimentary* and metamorphic rock.** Mountain glaciation and stream erosion have developed Dry Creek valley in a fault zone bordering the granitic intrusion. The lower watershed, west of the Wasatch Front, has slopes ranging from steep to gently rolling. The slopes consist of interbedded clay, silt, sand, and gravel deposited as lake beds, terraces or alluvial fans depending upon the stage of former Lake Bonneville.

Dam Site Geology:

One debris basin approximately 620 feet long and 35 feet high is being planned in Dry Creek. The proposed dam has a highly pervious foundation which will require special consideration in the design of the structure.

The abutments to about the level of the maximum flood pool elevation are composed of silts and clays of the Alpine formation. The Alpine formation in the vicinity of the dam has an estimated maximum thickness of 50 feet, but its thickness varies considerably because it lies on an old land surface. The Alpine formation has a westerly dip of about one degree and disappears beneath the gravels of the Provo formation about one-half mile below the proposed dam.

Subsurface investigations were conducted at four locations in Dry Creek valley to locate the most suitable and feasible site. Test holes were dug with a backhoe and some were extended with an auger to a depth of 25 feet. Both disturbed and undisturbed samples were collected and sent to the soils laboratory for testing.

Borrow areas were sampled by means of backhoe pits and auger borings. It has been determined that sufficient suitable materials are available for the embankment and upstream blanket.

American Fork Segment

General:

Above 6,500 feet in elevation, American Fork Creek is U-shaped drainage with extensive glacial deposits. Below 6,500 feet, it is a V-shaped canyon cut in Paleozoic rocks.*** Downstream from the wall-like

*Limestone, dolomite, shale
**Quartzite
***Limestones, quartzites, shales, and dolomites

mountain front, American Fork Creek flows across previously formed lake delta deposits to Utah Lake.

Sedimentary rocks in the upper watershed have been greatly deformed and altered due to folding, faulting, and landslides. Thrust faulting in the vicinity of Deer Creek has left rock beds standing in near vertical positions and brought rocks of the Carboniferous period in contact with those of the Tertiary. Large scale landslides have occurred in the upper reaches of American Fork Creek between Mary Ellen and Major Evans Canyons. Recent small scale landslides are evident near the mouth of Silver Fork in glacial deposits.

Dam Sites:

Silver Lake Flat Reservoir Dam. The Silver Lake Flat structure is designed as a storage reservoir and will be approximately 68 feet high and 1,600 feet long. The proposed dam has a pervious foundation and abutments, and will require an upstream blanket to prevent piping beneath the embankment. Varved, clayey sand of volcanic origin is exposed in the creek bottom at the dam centerline. This deposit has been disturbed by faulting or slumping as it dips 15-20° SW. The abutments consist of glacial deposits to an unknown depth. Beneath the till in the West abutment are red conglomerate beds which strike N. 50° W. and dip 40° NE. Carboniferous limestones underlie the till in the east abutment with about the same attitude as the conglomerate.

Reconnaissance geologic studies were made to determine feasibility of the site. The dam site is believed to be satisfactory for the proposed structure. Before final detailed designs are completed, foundation investigations will be made to determine the subsurface conditions.

Tibble Fork Debris Basin. The proposed Tibble Fork dam will be approximately 450 feet long and 48 feet high. The proposed dam has a highly pervious foundation to a depth of over 60 feet and will require a zoned fill and an upstream blanket, to prevent piping in the embankment and foundation.

Red conglomerate is exposed in the left (east) abutment and is underlain by reworked volcanic ash and breccia. These volcanic materials are slightly bentonitic and only partially consolidated. Bedding planes strike N. 70-80° W. and dip 40-50° N.E. The right (west) abutment is composed of volcanic ash interbedded with colluvium or till. These deposits have been disturbed by slumping or local faulting.

Foundation conditions were determined by core drilling. Six holes were drilled along the center line of the dam to depths of 30 to 84 feet and one hole was drilled in the reservoir area. Denison samples were taken of the volcanic materials to determine their stability and bearing strength.

Borrow areas were tested by means of backhoe pits and it has been determined that adequate satisfactory material for the embankment is available. Material for the upstream blanket has been located above the west abutment.

Timpanogos Face Segment

General:

Battle Creek, Grove Creek, and Dry Canyon are short, steep drainages which originate in the west face of Mt. Timpanogos. Their channels cross geologic structure at right angles to the strike and terminate at the base of the Wasatch Mountains on large alluvial cones. The drainages have cut deep gulches in Carboniferous rocks,* and at the mountain front their alluvial fans are interbedded with lacustrine deposits laid down in Lake Bonneville.

The sedimentary rocks between American Fork Canyon and Dry Canyon are tilted eastward and have been broken by a series of north-south trending faults. Total displacement along these faults is about 7,000 feet.

Dam Sites:

Two debris basins approximately 36 feet high are planned for this segment. Geologic conditions are quite similar at the two sites as the foundations are of recent alluvium consisting mainly of coarse gravels. The Grove Creek structure will bond to lake deposits (silt and clay) in the south abutment and alluvium in the north abutment. The proposed Battle Creek dam will bond to alluvium in the south abutment and colluvium in the north abutment. Both dams will require zoned embankments to better utilize the coarse fill and provide for foundation drainage. Part of the Grove Creek basin will need blanketing to prevent piping in the foundation.

Grove Creek and Battle Creek sites were investigated with backhoe pits. Sufficient borrow is available at the sites, but some may have to be obtained above the spillway crest elevations. A lime hardpan of limited area exists in the upper central part of the proposed Grove Creek retarding basin and this will increase the cost of the embankment material to a certain extent.

SEDIMENTATION

Dry Creek Segment

Erosion rates are low in the Dry Creek segment except in Box Elder Canyon and some of the tributaries which originate on the north slope of Box Elder Peak. Principal sediment sources in order of importance are: (1) gullied, alluvial filled valleys; (2) bench lands, valley walls, and divides which are being dissected by rills and gullies; and (3) gullied Lake Bonneville terrace deposits. The primary sediment source area is approximately 10 square miles.

*Limestones, shales, quartzites, and sandstones

It appears that most of the sediment is delivered to the main stem by summer flash floods and that snowmelt flows are responsible for transporting it to the damage area. Box Elder drainage has little runoff from snowmelt, but it is situated so that Dry Creek can pick up a part of its yield and transport it on downstream. Much of the gravel depositing in the channel near Alpine comes from Box Elder Canyon. Most of the Fort Creek drainage is already in fair vegetative condition and, therefore, contributes minor amounts of damaging sediment.

American Fork Segment

In the American Fork Creek segment, about two-thirds of the sediment passing through American Fork Canyon comes from the North Fork. The majority of the other one-third originates in Tank and Swinging Bridge Canyons and from talus slopes along the main channel below the forks. Sediment rates for the whole watershed are generally moderate, but some of the tributaries have high rates. Principal sediment sources in order of importance are: (1) gullied, alluvial filled valleys; (2) valley walls and divides which are being dissected by gullies and rills; and (3) talus slopes which terminate in the main channel. The primary sediment source area is about 13 square miles.

Mining operations in the head of American Fork Canyon have caused considerable erosion in the past, but none of the mines are operating at the present time. Mine dumps and access roads will continue to be eroded by rills and gullies, and will contribute some sediment to American Fork Creek. Timber cutting and grazing are being controlled more now than in the past, and present erosion rates are probably much lower than those that once existed.

It appears that most of the sediment is delivered to the main stem by summer flash floods. The sediment is later picked up in the main channel by snowmelt flows and transported to the damage areas. Occasionally, summer flash floods transport considerable sediment beyond the canyon mouth, but this is an infrequent occurrence.

Timpanogos Face Segment

Erosion rates are generally moderate in the Timpanogos Face segment except in the upper reaches of the principal drainages. About 20 percent of the mountainous watershed is a geologic area with exposures of resistant bedrock. Principal sediment sources in order of importance are: (1) gullied, alluvial filled valleys; (2) talus slopes which extend into the main channel; and (3) valley walls and divides which are being dissected by rills and gullies. Most of the sediment comes from bare or denuded areas in Battle Creek, Grove Creek, and Dry Canyon. These areas cover about 7 square miles.

Most of the erosion and sediment yield results from summer flash floods. Grove Creek is the only drainage which has substantial sediment movement during snowmelt runoff.

Effect of Land Treatment on Erosion and Sediment Yields:

The following table shows expected reductions in erosion and sediment yields after land treatment is fully effective:

Segment	Reduction in Gully Erosion	Reduction in Sheet Erosion	Reduction in Sediment Yields
American Fork	30%	60%	40%
Dry Creek	40%	70%	50%
Timpanogos Face	40-50%	55%	45%

Reductions in channel and gully erosion are based on estimated reductions in flood flow peaks and volumes.

Reductions in sheet erosion are based on improved vegetative cover and the area of the watershed over which improvement is expected. Sheet erosion amounts to about 25 percent of the gross erosion.

Expected Channel Stability:

Channel erosion below the Dry Creek structure is expected to be active for a time, but after 5 or 10 years the channel will become stabilized. Observations made of channel deposits indicate that about five acre feet will be scoured from the channel below the proposed structure and 90% of this material will move into irrigation systems. When the channel becomes stable, only the fines passing through the spillways will move into irrigation facilities and onto the land.

Some channel erosion will occur below the Tibble Fork structure on American Fork Creek, but after 5 years the channel is expected to be stabilized. An estimated ten acre feet of sand and gravel will be scoured from the channel below the Tibble Fork structure and 50 percent of this amount is expected to move into the irrigation canals and ditches. Sediments derived from talus slopes along the main channel and from Tank and Swinging Bridge Canyons will account for most of the future sediment production below the proposed dam. These sediment sources cannot be eliminated because structure sites are not available. Damages caused by fine sediments passing through the spillways will be slight, as the fine sands, silts, and clays amount to only 15 or 20 percent of the total load. A portion of the fine sediment moves into Utah Lake.

Channel erosion below the Grove and Battle Creek structures will be slight.

Investigations and Analyses:

Sediment rates have been determined by the following methods: (1) measurement of channel and gully voids, (2) size analysis studies in channels, (3) measuring deposits in debris basins and on flood fans, (4) by transect measurements of eroding areas to obtain percentages of

the various sediment sizes, and (5) by suspended-load samples. Sheet erosion rates were estimated from infiltrometer studies conducted in neighboring drainages and from cover condition inventories of the watershed.

(1) Channel and gully void measurements:

Drainage or Unit	Area (Sq.Mi.)	*Voids (Ac.Ft.)
American Fork Segment:		
American Fork Creek above Tibble Fork Dam	35.5	772
N. Fork of American Fork Creek	39.0	795
S. Fork of American Fork Creek	6.3	68
American Fork Creek above the Canyon Mouth	64.0	1,167
Dry Creek Segment:		
Fort Creek	6.7	56
Dry Creek above Alpine	11.6	660
Box Elder Canyon	2.9	536
Dry Creek terrace by proposed Dam Site	1.4	276
Total above the dam site	39.4	1,500
Total voids in Dry Creek		1,528
Timpanogos Face Segment:		
Dry Canyon	3.0	96
Battle Creek	5.5	198
Grove Creek	6.5	140
Rondevu Hollow	1.1	10

*Voids are assumed to have developed in the last 100 years.

(2) Size Analysis studies:

Samples were taken in the Dry Creek channel in order to estimate the sediment yield at the damsite. It was determined that about 55 percent of the bed-load would deposit before reaching the dam. By noting deposits in the channels and localized flood plains, it was determined that about 70 percent of the bed-load material would reach the Tibble Fork site.

(3) Deposits in Debris Basins:

Drainage	Area (Sq.Mi.)	Date of Construction	Amount of Deposition (Ac.Ft.)	Est. Trap Efficiency %	Annual Sediment Rate (Ac.Ft./ Sq.Mi.)
Wide Hollow	1.54	1936	19.4	60	1.05

Following are the sediment storage requirements at proposed structures sites:

Name of Structure	Percent of yield expected to deposit above crest elev.	Est. Trap Efficiency %	50-year storage requirement (Ac. Ft.)
Silver Lake Flat Res.	25	95	24
Tibble Fork Debris Basin	30	80	166
Dry Creek Debris Basin	25	80	185
Battle Creek Debris Basin	25-30	75	35
Grove Creek Debris Basin	30	80	40

ENGINEERING

General Design of Debris Basins

Capacity

Sediment storage capacity in each of the four debris basins is provided to contain the estimated sediment accumulation at the site for the next 50 years. The sediment volume used is the sediment yield with all land treatment measures installed, with allowance for lag in effectiveness where appropriate. These measures will be installed prior to or concurrently with the structure.

Floodwater retarding capacity is based on discharge of the 100-year frequency summer rainstorm flood through the principal spillway. Flood hydrographs used are those expected after the installation of those land treatment measures which are immediately effective, such as special purpose terraces.

Principal Spillways. The principal spillway was designed to reduce summer flood peaks of up to and including the 100-year frequency occurrence to a size non-damaging downstream and to pass normal stream flows during the summer months. The principal spillway will be equipped with an ungated, ported, reinforced concrete riser to the height of the expected level of sediment deposition at the upstream face of the dam.

Emergency Spillway. Topographic conditions and unstable materials, or the fact that the spillway will operate frequently during spring snowmelt flows, dictate the use of lined spillways.

Reinforced concrete chute spillways were selected. Routing of the principal spillway hydrograph (100-year frequency rainstorm) determined the minimum elevation of the crest of the chute spillway.

The freeboard hydrograph, using 2.5 times the designated 6-hour rainfall and moisture condition II, determined the minimum capacity of the chute and also was the basis used to establish the elevation of the settled top of the dam. Limiting criteria for the capacity of the emergency spillway for this class (C) structure is in accordance with SCS Engineering Memo No. 3 (Rev. 2), and SCS National Engineering Handbook, Section 4. Minimum capacity of the SAF stilling basin is governed by the 100-year instantaneous snowmelt peak.

Several alternative designs were made for each debris basin to compare costs using different widths of spillway and types of inlet. The design selected, using a chute spillway with a box inlet as shown in the Preliminary Plans, is the one giving a minimum total cost for the spillway, the embankment, and the principal spillway.

Special Investigations and Designs for Debris Basins

Dry Creek

Investigations and Surveys. Field investigations were conducted on all of Dry Creek above Lehi to locate possible sites for floodwater retarding and sediment storage structures. Topographic features eliminated all of the area along the stream except that within a mile either way of the point where State Highway #80 crosses Dry Creek. Within this area, detailed topographic maps were prepared to locate the best site. Considerations for the location included topographic conditions, foundation conditions, existing facilities, such as roads and the Provo Reservoir Canal Siphon, and the locations of irrigation diversions. At several possible sites, as determined by these considerations, test pits were dug and auger holes bored. The site finally selected is just above the Provo Reservoir Canal Siphon and above the diversions of the Lehi Irrigation Company. Reduction of sediment in this irrigation system was a factor in the selection of this site.

A survey and preliminary designs were made of another possible site on Fort Creek, above the town of Alpine; but it was determined that a structure here was not economically feasible.

Embankment. The design of the embankment for this structure is based on the results of test pits and auger holes. This site has a permeable foundation but impermeable abutments. It will be necessary to core drill this site before final construction designs are made. For the purpose of this work plan, a tentative design based on known data and considered conservative has been made. This includes a steel sheet piling cutoff to restrict the movement of water under the dam, an upstream compacted earth blanket in the bottom of the reservoir area, and a downstream toe drain. The dam is designed with 3 to 1 slopes both upstream and downstream.

Tibble Fork

Investigation and Surveys. Investigations for structure sites on American Fork Creek were limited to that portion of the stream above the mouth of American Fork Canyon, because of the developments in the canyon, including recreational areas, highway and power plants, and the fact that all of the normal flow of the stream is diverted for irrigation at the mouth of the canyon. No suitable sites were found in the lower reaches of the canyon and no feasible way was found to controlflood flows from Tank Canyon, Swinging Bridge Canyon, and South Fork. Treatment of these tributaries will be limited to the installation of land treatment measures.

Topographic maps were prepared of the Tibble Fork site just below the junction of Deer Creek and American Fork Creek, and two other possible sites above it. Tentative designs and cost estimates for structures at these sites showed that the Tibble Fork site is the only feasible site. This structure will control all summer floods and sediment originating in Deer Creek, Major Evans, Mary Ellen, Silver Fork, and Upper American Fork Canyon. This is the principal flood and sediment source area in this segment. Core drilling was done to determine foundation conditions and to check the possibility of the site being used for a multiple purpose structure incorporating both floodwater control and irrigation water storage. The foundation is too porous for storage of irrigation water.

Embankment. Embankment design is based on the results of core drillings and test pits in the foundation and in the reservoir and borrow areas. The dam will have 3 to 1 upstream slopes. Downstream slopes will be 2 to 1 except under the adjacent to the emergency spillway which will be 3 to 1 slope. Depth of core trench is based on analysis of data provided by core drilling. Blanketing in the reservoir area will be required to prevent excessive movement of water through the foundation.

Final designs for the Tibble Fork structure will not be made until investigations are completed on Silver Lake Flat Reservoir.

Grove Creek

Investigations and Surveys. Possible locations for structures on Grove Creek are very limited. Above the mouth of the canyon, steep slopes and topography in general eliminate any structure locations. Below the mouth of the canyon, urban development and the location of the Provo Reservoir Canal limit possible locations. The canal itself poses a serious flood threat to Pleasant Grove. Underpass structures with capacity for small flows are provided, but a flood of any consequence would break the canal and add as much as 200 c.f.s. of water to the flood.

A debris basin at the mouth of Grove Creek was constructed some 25 years ago. It is not effective in providing floodwater control. The sediment capacity of this structure has been maintained by means of an annual sediment removal program by the city and irrigation companies.

The area occupied by and adjacent to the existing debris basin offers the only possibility for location of a control structure. Surveys and estimates were prepared for possible alternatives in type and size of structures in this location. The presence of the Salt Lake Aqueduct in the upper end of the existing debris basin and the requirement for adequate cover and protection of this facility prevents the enlargement of this structure to the extent required. The structure proposed will be located immediately below the old basin. The old basin will not be altered except to protect the existing spillways with rock riprap. These spillways have adequate capacity for design floods.

A detailed topographic map was prepared of the area and preliminary designs based on this map. Location and quantities were verified by staking the structure in the field.

Embankment. The preliminary embankment design is based on data obtained by inspection of test pits at the structure site. The site has a pervious foundation which will require a zoned fill embankment with filter material in the downstream section. Excavation in the reservoir area will uncover some pervious areas that will require blanketing with less pervious material. Such material is available in the borrow area. Additional test pits will be dug before final detailed designs are made.

Principal Spillway. Normal summer flows of Grove Creek are piped from the canyon to the irrigation system at Pleasant Grove. The snowmelt floods will pass through the structure. Waters discharging through the principal spillway will be divided into two existing channels. This will permit all of the discharge to be handled by existing facilities of the irrigation company.

Battle Creek

Investigations and Surveys. Topographic conditions at Battle Creek are similar to those at Grove Creek. Similar investigations were made. At this site, the occurrence of spring snowmelt floods is practically nonexistent. Existing pipe lines in the canyon for both culinary and irrigation water have adequate capacity for the snowmelt runoff, and this type of flow ordinarily will not pass through the structure.

Embankment. Embankment design is based on data obtained by inspection of test pits at the structure site. The site has a pervious foundation which will require a zoned fill embankment and a toe drain to prevent piping. Suitable material is available in the borrow area. Additional test pits will be dug before final detailed designs are made.

Structural Measures for Agricultural Water Management

Silver Lake Flat Reservoir

The Silver Lake Flet Reservoir is designed for the storage of irrigation water and has incidental floodwater and sediment reduction benfits. It

will reduce the capacity required for sediment in the Tibble Fork structure below it and will reduce floodwater damage in the channel of American Fork Creek between Silver Creek and Tibble Fork.

This site was investigated by the SCS and the Utah Water and Power Board during the past ten years, and detailed designs for the structure were prepared by the Utah Water and Power Board. These designs have been revised in the light of existing criteria and additional information for this work plan. Spillway designs are based on the same criteria used for the designs of other structures in this plan. Alternative types and sizes were investigated to determine the most economical spillway structure. Similar investigations were made for the outlet works. Additional foundation and borrow area investigations by core drilling and test pits will be done before final designs are made.

Other Irrigation Measures

Existing conservation plans developed by the irrigation companies and the Alpine Soil Conservation District were used to determine the program of improvements included in this plan. Additional field investigations were made to verify locations, sizes, and types of measures needed. Water loss determinations to delineate the extent of canal lining and pipe lines needed and determination of need for additional regulatory structures such as ponds and diversion dams have been part of the conservation program of the irrigation companies and the Soil Conservation District in the past. Analysis of this data determined the measures for inclusion in the plan, which are necessary to improve irrigation efficiency, utilize the increased water supply, and complement the other works of improvement in the plan.

Field surveys were made and existing information used to supply design data. Standard designs used in the existing program of the Soil Conservation District were used.

Land Treatment (On-Farm) Measures

Engineering phases of the accelerated on-farm land treatment measures were based on analysis of the going program of the Alpine Soil Conservation District. Such items as size and location of measures, extent of treatment, and costs were included.

Costs

Preliminary plans and designs were prepared for each structure to determine the most economical alternative. Quantities of construction items were derived from the designs selected.

Unit costs used in the cost estimate were based on costs of similar work recently completed under contract in the vicinity modified according to availability and location of borrow material, accessibility and topography of the site, anticipated subsurface water

conditions, and shape and size of concrete appurtenances. Fifteen percent for contingencies was added to arrive at the construction cost.

Installation services for the debris basins and Silver Lake Flat Reservoir are estimated at 25% of the construction cost. This includes 17% for engineering services and 8% for other services. Additional costs for foundation exploration were included where necessary. Installation services for the irrigation system improvements are estimated at 20%, 13% for engineering services and 7% for other services. These are estimated lower than the same services for other structural measures because standard designs will be used and some engineering information is already available.

Costs of rights-of-way were furnished by the sponsors after negotiation with property owners. These costs reflect agreed-upon purchase prices.

Cost of relocation of the highway at the Tibble Fork debris basin was estimated by the engineering department of the Forest Service Regional Office.

Cost estimates of structures for irrigation system improvement were based on similar work currently being done under the going program of the Alpine Soil Conservation District.

ECONOMIC EVALUATION

Floodwater and Sediment Damages and Benefits

Evaluation of flood damages and of the economic effects and benefits which would be associated with works of improvement scheduled for installation under this plan was based on items of current and historical record to the greatest possible extent. Throughout the entire watershed, urban development is progressing at a rapid rate. Consequently, damages of record for flood events which occurred prior to the past ten year period have a limited application in the calculation of an average annual damage base.* In Dry Creek and American Fork Creek, the recent 1951-1953 flood events were well enough remembered and recorded so that items of the current monetary value of damages could be rather easily determined. In the Timpanogos Face segment of the watershed, the last flood of any significance occurred over 20 years ago and records or individual recollection of flood effects were vague. Further, urban development has progressed at so rapid a rate, on the flood fan of Battle Creek and Grove Creek, that values of items of past flood damages are of little significance. Available information on past floods in the Timpanogos Face area is chiefly useful in delineating potential damage areas. In the discussion to follow, the methods used in determining the damage base, and the manner by which benefits were established, are outlined.

*The damage base is the estimated total of future damages expressed in annual equivalent monetary values.

Damage Surveys

Flood damages have been appraised through a combination of the historical method and by a modified form of the frequency series method because of the erratic sequence of small and large flood occurrence through the watershed. The method used to determine the damages on Dry Creek is typical for American Fork Creek and is outlined below for purposes of illustration.

In Dry Creek, over 55 individuals were interviewed who had some direct knowledge of a specific item of flood damage or flood effect. These included property owners, County and State road officials, City officials, County officials, and irrigation company officers. In addition to the inventory of damage items from the 1951 flood, all available damage information was secured for previous flood events. Data on the annual maintenance costs induced or associated with flash flood damage to the channel and to the irrigation system was also secured.

Damages from inundation due to snowmelt floods are not included in the damage base. The expense of handling sediment moved by snowmelt floods or in maintaining adequate channel capacities was included, since project measures would bring about reduction in sediment movement.

In tabulating damages, six damage reaches were set up. They are, from Utah Lake to the top of the watershed:

	Beginning of Damage c.f.s.	Frequency of Damage Occurrence Years
Reach #1 - From Utah Lake to the west edge of Lehi City	110	10
Reach #2 - Through Lehi City to the Union Pacific Railroad	100	10
Reach #3 - From the Union Pacific Railroad to the siphon of the Provo Reservoir Canal crossing Dry Creek	115	10
Reach #4 - From the siphon to the west edge of Alpine	290	10
Reach #5 - Through Alpine to the mouth of Box Elder Creek	100	5
Reach #6 - From Box Elder to the Power Plant	300	8

Damage Calculations

The final damage base for Dry Creek was comprised of two parts: (1) the equivalent annual damages which occur as the direct result of intermittent flash floods, and (2) those damages induced by intermittent flood events which continue to show up long after each flood in the form of annual sediment movement into channels, canals, or onto farm lands. Direct flash flood damages were calculated by constructing a damage-frequency curve. Recurring damages were determined by a survey of maintenance expenses and from sedimentation data. Further details on these methods are given below.

The inventory of 1951 flood damages was taken as representing the damage level of a 50-year flood occurrence for channel and development conditions presently existing. Hydrologic determinations enabled a delineation of the enlarged area which would be effected by a 100-year flood. Damage susceptibility surveys of property in the area effected by each flood gave a basis for estimating the 100-year flood damage level.

Minimum channel capacities in the various reaches range from a low of 30 c.f.s. through Lehi City to a high of 700 c.f.s. above Alpine. In some reaches, where damageable items are situated back from the stream bank, flows must exceed channel capacities by a significant amount before important damage occurs. Where irrigation and power diversions are located in a channel, damage begins before channel capacities are exceeded. The frequency of overflow in the several reaches varies considerably and the extent of damage in each reach is influenced by the varying channel capacities and with the nature of damageable items in each reach. On Dry Creek, the beginning-of-damage point for each reach is listed below with projected damages for the 100-year and the recorded 50-year flood events.

	Floodwater		Sediment		Beginning of Damage	Frequency Of Damage Occurrence
Item of Damage	100 Year Frequency	50 Year Frequency	100 Year Frequency	50 Year Frequency	c.f.s.	Years
Residential	$18,655	$ 6,610	$ 2,945	$ 1,410	100	10
Commercial	1,045	630	5,100	3,080	100	10
Utilities	5,890	3,905	12,510	8,300	300	8
Irrigation Facilities	1,820	1,110	7,485	4,440	115	10
Roads - Transportation	1,995	1,045	12,265	6,405	100=	5
Crops	3,020	1,505	20,430	11,585	300	10
Land	235	100	3,595	1,575	300	25
Totals	$32,710	$14,905	$63,930	$36,795	xxx	xx

The three points determined by (1) the beginning of damage, (2) the inventory of damage from the 50-year flood of 1951, and (3) the projected 100-year flood enabled the construction of a damage-frequency curve for each reach and the average annual damage for each reach was computed from the curve.

In addition to the annual equivalent values obtained from the curves, annually recurring damages from sediment movement into canals, farm ditches, and onto farm lands was recognized, surveyed, and computed. Annual expense of handling or moving sediments in canals was estimated from irrigation company records. Costs and damages indiced by sediment in farm ditches and on farm land was calculated from sedimentation data. Total annual damage was obtained by adding these annually recurring damages to the annual equivalent curve values.

Adjustments for Anticipated Future Development

Appropriate adjustments in the annual totals for the damage categories were made in keeping with the effect of anticipated future urban or other developments. The rates of development were based in general on population predictions for the area by Stanford Research Institute, the Division of Economic and Business Review of the University of Utah, the Highway Planning Division of the Utah State Road Commission and the Utah County Planning Commission. Current predictions call for an increase of 74% in Utah County population by 1975. Increases beyond this point are expected during the balance of the evaluation period but the accuracy of projections beyond 1975 is in question. It is felt, however, that the 1975 prediction represents an average level which might be reasonably expected to obtain through the evaluation period in those residential, commercial, and agricultural areas which show evidence of being effected by imminent new development. Studies of current development rates and of the nature of such developments were made in each damage reach area and the final determination of future development and the effect on the current flood damage base was established on a composite of general population trends and local factors peculiar to each reach.

Thus, the damage items of residential, street, and irrigation facilities were increased by percentages which ranged up to 74% in the reaches where such values existed. Adjustments were also made to compensate for anticipated increases in maintenance costs or in added capital expenditures which will be necessary in operating an irrigation system in an increasingly congested urban area. Reductions in land and crop damages are projected in those areas where crop land will be converted to home sites.

Indirect Damages

Indirect damage estimates were chiefly based on interruptions to traffic and to commercial activity in the damage area. Traffic count information for the section of U. S. Highway #89-91 involved was obtained from the State Road Planning Division and estimated effects on business activity were based on 1951 flood effects. The indirect damage ranged from 8% to 25% of the direct damages in the reaches where floods would induce this type of damage.

Benefit Calculation

For the purpose of measuring benefits along Dry Creek, damage reaches are grouped in two general sections. The first section includes reaches 1, 2, and 3 and comprises the section of Dry Creek which will get flood protection from the floodwater retarding structure to be installed just above the Provo Reservoir Canal siphon. This structure will contain the runoff volume in a 100-year summer flood and also has capacity for 80% of the sediment which will move down to this point in the next 50-year period. Thus, floodwater damage will be eliminated and sediment damage greatly reduced. The residual annual damage calculated for this section of Dry Creek is based on the suspended sediment which will pass through

the spillway, and from a small amount of channel scour which will occur immediately below the structure during the initial ten years of the program. The chief effect of this sediment movement will be in farm ditches and on farm lands. Residual damages in these reaches are calculated at approximately 4% of the projected 50-year primary damage base.

The net floodwater and sediment damage reductions were taken as total reduction benefits and were divided among land treatment measures and structural measures. A portion of the damage reductions assigned to all land treatment measures were allocated to watershed protection measures on the basis of the hydrologic and sediment yield effect of these measures. On Dry Creek, this was calculated at 5% of the total future damage base. Onsite benefits from this group of measures were based on improvements in grazing capacity. Offsite benefits from the watershed protection measures, capitalized in perpetuity at 2½%, exceed the P.L. 566 share of the cost of installation of these measures.

Land treatment measures for flood prevention will function interdependently with the Dry Creek retarding structure to reduce flood damages in the three lower reaches of Dry Creek. The benefits remaining after allocation to watershed protection measures were divided between land treatment measures for flood prevention and the structural measures, on the basis of the ratio of the cost of each measure to the sum of all costs for flood preventive measures. Thus, land treatment measures for flood prevention are allocated 20.3% and structures 79.7% of the remaining benefits. Approximately 29% of the onsite grazing benefits were also allocated to land treatment measures for flood prevention.

In the three higher reaches, no structural treatment is planned and flood damage reductions in these reaches will all come from the same land treatment measures which will reduce damage in the lower reaches. Reductions in damages from this type of treatment were computed from calculated percentage reductions in flood peaks and sediment yields in the three upper reaches. Reductions in monetary damages in these reaches from land treatment was 24%. Benefits from land treatment in the three upper reaches were added to those allocated to land treatment in the three lower reaches for the total of all benefits allocated to land treatment measures.

Damage Surveys and Calculations - Other Segments. Damage surveys and calculations on the American Fork Creek segment of the watershed were done in substantially the same manner as for Dry Creek. Damages to recreational facilities in the American Fork segment were one of the more important items and good damage records were available from the Forest Service. The planned future development of additional recreation facilities was also available from the Forest Service and an upward adjustment in damageable values was made where such developments were planned. Appropriate discounts were applied to compensate for lag in installation.

The damage level for a 100-year frequency flood was established by the same method used for Dry Creek with data from the 1953 flood representing the 50-year flood frequency.

Both Grove Creek and Battle Creek had flash floods in the 1930's but reliable firsthand data on flood damages could not be obtained. Geologic evidence of relatively recent flash floods at the canyon mouths and data on hydrologic conditions in the upper watershed give weight to the probability of future flood occurrences. In order to establish a damage base in keeping with the physical conditions which exist and the current and future development of the urban area on the fan, the probable course and extent of a 100-year and a 50-year flood were determined. The route of the flood was principally established along the fragments of the old channel which goes through Pleasant Grove, although it is recognized that the network of streets and ditches will distribute floodwaters over a wide area.

Appraisal of the present level of urban damages from a 100-year and a 50-year flood was made by mapping all existing improvements on the flood plain and classifying them on the basis of their susceptibility to floodwater and sediment damages. At the same time, data on the current rate of development in the flood affected area was recorded and the location and size of sites for residential, commercial, or other urban development was mapped.

Four classes of damage susceptibility were set up. Briefly, these are:

Class I	- Highly susceptible (Basement establishments - low window wells) floor level less than 6 inches.
Class II	- Moderately susceptible (Window wells 6-12 inches above ground level) floor level 6-12 inches or low garage floor.
Class III	- Slightly susceptible (Window wells 12 inches plus, or situated on high ground, outbuilding floor level 6-12 inches.)
Class IV	- Non damageable (Structure situated where damage unlikely)

Values based on damages to urban property recorded in the 1956 Cedar City flood and from other areas were applied to each class in establishing the damage levels from a 100-year and a 50-year flood. Increased damageable values were projected into the future on the basis that 85% of available building sites would be utilized and that basement values, most of them highly susceptible to damage, would increase by 70% in the next 25 years as home owners add to them by improvements. Projected damages were also based on the assumption that future building would include 60% basement establishments. Average annual damage was calculated through the construction of a damage-frequency curve, using the data from the susceptibility survey to plot the damage levels for a 50 and a 100-year frequency flood.

In determining the future damage base, the presence of the Provo Reservoir Canal was construed as constituting a degree of protection for floods up to a 25-year size. For floods of 100-year size from Battle Creek and for 50-year and 100-year size from Grove Creek, the damage would be greatly increased by the canal being broken and the water in the canal being added to the floodwater.

Fire Damage and Fire Control Evaluation

Damages from fire were calculated on the basis of frequency and acreage of burn to be expected during the evaluation period. The benefits from improved fire protection were based on (1) average size and estimated damages of burn during the past fifteen years, (2) the frequency of burns during the past fifteen years; and (3) estimated reduction in size and damages of burn with adequate fire protection networks and fire suppression equipment. The Utah Department of Forestry and Fire Control has a going program of fire control in the watershed at the present time, and the added equipment would reduce fire suppression costs in the area by 50%.

Benefits and Costs

Benefits from land treatment were appropriately discounted for lag in accrual. Lag periods range up to 40 years. The average annual damages (damage reductions) and benefits were adjusted to the long-time price projections made by the U.S.D.A. Agricultural Research Service and Agricultural Marketing Service. Costs were based on current price levels expected to obtain during the installation period.

Method of Analysis - Agricultural Water Management Benefits

General

The principal problems of agricultural water management involve the supply of mid and late season water for irrigated land. The agricultural water management measures planned will all contribute, in a greater or lesser degree, to an increase in the supply or to a more efficient use of supplies now existing or which might be developed in the future.

About 74% of the water supply for lands irrigated in the watershed comes from the natural flow of streams which issue from the Wasatch Front. Only about 14% comes from reservoir storage outside the watershed and the stored water only partially fills in the maximum crop needs which develop in the months of July and August. The general overall disproportion between the pattern of supply and need is further exaggerated by the inequitable distribution of water rights between companies and, to a greater extent, among individuals. In most years, therefore, no more than about 71% of the irrigated lands have a full season supply of irrigation water and the supplies of early season water is used in the production of crops with a high early season crop requirement or of crops such as alflafa and pasture which produce partial seasonal yields on a short water supply. Net returns from lands with a short supply are low and the development of supplementary water for late season use which can be matched with the existing early supply will increase yields and allow for the conversion of short supply lands to crops which will bring higher net returns.

Methodology - Assignment of Value to Supplemental Irrigation Water

Assumptions and Considerations. The basis for assignment of value to supplemental irrigation water for this area was predicted upon two facts: (1) that there was an area of land in the watershed which had only a short, early season supply, and (2) that a supplemental supply would be mainly applied, in the long run, to those lands which at the present have only early water. An added basic consideration was that the needs of an expanding local economy and a growing population would develop an increased local market for dairy products, fruits, and vegetables; and a supplemental supply added to the existing short supply would enable the conversion of short supply acreage to meet this need.

The method of determining the benefits from the agricultural water management measures proposed in this plan requires that two measurements be made. They are (1) a measurement of added net returns which would come with the conversion of short supply lands to a composite of crops with higher net returns, and (2) the number of full supply acres which would be developed by each separable type of treatment.

The present cropping pattern for each irrigation company was determined as was normal yields under full and short water supplies. Crop budgets were prepared for each crop grown and net farm incomes were determined for crops receiving a full water supply and for crops with a short water supply. Care was taken to consider additional costs which would be incurred with additional water supplies. The crop distribution under each water supply situation was determined. Weighted net incomes for each situation was determined for each irrigation district. The difference between net incomes with a short supply and full supply was taken to represent the net value of the supplemental supply on a per acre basis.

The number of acres which would be benefited by a full water supply was determined for each separable group of practices. The first step in the analysis was to determine the per acre requirement, by months, of the composite of crops under each irrigation company. This determination was made for presently existing irrigation efficiencies and for the average level of efficiencies which will obtain with the anticipated application of on-farm practices under an accelerated program. The water supply for each company, natural streamflow, wells, and stored reservoir water was computed and the per acre crop requirement balanced with the available monthly supply so that the maximum acreage which could be irrigated with a full season supply was calculated. The application of on-farm treatment was taken as the first increment of treatment followed by canal lining, water storage, piping of springs, and overnight storage, as additional increments of treatment. The reduced gross needs brought about by the increase in farm efficiency from the on-farm measures and the added supplies developed by lining and storage produced changes in available supply and brought added acres into a full supply position. Differences in acreages between the successive increments of treatment were taken as acres benefited by each type of measure and the benefit was converted to a monetary value by multiplying the value per acre measured in the first section of the analysis by the acres benefited.

Secondary Benefits

These benefits are the values over and above the net values (or net returns) from the products produced by the improvements in water supply and water utilization. In the main, the secondary benefits will result from the chain of economic events involved in transporting, handling, marketing and processing the added agricultural products brought into being by the project.

These benefits were computed by applying appropriate percentage factors to the gross wholesale or retail market value of the dairy products, beef, fruits and vegetables calculated to be produced as a result of the agricultural water management measures. No secondary benefits were calculated as accruing from flood prevention measures.

TABLE 1a - STATUS OF WATERSHED WORKS OF IMPROVEMENT

(at time of Work Plan Preparation)

American Fork-Dry Creek Watershed, Utah

Measures (1)	Unit (2)	Applied To Date (3)	Total Cost (4)
			(Dollars) 1/
LAND TREATMENT			
Uinta National Forest			
Range Management fences	Mile	12	12,000
Range seeding	Acre	80	1,000
Pond construction, Stockwater	Each	10	1,500
Road erosion control	Mile	20	4,000
Trail erosion control	Mile	40	2,000
Deferred grazing (Being installed under going program)	AUM	2,550	12,750
Non-Federal Land			
Stubble Mulching	Acre	500	1,750
Land leveling	Acre	5,000	325,000
Range seeding	Acre	800	8,000
Pond construction, Stockwater	Each	3	525
Proper Use	Acre	1,000	5,000
STRUCTURAL MEASURES			
Non-Federal Land			
Canal lining	L.F.	27,800	55,600
Desilting basin	No.	1	600
Pond Construction, Irrigation	No.	6	6,600
Ditch Construction	Mile	53	95,400
TOTAL	xxxx	xxxxxx	531,725

1/ Price base 1958

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION

American Fork-Dry Creek Watershed, Utah

(Dollars) 1/

Structure Site No. Or Name	Federal Installation Cost					Non-Federal Installation Cost							Estimated Total Cost
	Construction		Instal. Services		Total Federal	Construction		Instal-lation Services	Other			Total Non-Federal	
	Eng. Est.	Contin-gencies	Engin-eering	Other		Eng. Est.	Contin-gencies		Adm. of Con-tracts	Ease-ments & R/W	Water Rights		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Dry Creek Debris Basin	135,655	20,345	29,920	14,080	200,000				1,000	12,300		13,300	213,300
Tibble Fork Debris Basin	136,465	20,470	26,680	12,555	196,170				1,000	25,000		26,000	222,170
Grove Creek Debris Basin	138,610	20,790	27,100	12,750	199,250				1,000	12,800		13,800	213,050
Battle Creek Debris Basin	90,700	13,600	17,730	8,345	130,375				1,000	7,000		8,000	138,375
Silver Lake Flat Res.	88,385	13,260	70,750	33,295	205,690	221,340	33,200		2,000			256,540	462,230
Canal Lining	121,095	18,165	50,815	27,365	217,440	218,815	32,825		19,545			271,185	488,625
Drop Spillway Const.	930	140	390	210	1,670	1,680	250		150			2,080	3,750
Desilting Basins	930	140	390	210	1,670	1,680	250		150			2,080	3,750
Pipe Lines	12,585	1,890	5,285	2,845	22,605	22,750	3,415		2,030			28,195	50,800
Diversion Dam	775	115	325	175	1,390	1,400	210		125			1,735	3,125
Pond Construction	6,815	1,020	2,860	1,540	12,235	12,320	1,845		1,100			15,265	27,500
Ditch Construction	4,955	745	2,080	1,120	8,900	8,955	1,345		800			11,100	20,000
GRAND TOTAL	737,900	110,680	234,325	114,490	1,197,395	488,940	73,340		29,900	57,100*		649,280	1,846,675

1/ Price Base 1958

Date November 1958

* Includes $32,800 for relocations of highways, power lines, and pipelines

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TABLE 3 - STRUCTURE DATA

DEBRIS BASINS AND IRRIGATION RESERVOIR

American Fork - Dry Creek Watershed, Utah

ITEM	UNIT	STRUCTURE NAME					TOTAL
		Grove Creek	Battle Creek	Dry Creek	Tibble Fork	Silver Lake Flat	
		DB	DB	DB	DB	Res.	
Drainage Area	sq.mi.	6.5	5.5	39.4	31.2	4.3	86.9
Storage Capacity:							
Sediment	ac.ft.	40	35	185	166	24	450
Floodwater pool	ac.ft.	50	31	85	68	---	234
Irrigation pool	ac.ft.	---	---	---	---	921	921
Total	ac.ft.	90	66	270	234	945	1,605
Surface Area:							
Sediment pool	ac.	4.7	2.6	18.7	11.5	4.6	42.1
Floodwater pool	ac.	8.9	4.6	23.3	13.9	---	50.7
Irrigation pool	ac.	---	---	---	---	43.0	43.0
Maximum dam height	ft.	36	36	35	48	68	---
Volume of fill	cu.yd.	102,000	79,000	77,000	65,000	243,000	566,000
Emergency Spillway:							
Type - Reinforced concrete chutes							
Frequency of use	yrs.	2	5	1	1	1	
Design storm							
Duration	hrs.	6	6	6	6	6	
Total depth	in.	7.5	7.5	7.5	7.5	7.5	
Width of chute	ft.	12	8	24	16	10	
Design depth	ft.	3.1	2.3	4.0	3.7	3.0	
Design capacity	c.f.s.	1,450	850	2,620	2,000	450	
Freeboard, crest to top of dam	ft.	4.0	3.0	5.0	4.5	5.0	
Total capacity, at top of dam	c.f.s.	2,220	1,340	3,740	2,800	1,180	
Principal Spillway:							
Type - Drop inlet, with ported riser and R/C pipe outlet							
Capacity, at chute crest	c.f.s.	33	33	110	206	---	
Class of Structure		C	C	C	C	C	

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TABLE 4 - SUMMARY OF PHYSICAL DATA

American Fork-Dry Creek Watershed, Utah

Item	Unit	Quantity Without Project	Quantity With Project
Watershed area	Sq. Mile	185.5	xxxxxx
Watershed area	Ac.	118,710	xxxxxx
Area privately owned	Ac.	58,700	xxxxxx
Area non-Federal public	Ac.	1,270	xxxxxx
Area Federally owned (By agency)	Ac. - F.S.	57,840	xxxxxx
	Ac. - B.L.M.	640	xxxxxx
	Ac. - N.P.S.	260	xxxxxx
Area of cropland	Ac.	27,980	27,980
Area of grassland	Ac.	27,130	32,370
Area of woodland	Ac.	63,600	58,360
Overflow area subject to damage	Ac.	2,545	320
Area damaged annually by:			
Sediment	Ac.	760	410
Floodplain scour	Ac.	200	60
Swamping	Ac.	0	0
Streambank erosion	Ac.	6	4
Sheet erosion	Ac.	66,100	40,600
Annual rate of erosion			
Sheet	Tons/yr.	21,543	8,252
Gully	Tons/yr.	59,764	38,179
Streambank	Tons/yr.	1,002	653
Scour	Tons/yr.	2,180	980
Sediment production	Tons/Ac./yr.	0.76	0.43
Average annual rainfall - range	Inches	12 - 45	xxxxxx

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TABLE 5 - SUMMARY OF PLAN DATA

American Fork-Dry Creek Watershed, Utah

Item	Unit	Quantity
Years to complete project	Year	10 1/
Total installation cost		
Public Law 566 funds	Dollar	1,677,855
Other	Dollar	2,113,430
Annual O & M cost		
Federal	Dollar	1,850
Non-Federal	Dollar	3,725
Average annual monetary benefits 2/	Dollar	171,750
Agricultural	Percent	79
Non-agricultural	Percent	21
Structural Measures		
Debris Basins	Each	4
Area inundated by structures		
Upland		
Sediment pool	Ac.	42
Detention pool	Ac.	51
Water supply pool	Ac.	42
Watershed area above structures	Ac.	55,635
Reduction of floodwater damage	Dollar	15,610
By Land Treatment Measures -		
Watershed Protection	Percent	4
Flood Prevention	Percent	20
By Structural Measures	Percent	61
Reduction of sediment damage	Dollar	39,845
By Land Treatment Measures -		
Watershed Protection	Percent	5
Flood Prevention	Percent	21
By Structural Measures	Percent	55
Range Conservation Benefit	Dollar	525
Incidental Flood Prevention Benefits	Dollar	3,310
Irrigation Benefits (Primary)	Dollar	56,150
Acres with full season irrigation supply increased by irrigation measures	Acre	4,077

1/ Structural Program and Land Treatment for Flood Prevention to be completed in 5 years. November 1958

2/ From Structural Measures and Land Treatment Measures for Flood Prevention. Includes secondary benefits.

TABLE 6 - ANNUAL COSTS

American Fork-Dry Creek Watershed, Utah

(Dollars) 1/

Measures (1)	Amortization of Installation Cost (2)	Operation and Maintenance Costs Federal (3)	Non-Federal (4)	Total (5)	Other Economic Costs (6)	Total (7)
Dry Creek Debris Basin and Interdependent Land Treatment for Flood Prevention	9,220	340	500	840		10,060
Tibble Fork Debris Basin and Land Treatment	13,280	970	620	1,590		14,870
Grove Creek Debris Basin and Land Treatment	8,415	180	800	980		9,395
Battle Creek Debris Basin and Land Treatment	5,245	70	800	870		6,115
Independent Land Treatment Measures for Flood Prevention	1,450	290	5	295		1,745
Irrigation Measures (Includes Silver Lake Flat Reservoir, canal lining, etc.)	37,365		1,000 2/	1,000		38,365
TOTAL	74,975	1,850	3,725	5,575		80,550

1/ Price Base 1958, Interest rate 2½%, Amortization period 50 years.

2/ Silver Lake Flat Reservoir only. Operation and Maintenance not included on other irrigation measures, where benefits from reduced operation and maintenance resulting from installation of these measures is not computed.

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TABLE 7 - MONETARY BENEFITS FROM STRUCTURAL MEASURES AND LAND TREATMENT MEASURES FOR FLOOD PREVENTION

American Fork-Dry Creek Watershed, Utah

(Dollars) 1/

ITEM (1)	ESTIMATED AVERAGE ANNUAL DAMAGE				AVERAGE ANNUAL MONETARY BENEFITS (Col. 3-5) (6)
	Without Project (2)	After Land Treatment For W/S Protection (3)	After all Land Treatment (4)	With Project (5)	
Floodwater					
Residential-Commercial	5,740	5,495	4,325	805	4,690
Irrigation Facilities	3,090	2,960	2,330	435	2,525
Roads - Utilities	3,110	2,980	2,345	435	2,540
Recreation Facilities	2,210	2,115	1,665	310	1,805
Land and Crop Damage	1,460	1,395	1,105	210	1,190
Subtotal	15,610	14,945	11,770	2,195	12,750
Sediment					
Residential-Commercial	10,910	10,425	8,170	2,160	8,265
Irrigation Facilities	10,745	10,265	8,050	2,130	8,135
Roads - Utilities	8,080	7,715	6,050	1,600	6,115
Recreation Facilities	5,000	4,775	3,745	990	3,785
Land and Crop Damage	5,110	4,885	3,825	1,020	3,865
Subtotal	39,845	38,065	29,840	7,900	30,865
TOTAL DIRECT DAMAGE	55,455	53,010	41,610	10,065	42,915
INDIRECT DAMAGE	7,665	7,320	5,665	1,240	6,085
TOTAL, ALL DAMAGE	63,120	60,330	47,275	11,305	49,000
Changed Land Use					
Range Cons. Benefits					525
Incidental F.P. Benefits					3,310
SUBTOTAL					
TOTAL FLOOD PREVENTION BENEFITS					52,835
TOTAL NON-AGRICULTURAL WATER MANAGEMENT BENEFITS					
Total, Direct Benefits					56,150
Indirect Benefits					
Total, Primary Benefits					56,150
Secondary Benefits					62,765
TOTAL AGRICULTURAL WATER MANAGEMENT BENEFITS					118,915
TOTAL PRIMARY BENEFITS FOR PROJECT					108,985
TOTAL MONETARY BENEFITS					171,750

1/ Price base Long Range

Date November 1958

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TABLE 8 - BENEFIT COST ANALYSIS

American Fork-Dry Creek Watershed, Utah

(Dollars) 1/

Measures	AVERAGE ANNUAL BENEFITS										Ave. Annual Cost	Benefit Cost Ratio
	Flood Prevention					Agricultural Water Management			Non-Agricultural Water Mgt.	Total		
	Floodwater	Sediment	Erosion	Indirect	Other	Drainage	Irrigation	Other				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Dry Creek Debris Basin with Interdependent Land Treatment for Flood Prevention	2,830	7,075		1,350	1,610					12,865	10,060	1.3 : 1
Tibble Fork Debris Basin with Interdependent Land Treatment for Flood Prevention	4,910	10,570		2,345						17,825	14,870	1.2
Grove Creek Debris Basin with Interdependent Land Treatment for Flood Prevention	2,785	6,960		1,330						11,075	9,395	1.2
Battle Creek Debris Basin with Interdependent Land Treatment for Flood Prevention	1,825	4,555		870						7,250	6,115	1.2
Independent Land Treatment Measures for Flood Prevention	400	1,005		190	525					2,120	1,745	1.2
Irrigation Measures (Includes Silver Lake Flat Res. Canal Lining, etc.)					1,700		56,150			57,850	38,365	1.5
GRAND TOTAL	12,750	30,165		6,085	3,835		56,150			108,985	80,550	1.4 : 1

1/ Price base 1958

Date November 1958

USDA-SCS-PORTLAND, OREG. 1958

TABLE 8A - BENEFITS AND COSTS BY CONSTRUCTION UNITS

American Fork-Dry Creek Watershed, Utah

(Dollars) 1/

Construction Unit and Structures	Annual Benefits	Annual Costs
Dry Creek Debris Basin and Interdependent Land Treatment Measures for Flood Prevention	12,865	10,060
Tibble Fork Debris Basin and Interdependent Land Treatment Measures for Flood Prevention	17,825	14,870
Grove Creek Debris Basin and Interdependent Land Treatment Measures for Flood Prevention	11,075	9,395
Battle Creek Debris Basin and Interdependent Land Treatment Measures for Flood Prevention	7,250	6,115
Irrigation Measures	57,850	38,365
Silver Lake Flat Reservoir	19,120	17,300
Alpine Irrigation Company	6,820	2,925
Pleasant Grove Irrigation Company	10,525	7,960
American Fork Irrigation Company	7,545	4,715
Lehi Irrigation Company	13,840	5,465

1/ Price base: Costs - 1958 Prices
Benefits - Long Range Prices

November 1958

TABLE 9 - CLASSIFICATION OF AGRICULTURAL WATER MANAGEMENT BENEFITS

American Fork-Dry Creek Watershed, Utah

(Dollars) 1/

Purpose	Direct Identifiable		Other			Total
	Dollars	Percent	Public	Incidental	Secondary 2/	
Drainage						
Irrigation Measures	56,150	47			62,765	118,915
Other						
Total	56,150	47			62,765	118,915

1/ Price base Long Range

2/ Not used for project justification.

November 1958

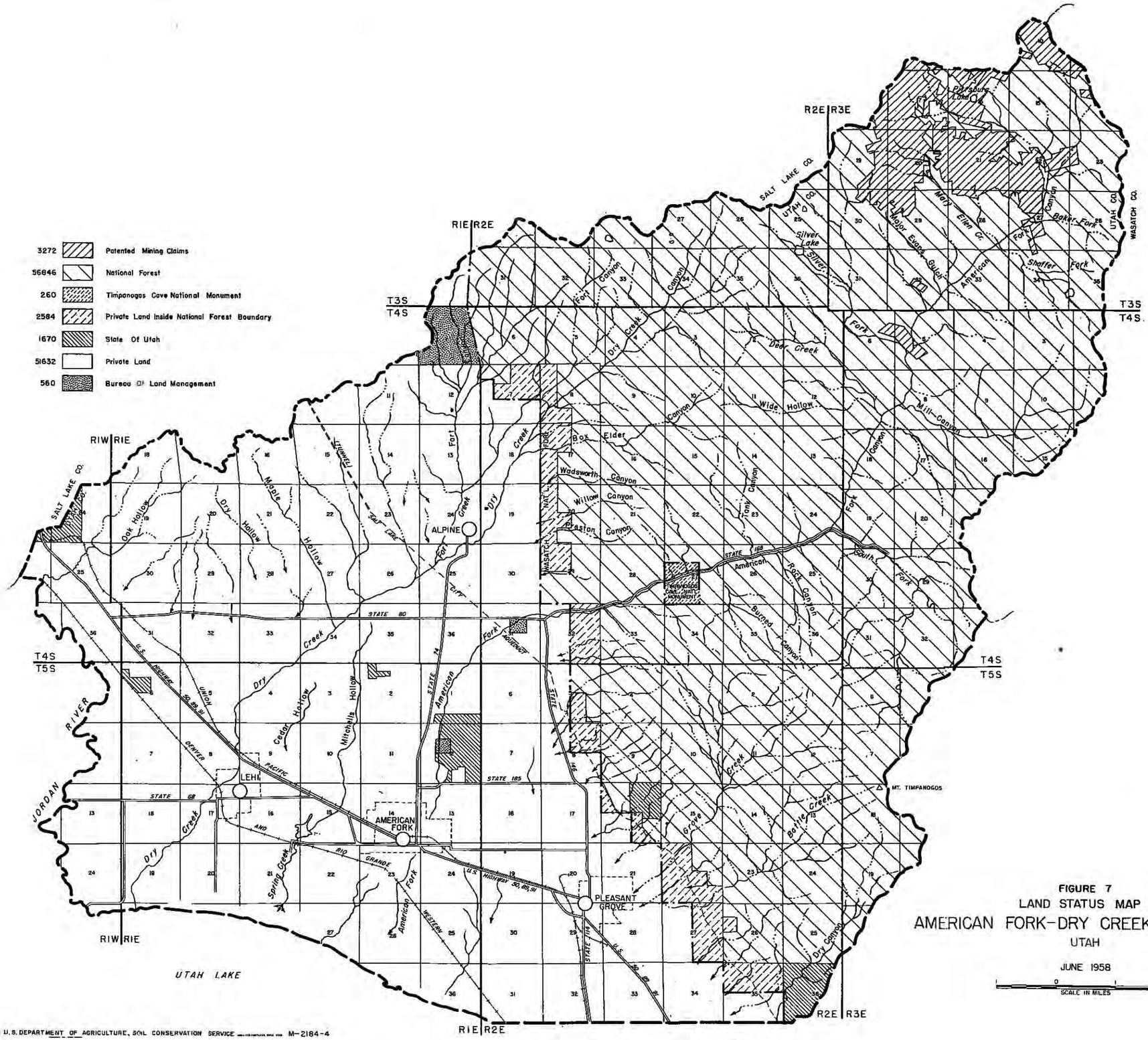

FIGURE 7
LAND STATUS MAP
AMERICAN FORK-DRY CREEK WATERSHED
UTAH

JUNE 1958

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE M-2184-4

7-S-19398-N

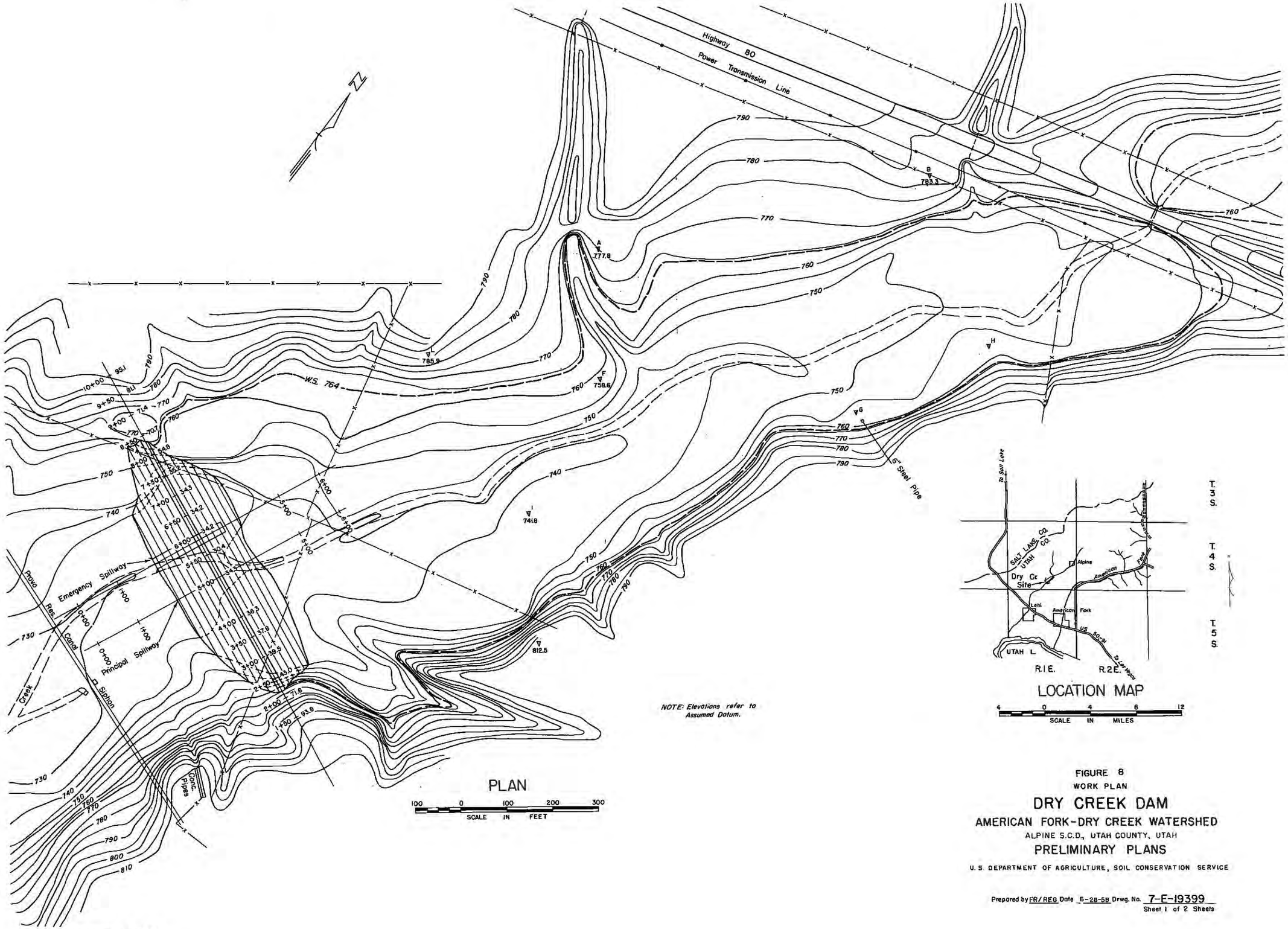

FIGURE 8

WORK PLAN

DRY CREEK DAM

AMERICAN FORK-DRY CREEK WATERSHED

ALPINE S.C.D., UTAH COUNTY, UTAH

PRELIMINARY PLANS

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Prepared by FR/REG Date 6-28-58 Drwg. No. 7-E-19399

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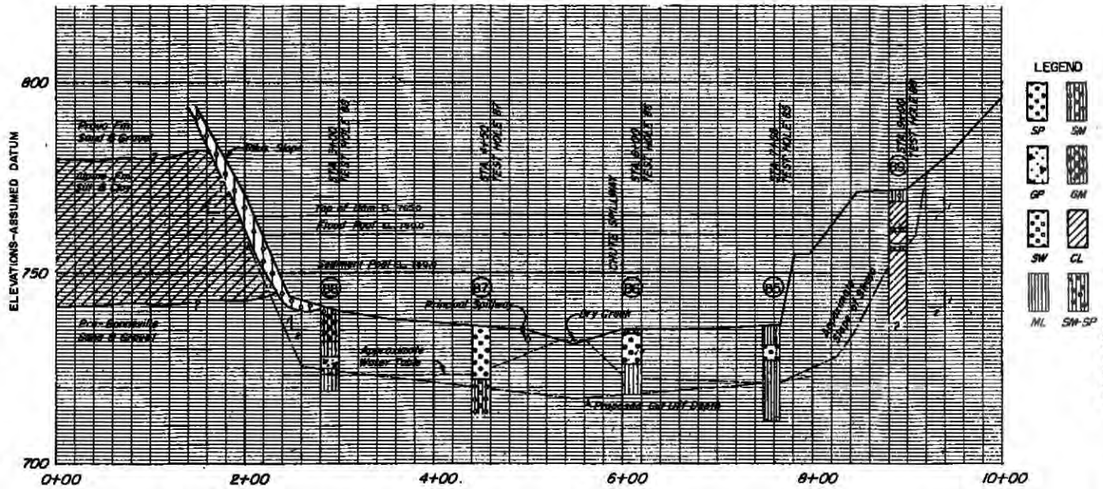
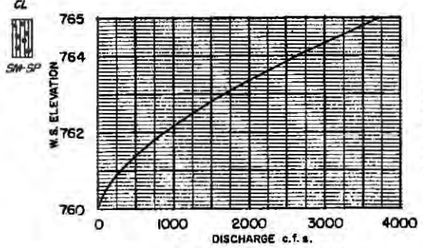
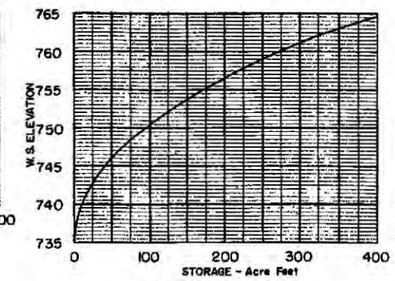


PROFILE AND LOG OF TEST HOLES

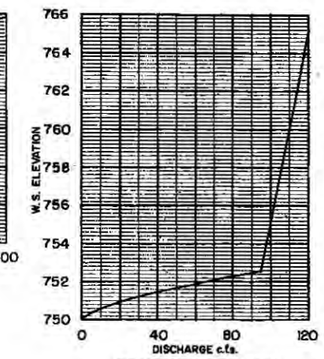
SCALE
VERT 1" = 20'
HORZ. 1" = 80'



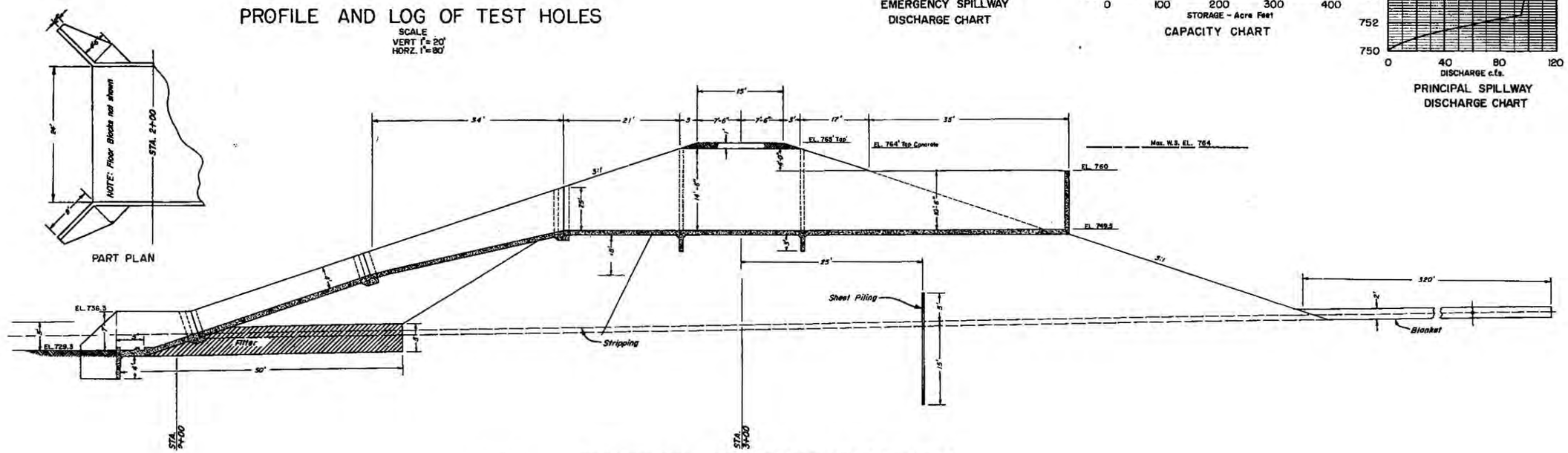
EMERGENCY SPILLWAY
DISCHARGE CHART



CAPACITY CHART

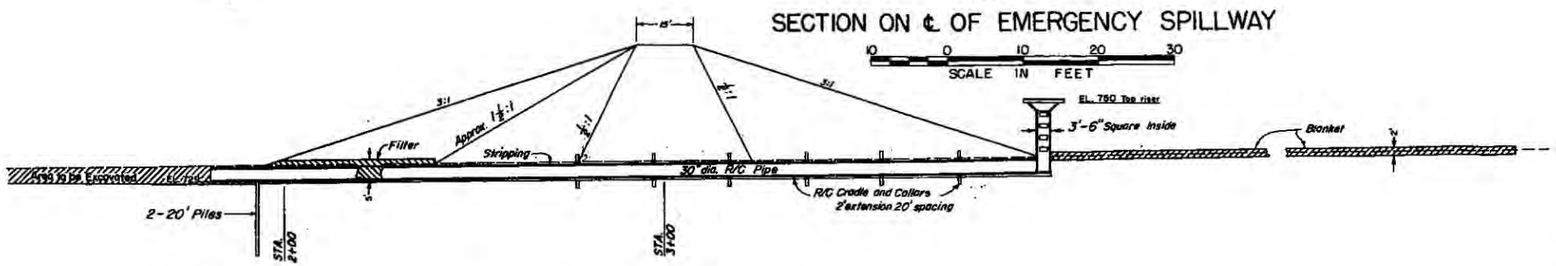


PRINCIPAL SPILLWAY
DISCHARGE CHART



SECTION ON ℄ OF EMERGENCY SPILLWAY

10 0 10 20 30
SCALE IN FEET



SECTION ON ℄ OF PRINCIPAL SPILLWAY

20 0 20 40 60
SCALE IN FEET

FIGURE 9
WORK PLAN

DRY CREEK DAM

AMERICAN FORK-DRY CREEK WATERSHED
ALPINE S.C.D. UTAH COUNTY, UTAH

PRELIMINARY PLANS

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

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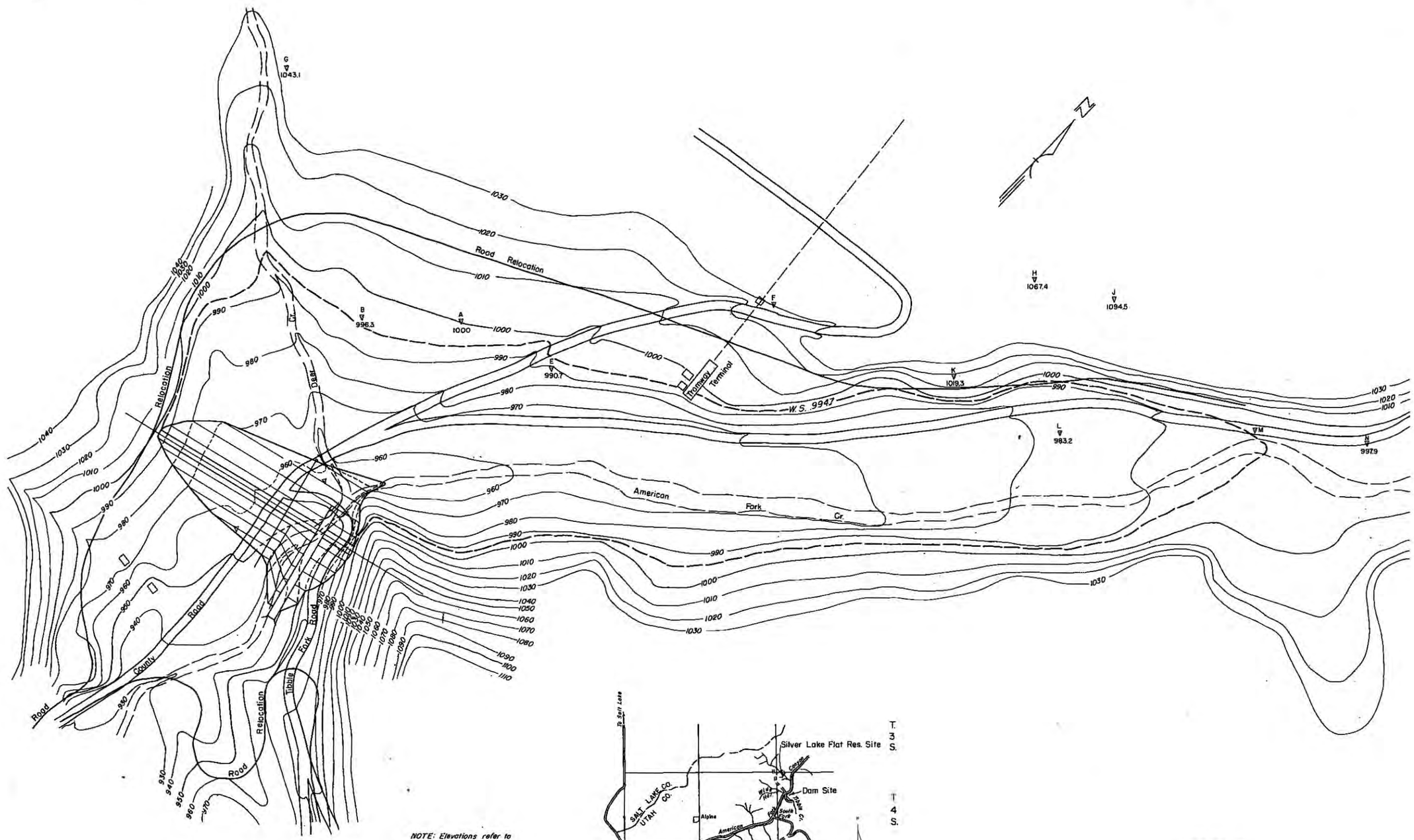
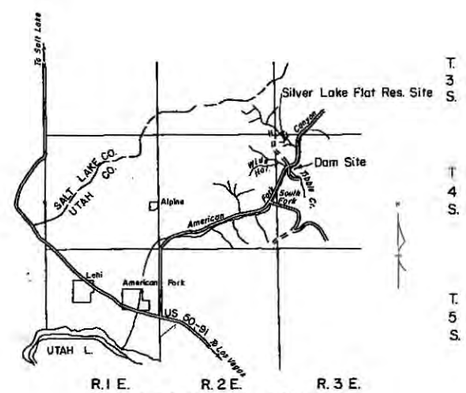
M-2184-6



NOTE: Elevations refer to Assumed Datum.

PLAN

60 0 60 120 180
SCALE IN FEET



LOCATION MAP

4 0 4 8 12
SCALE IN MILES

FIGURE 10
WORK PLAN

TIBBLE FORK DAM

AMERICAN FORK-DRY CREEK WATERSHED
ALPINE S.C.D., UTAH COUNTY, UTAH
PRELIMINARY PLANS
U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

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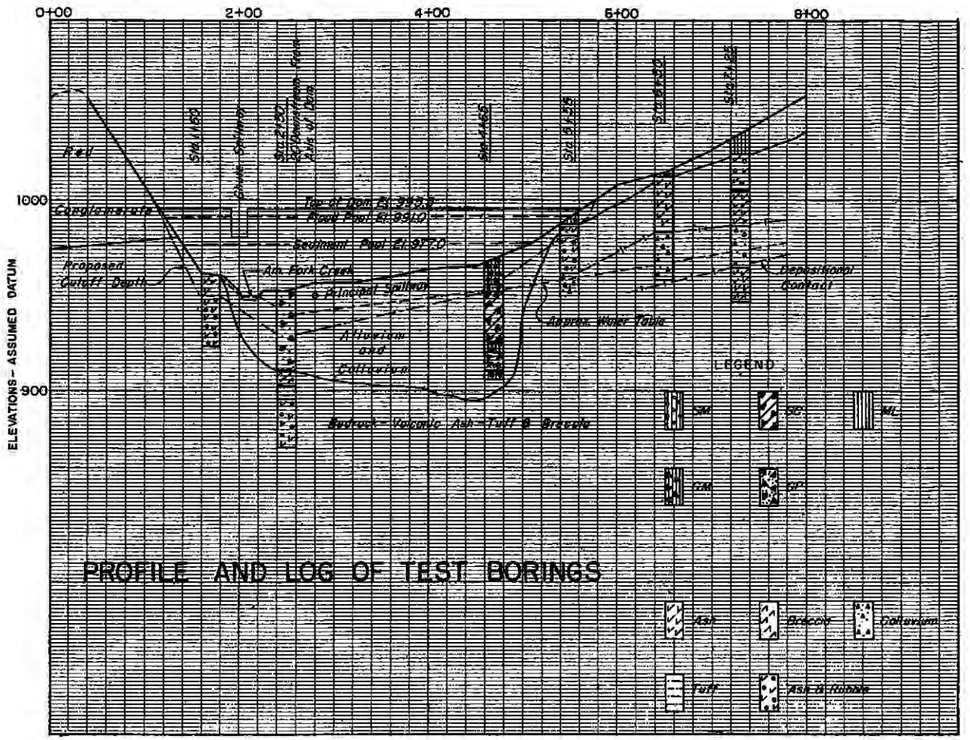
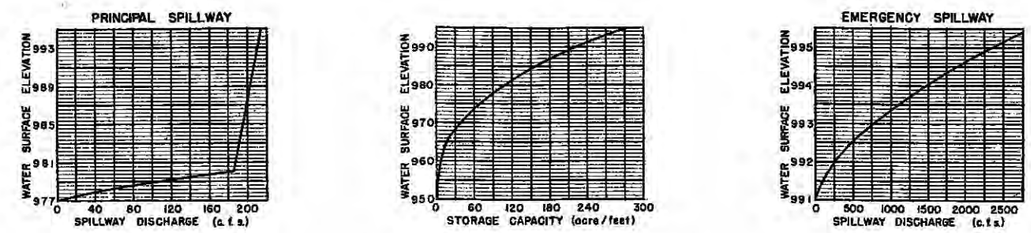
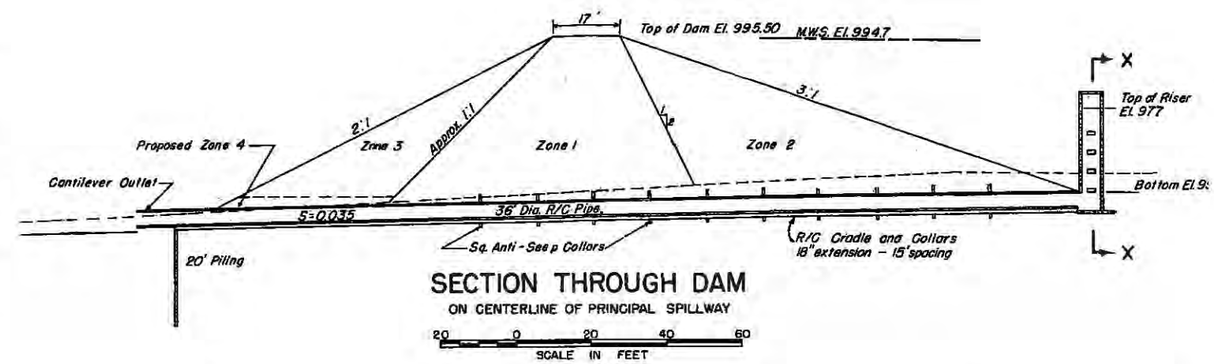
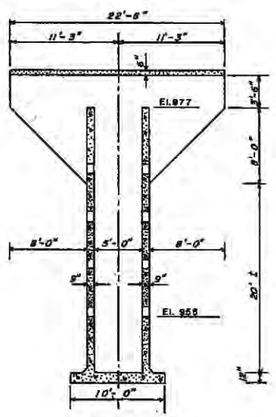




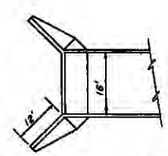
STORAGE - DISCHARGE CURVES



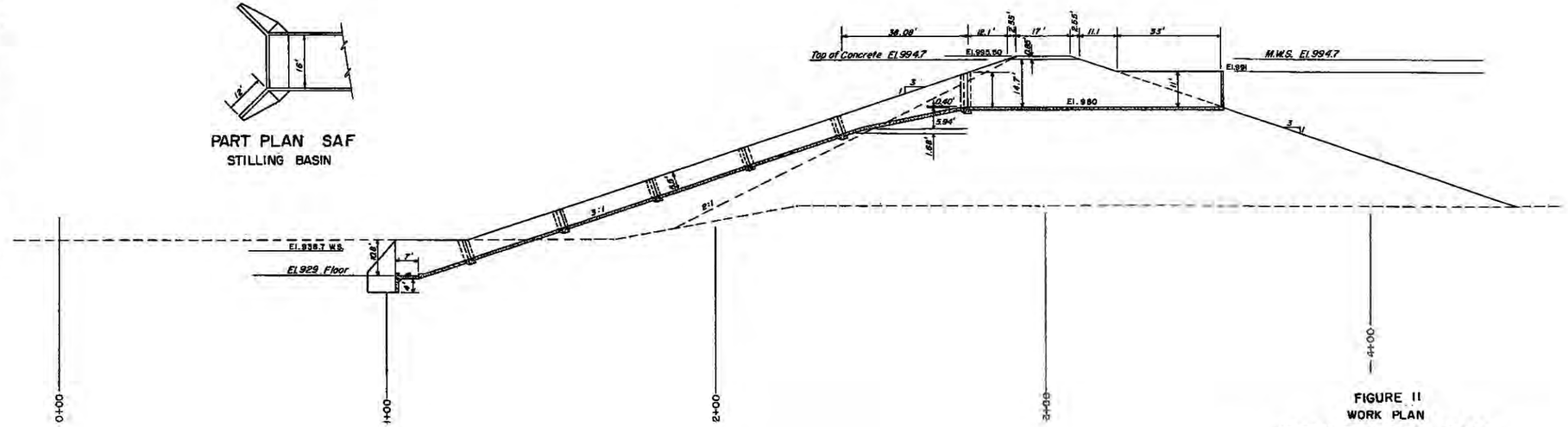
SECTION THROUGH DAM
ON CENTERLINE OF PRINCIPAL SPILLWAY



DROP INLET
SECTION X-X



PART PLAN SAF
STILLING BASIN



SECTION THROUGH DAM
ON CENTERLINE OF EMERGENCY SPILLWAY

FIGURE 11
WORK PLAN

TIBBLE FORK DAM

AMERICAN FORK-DRY CREEK WATERSHED
ALPINE S.C.D., UTAH COUNTY, UTAH

PRELIMINARY PLANS

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

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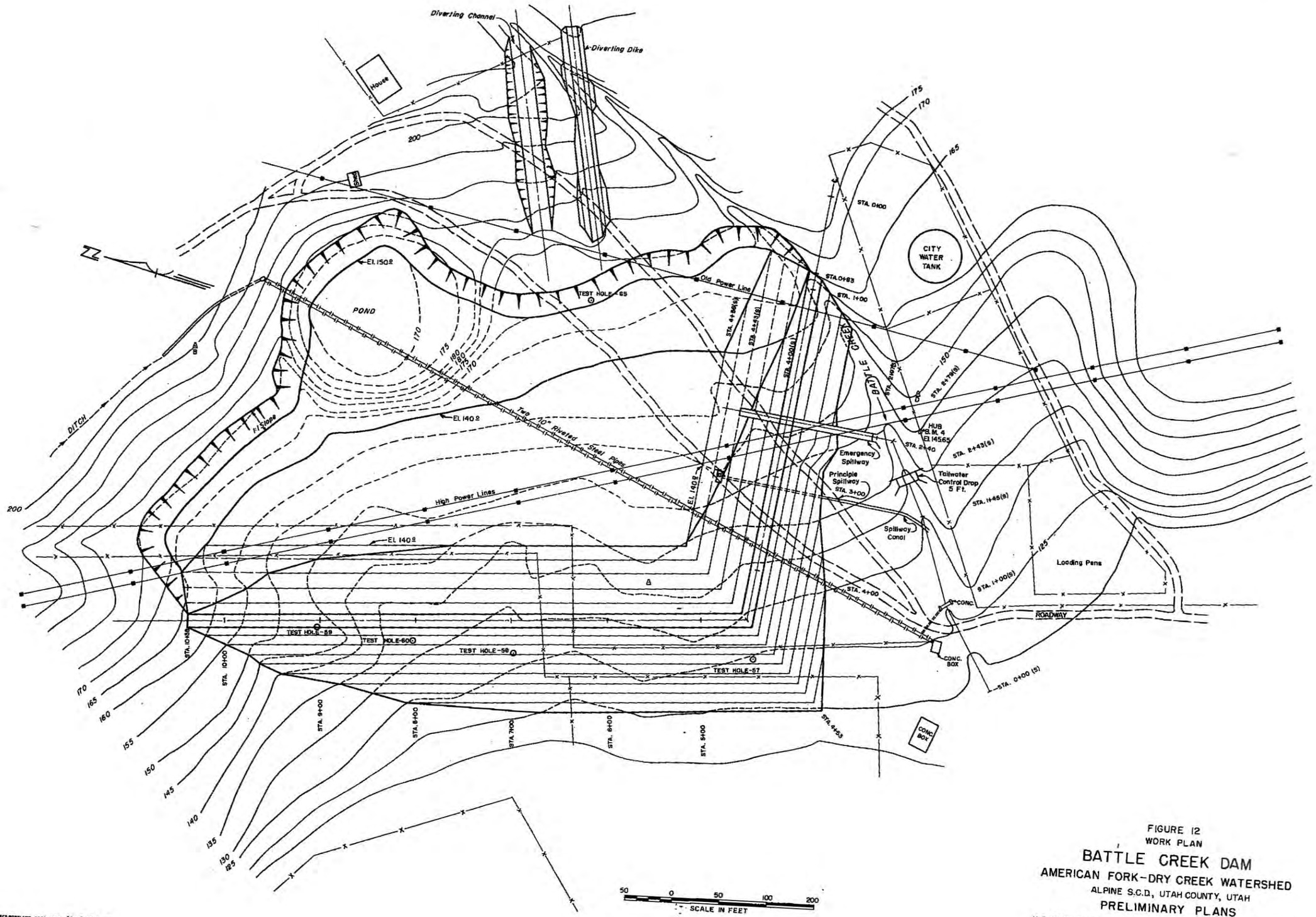


USDA-SCS-PORTLAND, OREG 1958 M-2184-9

FIGURE 12
WORK PLAN

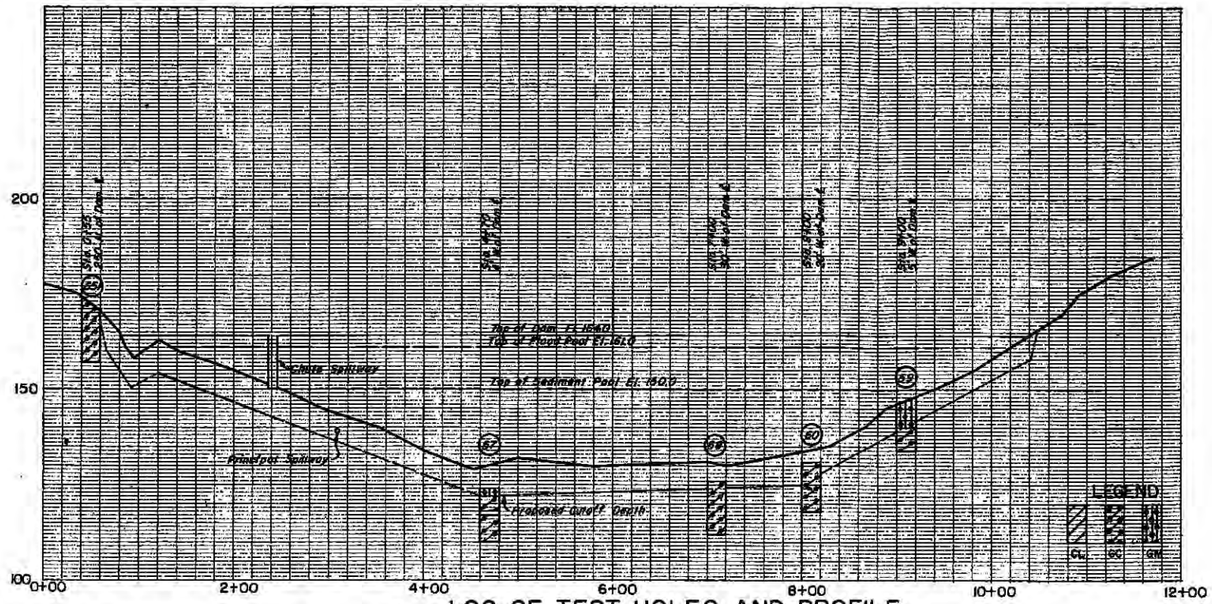
BATTLE CREEK DAM

AMERICAN FORK-DRY CREEK WATERSHED
ALPINE S.C.D., UTAH COUNTY, UTAH

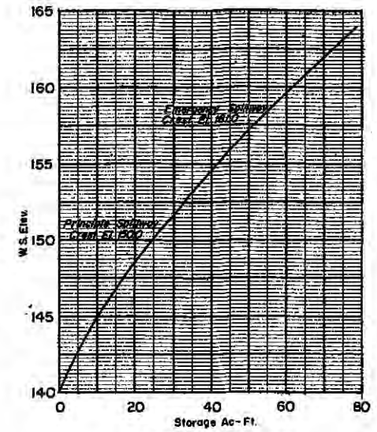
PRELIMINARY PLANS

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

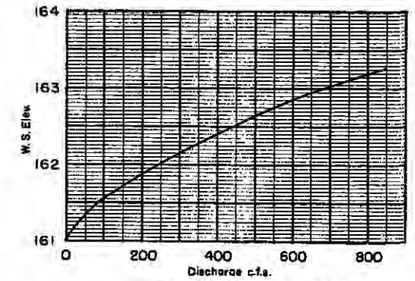
Prepared by_____ Date_____ Drwg No 7-E-19401-N



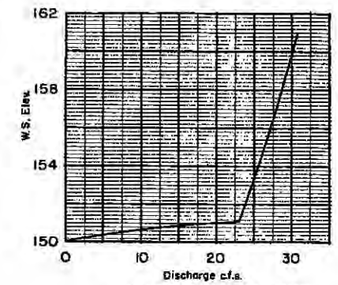
LOG OF TEST HOLES AND PROFILE



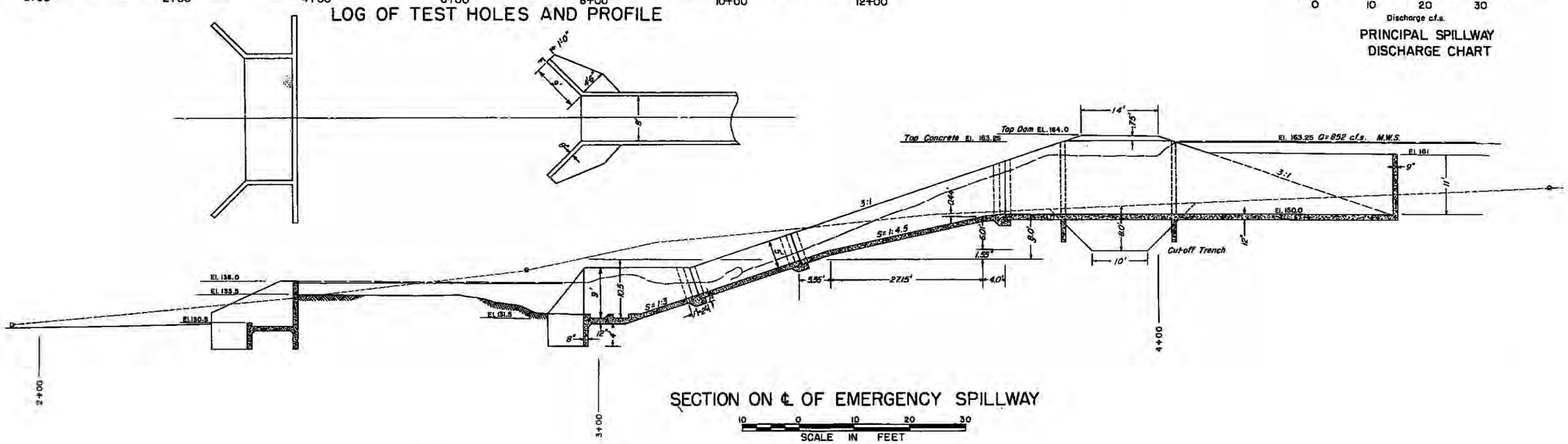
CAPACITY CHART



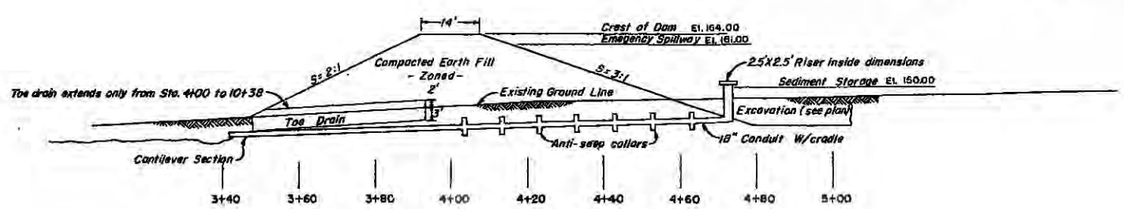
EMERGENCY SPILLWAY DISCHARGE CHART



PRINCIPAL SPILLWAY DISCHARGE CHART



SECTION ON ℄ OF EMERGENCY SPILLWAY



SECTION ON ℄ OF PRINCIPAL SPILLWAY

FIGURE 13
WORK PLAN

BATTLE CREEK DAM

AMERICAN FORK-DRY CREEK WATERSHED
ALPINE S.C.D., UTAH COUNTY, UTAH

PRELIMINARY PLANS

U S DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

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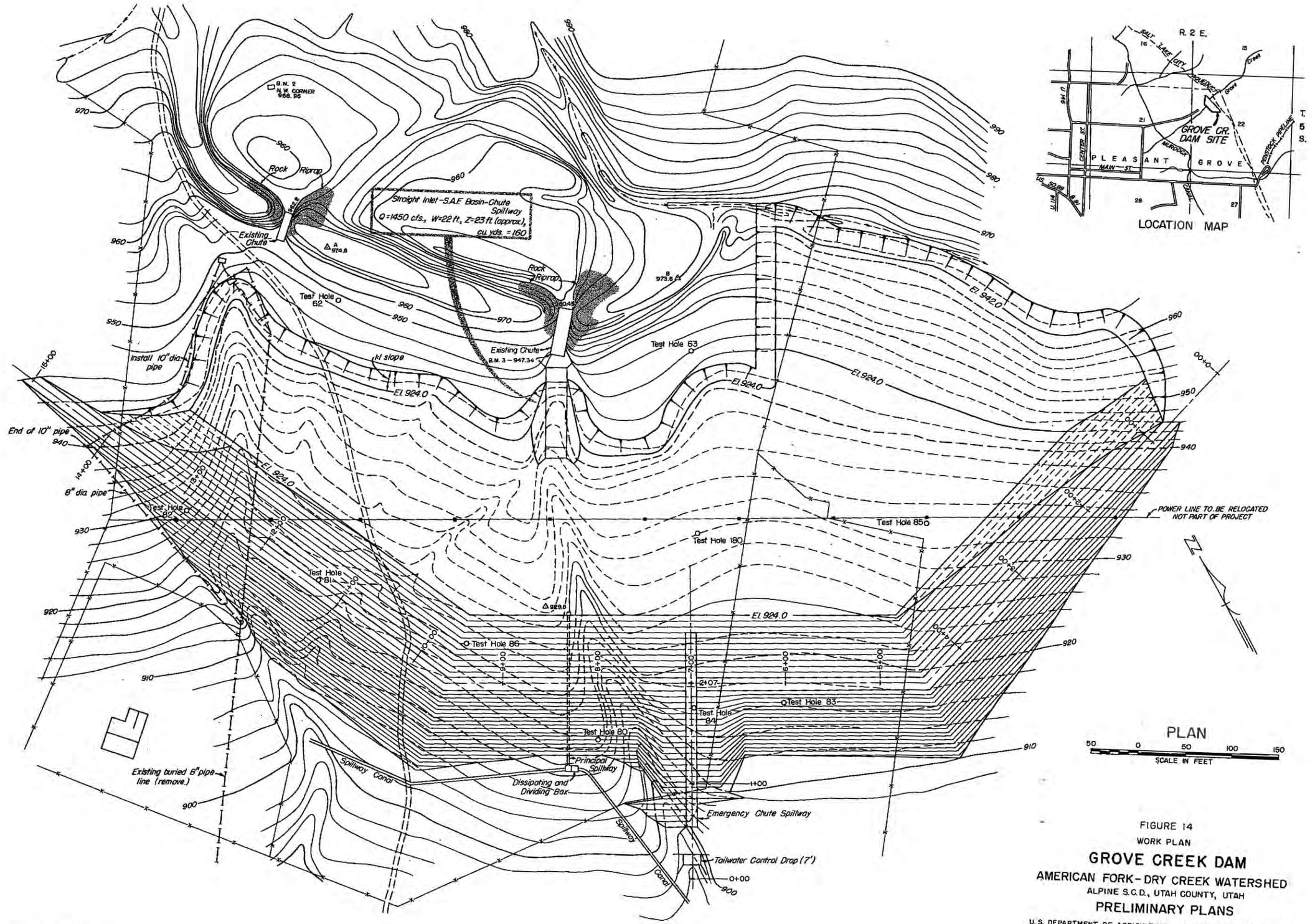

FIGURE 14

WORK PLAN

GROVE CREEK DAM

AMERICAN FORK-DRY CREEK WATERSHED

ALPINE S.C.D., UTAH COUNTY, UTAH

PRELIMINARY PLANS

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

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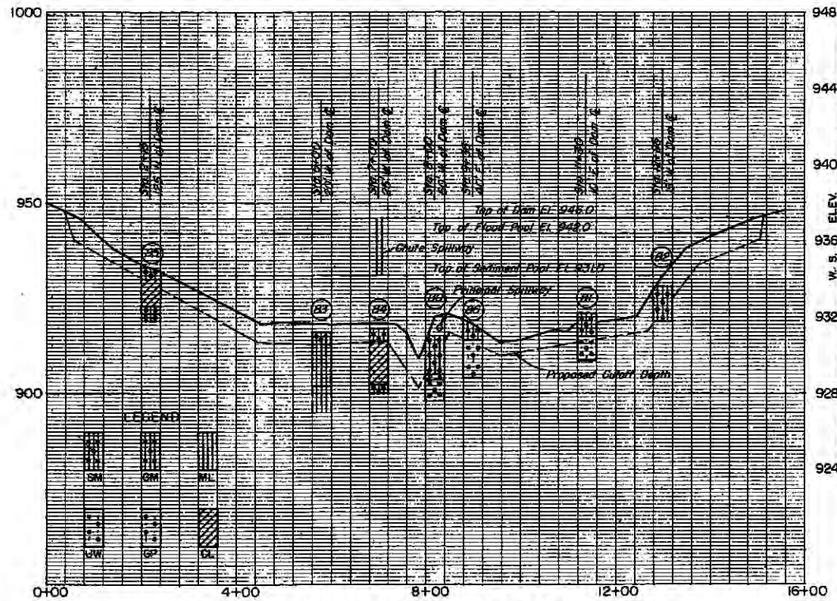
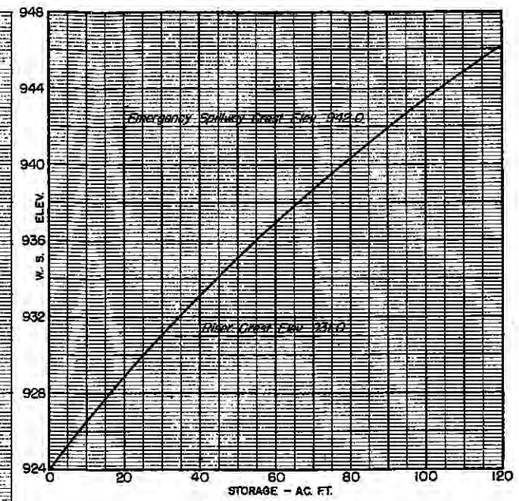
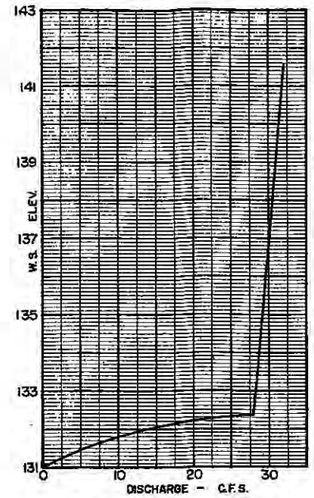


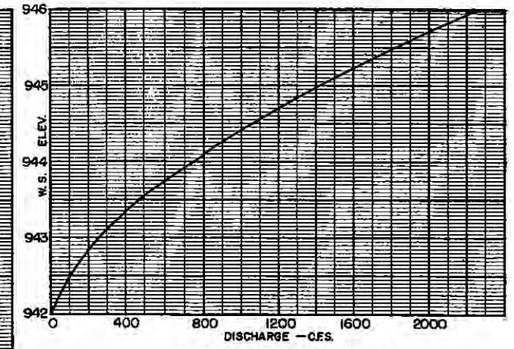
LOG OF TEST HOLES AND PROFILE



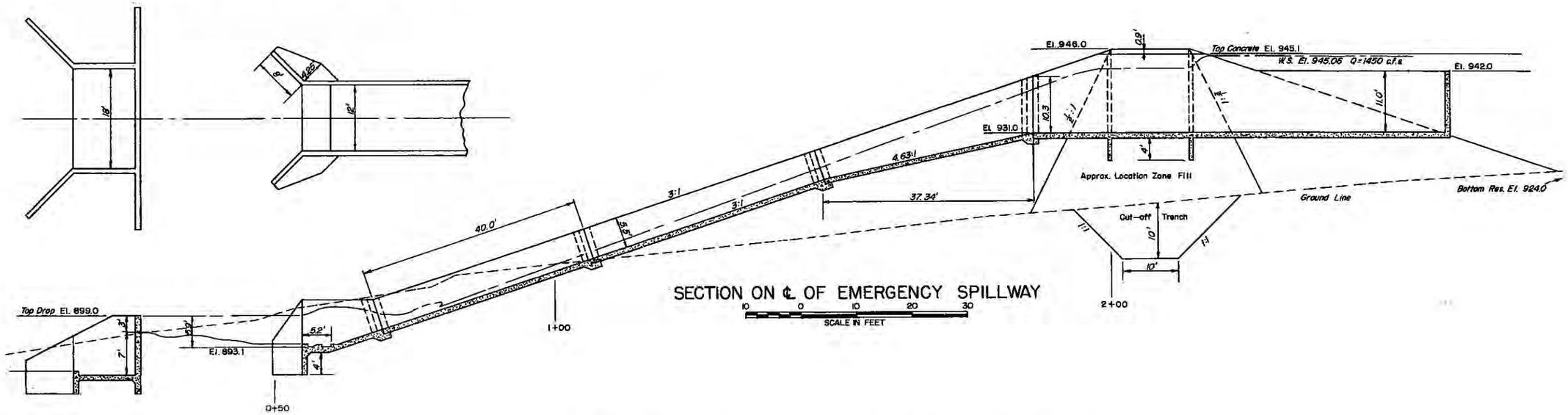
CAPACITY CHART



PRINCIPAL SPILLWAY DISCHARGE CHART

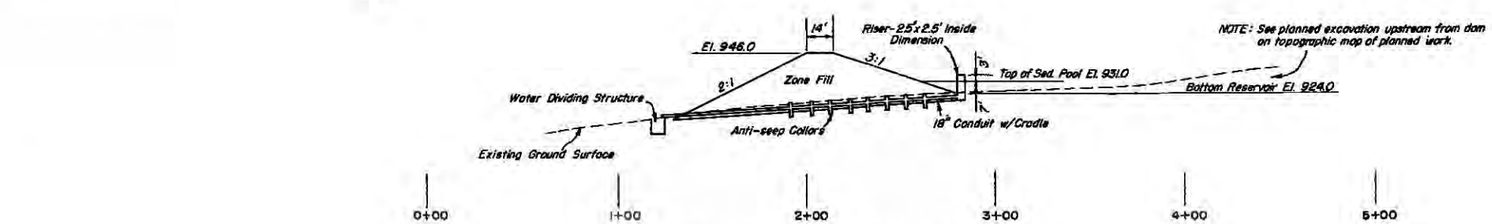


EMERGENCY SPILLWAY DISCHARGE CHART



SECTION ON ℄ OF EMERGENCY SPILLWAY

10 0 10 20 30
SCALE IN FEET



SECTION ON ℄ OF PRINCIPAL SPILLWAY

40 0 40 80 120
SCALE IN FEET

FIGURE 15

WORK PLAN

GROVE CREEK DAM

AMERICAN FORK - DRY CREEK WATERSHED

ALPINE S.C.D., UTAH COUNTY, UTAH

PRELIMINARY PLANS

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Prepared by G.E.C. Date June 1958 Drwg. No. 7-E-19402-N

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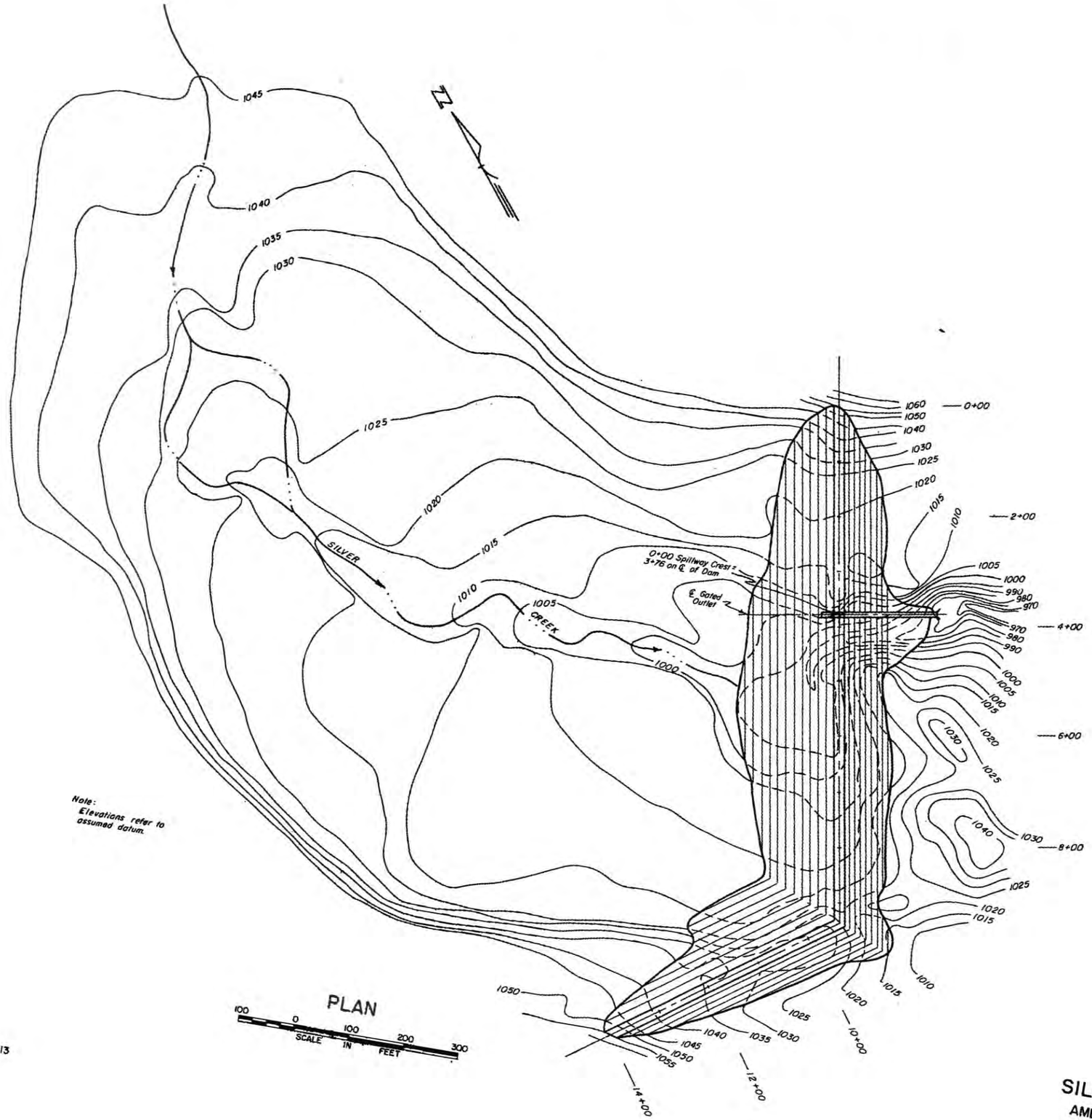

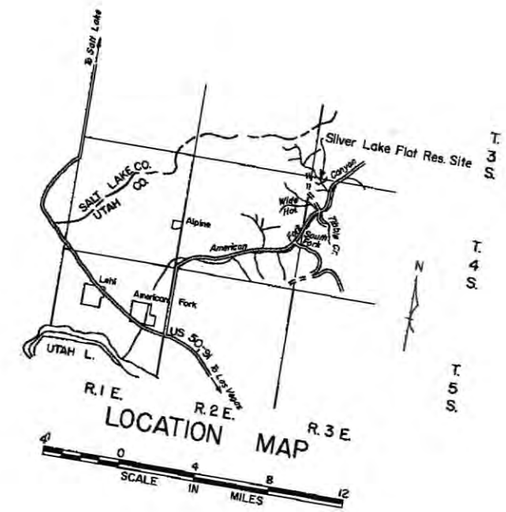

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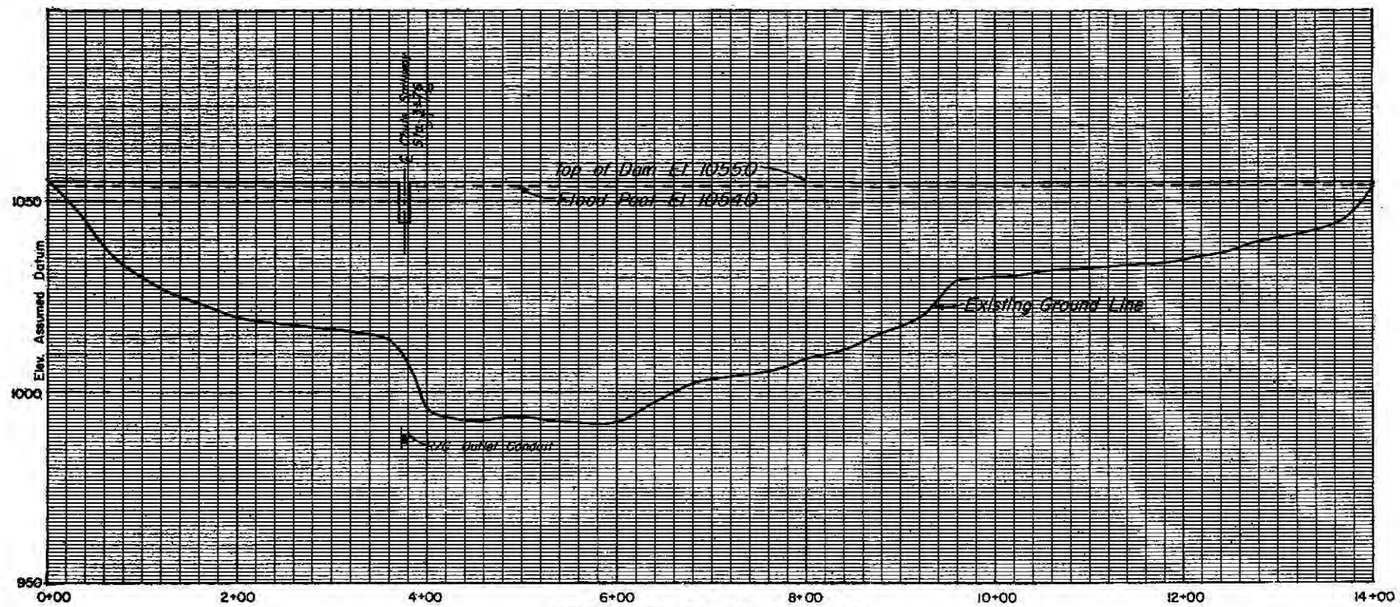
FIGURE 16
WORK PLAN

SILVER LAKE FLAT RESERVOIR

AMERICAN FORK-DRY CREEK WATERSHED
ALPINE S.C.D., UTAH COUNTY, UTAH
PRELIMINARY PLANS
U. S. DEPARTMENT OF AGRIC...



PROFILE ON ℄ OF DAM

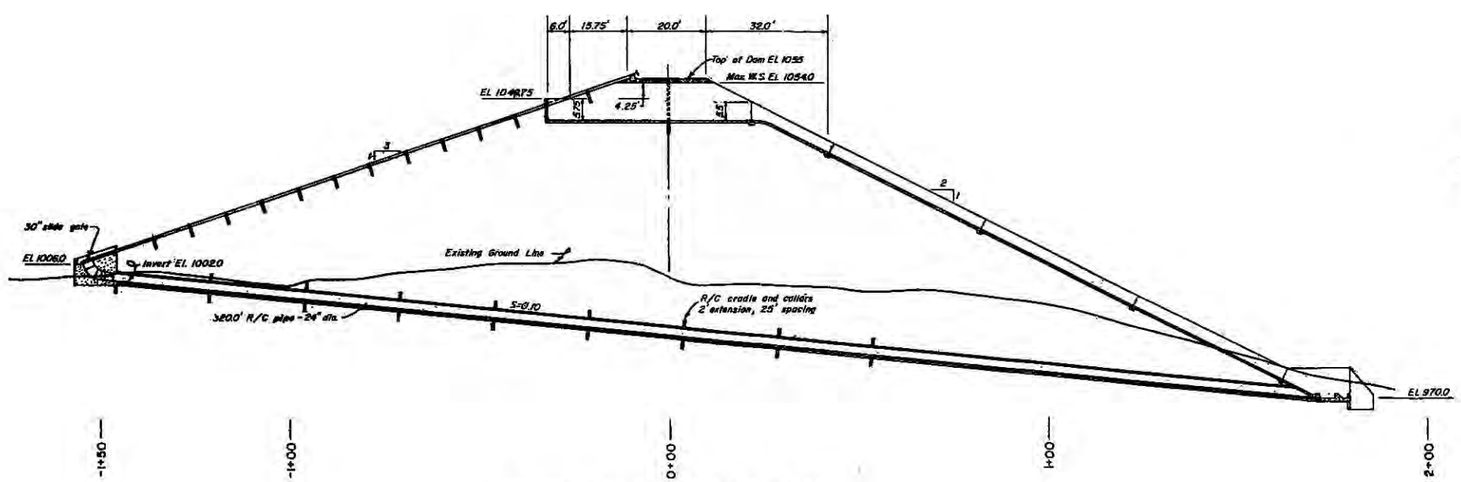
STORAGE CAPACITY CHART (Ac. Ft.)

CONTOUR	AREA AT CONTOUR ACRES	ACRE FEET BETWEEN CONTOUR	ACRE FEET CAPACITY OF RESERVOIR AT CONTOUR
99.5	0.22	2.55	
1000	0.80	6.55	2.55
1005	1.82	16.63	9.10
1010	4.83	38.33	26.73
1015	10.50	63.08	64.06
1020	14.73	87.87	27.14
1025	20.40	115.20	215.01
1030	25.68	136.41	330.21
1035	28.91	156.40	466.69
1040	33.65	180.95	623.09
1045	38.73	79.46	804.04
1047	40.73		823.50
1050			1005.00
1054			1180.0

EMERGENCY SPILLWAY

W.S. ELEV.	DISCHARGE
1049.75	0
1050.25	25
1050.75	76
1051.25	145
1051.75	240
1052.25	341
1052.75	465

STORAGE - DISCHARGE TABLES



SECTION THROUGH DAM

ON CENTERLINE OF CONDUIT AND CHUTE

20 0 20 40 60

SCALE IN FEET

FIGURE 17

WORK PLAN

SILVER LAKE FLAT RESERVOIR

AMERICAN FORK-DRY CREEK WATERSHED

ALPINE S.C.D., UTAH COUNTY, UTAH

PRELIMINARY PLANS

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Prepared by FR/REG Date June, 1956 Drwg No. 7-E-19403-N

Sheet 2 of 2 Sheets

5.0 file

SUPPLEMENTAL WATERSHED WORK PLAN AGREEMENT NO. 4

between the

Alpine Soil Conservation District

North Utah County Water Conservancy District

Alpine Irrigation Company

Lehi Irrigation Company

American Fork Irrigation Company

Pleasant Grove Irrigation Company

Lehi City

Alpine City

Pleasant Grove City

American Fork City

Utah County

Utah State Department of Fish and Game

(hereinafter referred to as the Sponsoring Local Organization)
State of Utah

and the

Soil Conservation Service
United States Department of Agriculture
(hereinafter referred to as the Service)

Whereas, the Watershed Work Plan Agreement for the American Fork-Dry Creek Watershed, State of Utah, executed by the Sponsoring Local Organization named therein and the Service, became effective on the 21st day of May 1959; and

Whereas, three supplemental agreements dated September 11, 1959, October 13, 1960, and April 2, 1962, have been previously executed; and

Whereas, in order to carry out the watershed work plan for the said watershed, it has become necessary to modify said watershed work plan agreement as supplemented; and

Whereas, a supplemental watershed work plan which modifies the watershed work plan dated June 1958 for said watershed has been developed through the cooperative efforts of the Sponsoring Local Organization and the Service which plan is annexed to and made a part of this agreement.

Now, therefore, the Sponsoring Local Organization and the Service hereby agree on the following modifications in the terms, conditions, and stipulations of said watershed work plan agreement as supplemented.

1. It is agreed that the Utah State Department of Fish and Game will become one of the sponsors of the watershed work plan with responsibility for participation in the installation of works of improvement as set forth hereinafter.

2. Paragraphs of the watershed work plan agreement as supplemented are modified as shown below.

Paragraph number 1 is modified to read as follows:

1. The Sponsoring Local Organization will acquire without cost to the Federal Government such lands, easements, and rights-of-way and make such relocations of facilities as will be needed in connection with the works of improvement (estimated cost, $64,600).

Paragraph number 3 is modified to read as follows:

3. The percentage of construction costs of structural measures to be paid by the Sponsoring Local Organization and by the Service is as follows:

Works of Improvement	Sponsoring Local Organization (Percent)	Service (Percent)	Estimated Construction Cost (Dollars)
Dry Creek, Grove Creek, and Battle Creek Debris Basins	0	100	404,000
Tibble Fork Debris Basin			
Specific Costs (Recreation)			
Stripping	6 1/	94	22,330
Blanketing	26 1/	74	34,200
Remaining (Flood Prevention)	0	100	171,970
Structural Measures for Agricultural Water Management			
Irrigation System Improvements			
Measures constructed or now under project agreement.	64.4	35.6	256,360
Measures not now under project agreement	50	50	275,680
Silver Lake Flat Reservoir	50	50	577,000

1/ 12% of stripping and 54% of blanketing costs are specific costs charged to recreation

Paragraph 4 is modified to read as follows:

4. The Service will bear the costs of all installation services applicable to structural measures for flood prevention, recreation, and agricultural water management (estimated cost, $428,845).

Paragraph 5 is modified to read as follows:

5. The Sponsoring Local Organization will bear the costs of administering contracts (estimated cost, $32,600).

Alpine Soil Conservation District
Local Organization

By Leo P Haney

Title Chairman

Date Apr 8-1963

The signing of this agreement was authorized by a resolution of the governing body of the Alpine Soil Conservation District
Local Organization

adopted at a meeting held on March 11, 1963

Johnny Swenson
(Secretary, Local Organization)

Date April 8, 1963

North Utah County Water Conservancy District
Local Organization

By Leo P Harvey

Title Chairman

Date Apr 8-1963

The signing of this agreement was authorized by a resolution of the governing body of the North Utah County Water Conservancy District
Local Organization

adopted at a meeting held on March 14, 1963

Weber Dean Stirm
(Secretary, Local Organization)

Date April 8, 1963

Alpine Irrigation Company
Local Organization

By Wendell T Moyle

Title President

Date 4-8-63

The signing of this agreement was authorized by a resolution of the governing body of the Alpine Irrigation Company
Local Organization

adopted at a meeting held on April 8-1963

Leland Beck
(Secretary, Local Organization)

Date April 8-1963

Lehi Irrigation Company
Local Organization

By Eldred V. Fox

Title President

Date April 6, 1963

The signing of this agreement was authorized by a resolution of the governing body of the Lehi Irrigation Company
Local Organization

adopted at a meeting held on March 25, 1963

Norman Coates
(Secretary, Local Organization)

Date April 6, 1963

American Fork Irrigation Company
Local Organization

By Marion Green

Title President

Date April 5, 1963

The signing of this agreement was authorized by a resolution of the governing body of the American Fork Irrigation Company
Local Organization

adopted at a meeting held on March 14, 1963

Albert S. Bailey
(Secretary, Local Organization)

Date April 5, 1963

Pleasant Grove Irrigation Company
Local Organization

By Leo C Harvey

Title Pres

Date Apr 8 1963

The signing of this agreement was authorized by a resolution of the governing body of the Pleasant Grove Irrigation Company
Local Organization

adopted at a meeting held on March 9 1963

Harold S. Parker
(Secretary, Local Organization)

Date Apr 8 1963

Lehi City
Local Organization

By Harold D. Westring

Title Mayor

Date April 8, 1963

The signing of this agreement was authorized by a resolution of the governing body of the Lehi City
Local Organization

adopted at a meeting held on 26 MARCH 1963

W E Nielson
(Secretary, Local Organization)

Date 26 MARCH 1963

Alpine City
Local Organization

By Vern W. Clark

Title mayor

Date April 8, 1963

The signing of this agreement was authorized by a resolution of the governing body of the Alpine City
Local Organization

adopted at a meeting held on 8 April 1963

Carl A Park
(Secretary, Local Organization)

Date 8 April 1963

Pleasant Grove City
Local Organization

By Paul T Sandham

Title Mayor

Date April 8 1963

The signing of this agreement was authorized by a resolution of the governing body of the Pleasant Grove City
Local Organization

adopted at a meeting held on April 1- 1963

Mellon D Rodwell
(Secretary, Local Organization)

Date April - 1- 1963

American Fork City
Local Organization

By Glen T Anderson

Title Mayor

Date April 8, 1963

The signing of this agreement was authorized by a resolution of the governing body of the American Fork City
Local Organization

adopted at a meeting held on April 8, 1963

Hugh P. Shelley
(Secretary, Local Organization)

Date April 8, 1963

Utah County
Local Organization

By Marvell J. Grimmel
Sterling H. Jones

Title Commissioners

Date 4/5/63

The signing of this agreement was authorized by a resolution of the governing body of the Utah County
Local Organization

adopted at a meeting held on April 5 1963

Marie Van Wagenen
(Secretary, Local Organization)

Date April 5, 1963

Utah State Department of Fish and Game

By Harold L. Cox

Title Director

Date April 8, 1963

Soil Conservation Service
United States Department of Agriculture

By J. A. Libby
State Conservationist

Date April 8, 1963

SUPPLEMENTAL WATERSHED WORK PLAN

AMERICAN FORK-DRY CREEK WATERSHED

Utah County, Utah

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress, 68 Stat. 666) as amended by the Act of August 7, 1956 (Public Law 1018, 84th Congress, 70 Stat. 1088).

Prepared by:

Alpine Soil Conservation District
North Utah County Water Conservancy District
Pleasant Grove City
American Fork City
Alpine City
Lehi City
Pleasant Grove Irrigation Company
American Fork Irrigation Company
Alpine Irrigation Company
Lehi Irrigation Company
Utah County
Utah State Department of Fish and Game

With assistance by:

U. S. Department of Agriculture, Soil Conservation Service
U. S. Department of Agriculture, State Office of the Agricultural Stabilization and Conservation Committee
U. S. Department of Agriculture, Forest Service
U. S. Department of Interior, Bureau of Land Management
U. S. Department of Interior, Fish and Wildlife Service
U. S. Department of Interior, National Park Service
Utah State Fish and Game Department
Utah State Land Board
Utah State Department of Forestry and Fire Control
Utah State Road Commission
Utah Cooperative Extension Service

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Introduction

The American Fork-Dry Creek Watershed was approved for operations May 21, 1959. Since that time, approximately 50% of the land treatment measures, two of the debris basins, and 35% of the improvements on irrigation company systems have been installed.

Crop and range lands, on national land reserve and private land, are being converted at an accelerated rate to urban, industrial and recreational uses.

Studies made by the U. S. Forest Service in connection with the application of planned land treatment measures on National Forest lands reveal a need for increasing the extent of such treatment.

The Sponsoring Local Organizations feel that adjustments including deletions as well as increases or decreases in the extent of planned improvements on irrigation company systems are needed. Experience gained in operation of the improvements installed to date show that these changes can be made with no decrease in benefits.

Unit cost of construction for planned structural measures have increased approximately 52% since the work plan was prepared.

Problems uncovered in detailed foundation and borrow investigation for the particularly complex soils and geologic conditions associated with the Tibble Fork debris basin and the Silver Lake Flat Reservoir as well as changes in hydrologic criteria for the Tibble Fork structural emergency spillway require that designs and work plan estimates for these structures be revised upward.

Continued population expansion and economic growth both within and adjacent to the watershed have made the Sponsoring Local Organizations increasingly aware of the growing demand for recreational opportunity within the watershed.

The Sponsoring Local Organizations have requested the Department of Agriculture, Soil Conservation Service, to assist in the preparation of a supplemental watershed work plan including the needed adjustments in planned treatment, adjustments in cost estimates, fisheries for recreation in the Tibble Fork and Silver Lake Flat Reservoir, revisions in cost sharing for measures not now under project agreement.

The revisions included herein are outlined below.

1. Deletion of land treatment measures for watershed protection as follows: 2,000 acres of cross slope strip cropping, 800 acres of range seeding on private land, and 80 acres of range seeding and 1.5 miles of fencing on the National Land Reserve (BLM).

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These treatment measures were planned for installation on lands where urban, industrial, and recreational uses now or will in the near future limit its use for agricultural purposes.

2. Increases in land treatment measures for flood prevention on National Forest lands: channel stabilization, 615 feet; contour furrowing, 40 acres; trail erosion control, 3.4 miles.

3. Deletion of 9,500 feet of canal lining, one desilting basin, 4,420 feet of pipeline, 8 ponds (ponds construction), and 3.1 miles of ditch construction from agricultural water management structural measures to be installed on irrigation company systems.

4. Inclusion of a fishery in the Tibble Fork debris basin incidental to its flood prevention purpose.

5. Inclusion of a fishery in the Silver Lake Flat Reservoir.

6. Revised costs for all structural measures brought about by increased cost of construction, changes in design and inclusion of the fisheries in the design of the Tibble Fork debris basin and the Silver Lake Flat Reservoir.

7. Revised cost sharing for all structural measures not now under project agreement.

8. The Utah State Department of Fish and Game has been added as a sponsor to carry out the development of a fishery in the Silver Lake Flat Reservoir and Tibble Fork debris basin.

9. Revised responsibilities for the North Utah County Water Conservancy District for the construction and operation of Silver Lake Flat Reservoir.

10. Pages 1, 2, 17, 18, 19, 20, 21, 25, 26, 27, 28, 29, 30, 31, 34, 35, 36, and Tables 1, 2, 3, 5, 6, 7, 8, and 8a of the watershed work plan are modified. They conform to the same page and table numbers included in the supplemental work plan dated April 1963 which is a part of this supplemental agreement.

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SUPPLEMENTAL WATERSHED WORK PLAN

AMERICAN FORK-DRY CREEK WATERSHED

Utah County, Utah

SUMMARY OF PLAN

The Watershed Work Plan for the American Fork-Dry Creek Watershed was prepared by the Alpine Soil Conservation District, the cities of American Fork, Pleasant Grove, Lehi, and Alpine, the American Fork, Pleasant Grove, Lehi, and Alpine Irrigation Companies, the North Utah County Water Conservancy District, and Utah County. Technical assistance was provided by the Soil Conservation Service, Forest Service, and the State Offices of the Agricultural Stabilization and Conservation Committee, United States Department of Agriculture; the Bureau of Land Management, National Park Service, the Fish and Wildlife Service, United States Department of Interior; the Utah State Fish and Game Department, Utah State Land Board, Utah State Department of Forestry and Fire Control, the Utah State Road Commission, and the Utah Cooperative Extension Service.

This work plan covers an area of approximately 118,710 acres in northern Utah County, Utah.

Measures to be Installed

The plan was developed to reduce sediment and floodwater damages to urban property, irrigation systems, farmland, recreational facilities, and roads and bridges within the watershed; reduce water losses in canals and ditches; improve irrigation efficiencies on the farms; and to provide additional late season irrigation water. It includes a combination of land treatment measures and debris basins to reduce sediment yields and summer flood flows, an irrigation storage reservoir, and improvements to canal systems and farm irrigation facilities. The estimated cost of installation for the works of improvement included in the work plan is $4,195,560. The Federal (P.L. 566) share of this will be $2,053,590. The share from other funds will be $2,141,970.

Land Treatment Measures

The restoration of vegetative cover on approximately 74,200 acres of upper watershed land involves terracing, seeding, management, increased fire protection, and other works to stabilize critical floodwater and sediment source areas. The measures will be installed on both public and private lands. Land treatment for the improvement of irrigation efficiencies and the conservation of soil and water will be accelerated and will include such measures as land leveling, canal lining, drainage, grassed waterways, and others. The total installation cost of these measures is estimated to be $1,967,625 of which $484,755 or 25% will be Federal (P.L. 566) cost and $1,442,870 or 75% from other funds. Cost of the treat-

ment on federal lands is estimated to be $358,075. Cost on non-federal lands is estimated to be $1,569,550.

Structural Measures

The structural measures to be installed consist of four debris basins, an irrigation storage reservoir, ditch lining, pipe lines, overnight storage ponds, ditch construction, drop spillways, desilting basins, and a diversion dam. Estimated total installation cost of the structural measures is $2,267,935 of which $1,568,835 or 72% will be federal (P.L. 566) cost and $699,100 or 28% will be from other funds. The installation cost includes the cost of lands, easements, and rights-of-way for the structural sites, relocation of existing facilities, and contract administration, all of which will be borne entirely by non-federal interests.

Damages and Benefits

The project will reduce or eliminate sediment and floodwater damages from summer floods of up to and including 100-year frequency events. It will provide an adequate irrigation water supply for irrigated lands now only partially supplied. Average annual flood prevention benefits will be $54,560, agricultural water management primary benefits $56,150. Average annual cost of the measures for flood prevention and agricultural water management will be $101,440. The ratio of average annual benefits to average annual costs is 1.6 to 1.

Provisions for Accomplishing and Financing Construction

Sponsoring organizations will acquire necessary land, easements, and rights-of-way, execute agreements with owners of private lands for installation of the land treatment measures, provide the non-federal share of the installation costs of structural and land treatment measures, cooperate with the Forest Service and Bureau of Land Management for installation of the program on federal lands within the watershed and other local, state, and federal agencies concerned with the project. Water rights affecting works of improvement have already been acquired. Local sponsoring organizations will contract for the construction of the structural measures in the work plan.

Operation and Maintenance

Annual operation and maintenance costs are estimated to be $5,575.

Land treatment measures on private land will be maintained by owners and operators of the land or by local sponsoring organizations under agreement with the landowners. Maintenance costs for land treatment measures on federal land during the project installation period will be borne by project funds. After the project installation period, maintenance of land treatment measures on federal lands will be financed from regular appropriations of the respective federal agencies.

All structural measures will be maintained by the local sponsoring organizations. Specific responsibilities are detailed under "Provisions for Operation and Maintenance."

EXISTING OR PROPOSED WORKS OF IMPROVEMENT

Management programs are in existence for all land and water resources within the watershed. Private lands are included in the regular conservation programs of the Alpine Soil Conservation District and Agricultural Conservation Program Service. Publicly owned National Forest, National Monument, Federal Range, and State of Utah lands are managed under legal authorities applying to them. Accomplishments under these programs in the past 10 years are summarized in Table 1a. The Utah State Fish and Game Department and the U. S. Fish and Wildlife Service have management programs for the wildlife resources. The Utah State Department of Forestry and Fire Control participates in forestry and fire control on private and state lands.

The Bureau of Reclamation Deer Creek project furnishes some water to the area through the Provo Reservoir Canal and the Salt Lake Aqueduct. These facilities will be protected from flood hazards by the works of improvement to be installed under the watershed project. The Bureau of Reclamation is currently planning the Central Utah Project which, when constructed, will furnish supplementary water to areas within the watershed. The irrigation storage facilities proposed in this plan will not serve any areas currently scheduled to receive supplemental water under the proposed Central Utah Project.

WORKS OF IMPROVEMENT TO BE INSTALLED

The works of improvement to be installed constitute an effective and feasible combination of land treatment and structural measures needed to stabilize and improve watershed resources. The works of improvement will reduce damages from recurring floods, improve irrigation water management, reduce water loss, provide additional water for late season use, provide increased opportunity for recreation, reduce operation and maintenance costs on irrigation systems, and insure the economic stability of the agricultural enterprise. These measures are summarized in Table 1.

Land Treatment Measures

The land treatment measures to be installed include only those measures that have measurable effect in reducing runoff and erosion, will bring about more efficient use of the improved water supply resulting from the proposed structural measures for agricultural water management, and provide for the use of the land within its capabilities. In addition, the land treatment measures will provide significant returns to the land owners or operators. These measures include those to be installed under going federal, state, and local programs and measures needed to accelerate the going programs.

The measures planned will accomplish these objectives through the improvement of plant cover, augmented by mechanical treatment of the critical floodwater and sediment source areas, and by more efficient control of irrigation water on the irrigated crop land.

The full effect of the upstream land treatment measures in reducing summer flood peaks and sediment yield from critical areas will not be realized immediately. Structural measures are required to store and retard floodwater sediment during and subsequent to the installation period.

The downstream land treatment measures will have a substantial effect in reducing irrigation water deficiencies. Structural measures will further reduce these deficiencies by increasing the water supply by storage, reducing losses from seepage and non-beneficial use by riparian vegetation, and regulation of streamflow for better utilization of the water supply.

Land Treatment Measures for Watershed Protection

These measures are an important part of this plan. Those to be installed on range land include proper use, stockwater developments, seeding, contour furrowing, fencing, and pitting. These will reduce sediment yields and flood peaks, increase the efficiency of the land treatment measures for flood prevention, and increase forage production. After the land treatment measures have become effective, livestock and big game use of the area will be managed to insure continued stabilization of the critical areas. Road and trail construction and maintenance, logging operations, recreation, and other land uses will be planned and coordinated with soil and water management needs.

Measures to be installed on dry cropland include stubble mulching, grassed waterways, and fall tillage. These will reduce erosion and increase crop production.

Measures to be installed on irrigated cropland include improved water management, land leveling, drainage, canal lining (on-farm), and minor structures. They are an acceleration of the going program of the Alpine Soil Conservation District. They will provide for better use of the land and water resource.

Acceleration of conservation planning and application is feasible within the project period both on private and federally owned lands. Costs and quantities of measures to be installed for watershed protection are listed on Table 1. Cost of technical assistance for the installation of the accelerated portion of the land treatment program on non-federal lands, estimated to be $166,840, and the total cost of the accelerated portion of the program on National Forest Range lands, estimated to be $48,455, will be borne from P.L. 566 funds. Cost of technical assistance for the installation of going program measures on non-federal lands, estimated to be $123,100, will be borne from regular appropriations of the Soil Conservation Service. Total installation cost of the going program measures, on National Forest lands, including technical assistance, estimated to be $75,200, will be borne from regular appropriations of the Forest Service. Installation costs other than technical assistance on non-federal lands, estimated to be $1,227,170, will be from other funds.

Land Treatment Measures for Flood Prevention

The measures planned for installation on the critical floodwater and sediment source areas will reduce sediment production and summer flood peaks, chiefly through the improvement of plant cover but also through the installation of mechanical treatment such as special purpose terraces, gully control, drop spillways at headcuts, and road and trail erosion control. Practices such

as increased fire protection, tree planting, and contour furrowing will assist in the revegetation of the area. Increased fire protection will be secured by the purchase and operation of additional fire control equipment such as pumper trucks, hand tool outfits, tanks, etc. Quantities of land treatment measures for flood prevention are listed in Table 1.

The cost of installing these measures is estimated to be $286,860. Cost from P.L. 566 funds will be $269,460; from other funds $17,400. Cost of these measures on federal lands is $234,420.

Structural Measures for Flood Prevention

Four debris basins will be installed, on Dry Creek, Grove Creek, Battle Creek, and American Fork Creek. These structures will be earth-fill dams, at locations shown on Figure 2. Each structure will be provided with a principal spillway and a reinforced concrete emergency spillway. All principal and emergency spillways will discharge into existing channels. Borrow areas will be graded to prevent dead storage.

The sediment pool of the Tibble Fork debris basin located on American Fork Creek, will be used as a fishery incidental to its flood prevention purpose until such time as the accumulation of sediment prevents it. In order to develop a fishery in the sediment pool, it will be necessary to increase the extent of stripping and increase the extent of blanketing. The cost to be incurred for this work, over that required for the debris basin, has been assigned to recreation purposes as a specific cost.

Principal features of the structures are shown on the Preliminary Plans, and capacities, sizes, areas, and other details on Table 3.

Each debris basin will have capacity for the expected sediment accumulation for the next 50 years, and floodwater retarding capacity to reduce summer flood peaks. It will be provided with an ungated principal spillway with ported riser to drain the basin after summer floods and pass ordinary streamflows. Summer flood peaks of 100-year frequency size will be reduced from 360 cfs to 100 cfs by the Dry Creek Basin, from 1500 cfs to 206 cfs by the Tibble Fork basin, from 655 cfs to 32 cfs by the Grove Creek basin, and from 411 cfs to 32 cfs by the Battle Creek basin. The debris basins will have little or no effect in reducing snowmelt flood peaks. The Dry Creek debris basin will incidentally reduce the differential between day and night flows during parts of the snowmelt runoff period.

The estimated total installation cost of these measures is $864,950. Distribution of costs for each structure is shown in Table 2. Approximately 70% of the critical sediment and floodwater source areas will be upstream from these structures.

Structural Measures for Agricultural Water Management

These measures will increase irrigation efficiency, reduce water losses and erosion of ditches. They are that part of the going conservation plans of the irrigation companies that will be accelerated to complement the land treatment and flood prevention phases of this plan.

Other Irrigation Measures. The Lehi Irrigation Company will install 49,600 lined feet of concrete canal lining, on the First North, Second North, Field, Gess Gurney, Fox, Buchanan, Smith, Cedar Hollow, Upper South Club, New Survey, and Fort Canyon Cutoff canals. These canals have capacities varying from 8 to 70 cfs. The lining will be Portland cement concrete, with a bottom width of 12 inches, 30 inches, or 48 inches depending on the quantity of water to be handled. Thickness of the lining will be 2-1/2 inches. The lining is designed for installation by slipform machines. Cost of this work, including technical assistance and contract administration, is estimated to be $155,000.

The American Fork Irrigation Company will install 39,730 lineal feet of concrete lining on the McArthur, Cemetery, West Fields, Mitchell, East, Mitchell Main, Wagstaff, and Mott canals. These canals have capacities varying from 15 to 90 cfs. Lining will be of the type described for the Lehi Irrigation Company canals. Total cost of the lining is estimated to be $178,695. Two concrete drop spillways will be installed on the Mitchell Main canal and at the West Division, at a cost of $8,595; and one desilting basin, approximately 10 acre feet capacity, on the Mitchell Main canal at a cost of $1,875. Total cost on this irrigation system is estimated to be $189,165.

The Pleasant Grove Irrigation Company will install 60,186 lineal feet of concrete lining on the Meredith, Gardner, Mill, 80-Rod, and Main canals. These canals have capacities varying from 8 to 20 cfs. Lining will be of the type described for the Lehi Irrigation Company canals. Total cost of the lining is estimated to be $181,365. Three thousand five hundred lineal feet of pipeline, with a capacity of 15 cfs, will be installed in Battle Creek to bring irrigation water from Big Spring to existing facilities of the irrigation company at the mouth of the canyon. This pipeline will be 14-inch steel pipe. Total cost of the pipeline is estimated at $28,350. Total cost on the Pleasant Grove Irrigation Company system is estimated to be $209,715.

The Alpine Irrigation Company will install 8,700 lineal feet of concrete canal lining on the Chipman Creek--Alpine, and Fort Canyon--Hog Hollow canals. These canals have capacities of 18 cfs and 20 cfs respectively. Lining will be of the type described for the Lehi Irrigation Company canals. Total cost is estimated at $56,915. A 6-inch concrete pipeline to carry 1 cfs from Box Elder Creek to Grove Spring, 4,000 lineal feet, will be installed at a total cost of $15,000. A reinforced concrete diversion dam on Dry Creek will be constructed at a total cost of $8,250. Total cost on this system is estimated to be $80,165.

The Alpine Soil Conservation District will install 6,800 lineal feet of concrete canal lining on North Union Canal. These canals will be of the type described for the Lehi Irrigation Company. Total cost of the lining is estimated to be $30,940.

These measures are to be installed on existing company-owned rights-of-way. Total installation cost of the measures for agricultural water management is estimated to be $664,985, shown in Table 1 and 2. Federal share is $335,535, non-federal share is $329,450. Locations are shown in Figure 2.

Multiple Purpose Structure

Silver Lake Flat Reservoir. This structure will be located on Silver Fork, a tributary of American Fork Creek, approximately 4-1/2 miles above Tibble Fork debris basin. Storage is provided for a fishery and water for irrigation. The stored irrigation water will be for late season use on lands served by the Lehi, American Fork, and Pleasant Grove Irrigation Companies. Principal features of the structure are shown on the preliminary plans, figures 16 and 17, and capacities, etc. on table 3.

The estimated installation cost is $738,000. Share from P.L. 566 funds is $447,500; from other funds, $290,500. See table 2 for distribution of costs.

The Lehi, Pleasant Grove, and American Fork Irrigation Companies have an approved right to develop water storage at this site.

TABLE 1

(Follows Page 36a, This Supplement)

BENEFITS FROM WORKS OF IMPROVEMENT

Physical Effects

The structural and land treatment measures proposed in this plan will have significant physical effects on water and soil resources of the watershed. In the upper watershed, the land treatment measures will (1) reduce sediment yield and surface runoff from principal sediment and flood source areas, (2) reduce sheet and gully erosion and accelerate the revegetation of eroded and gullied areas, (3) bring about a general overall improvement of the vegetal cover of the upper watershed, (4) provide an effective means of suppressing forest or brush fires and for reducing the extent of damage from such fires, (5) decrease the discharge of sediment and debris into the main channels; and, (6) generally improve the area for recreation, grazing, or other use.

In the lower watershed and along the major channels, the land treatment and structural measures will (1) decrease the magnitude of summer flash flood flows in the main channels and reduce the frequency of overbank flooding, (2) reduce the task of maintaining adequate channel capacities through American Fork and Lehi, (3) decrease the quantity of sediment which must be handled through irrigation and power diversions or in canals and ditches, (4) reduce the frequency by which floods damage roads, bridges, culverts, railroads, or diversions; and (5) minimize indirect damages which result from interruptions to travel, to commercial activity, or to irrigation.

The major structures, particularly those on Dry Creek and American Fork Creek, will also have the effect of smoothing diurnal fluctuations in streamflow during periods of snowmelt runoff, and permit increased efficiency in the use of irrigation water during this period. The fisheries in the Tibble Fork structure and the Silver Lake Flat Reservoir will make an important contribution to recreation opportunity in the watershed.

The maximum efficient utilization of the land and water resources in the irrigated portion of the watershed will be facilitated by the combination of agricultural water management measures and on-farm land treatment measures installed under this plan. Further, the full accomplishment of the benefits calculated for this group of measures is based on the interdependent effect of the various measures and calls for the establishment of all of the measures during the ten year installation period.

On-farm measures included in this plan will improve irrigation efficiencies so that the gross irrigation needs of crops will be reduced. This will have the immediate effect of insuring the greatest possible benefits from the added available mid-season water developed through lining, piping, and storage. In the long run, it will also effectively add to the mid and late season water supply on the remaining short supply lands by virtue of the reduced gross volume of irrigation water required for full production.

The lining of canals and ditches will have the effect of adding to the full season irrigation water supply but, more important, it will add to the critical mid-season supply. Further, lining will also reduce the accretion of seepage water to the water table in poorly drained areas below the canals. The piping of springs into the main irrigation canals will have essentially the same effect as lining.

The storage of irrigation water for mid-season use is an essential factor

in achieving a stabilized full season supply for a maximum acreage of irrigated crop land. The development of a full season supply for the greatest possible acreage has an important influence on the successful application of improved on-farm irrigation management measures and on other improved farm management measures. The maximum productive effect of fertilizer, for instance, cannot be realized without a full water supply.

Floodwater and Sediment Damage Reduction Benefits

The benefits outlined below include reductions in floodwater and sediment damages from summer floods and reductions in sediment damages from snowmelt floods. No reduction in damages from snowmelt floodwaters is claimed, and these damages are not included in the damage base.

Combined monetary benefits of $54,560 from floodwater and sediment damage reductions throughout the entire watershed amount to 33% of all benefits claimed for the project. The combination of land treatment and structural measures for flood prevention will bring about damage reductions of 88% on Dry Creek, 77% on American Fork Creek, and 89% in the Timpanogos Face area. Initial reductions in 100-year flood peaks (within the installation period) affected by land treatment measures for flood prevention will range from 6% to 25% in the various treatment areas of the watershed. When the land treatment becomes fully effective (30-40 years hence) reductions of up to 75% in flood peaks will be attained in some of the treatment areas. Reduction in sediment rates will range from 40% to 50% in the lower reaches of the three major segments of the watershed, and reductions of sheet erosion--principally in the upper watershed--will range from 55% to 70%.

The downward trend in the production of range forage in the upper watershed will be arrested and a small increase in available forage will be attained when deteriorated range sites have been fully revegetated.

The nature and magnitude of benefits from the project are shown in Table 7.

Agricultural Water Management Benefits

The primary monetary benefits, $56,150, from agricultural water management measures comprise 52% of all primary benefits. Additional secondary benefits, stemming from the increased value of agricultural production will accrue and are set forth in Table 7.

One of the principal benefits of the agricultural water management measures will be the effective increase in the irrigation water supply brought about by the on-farm treatment and the irrigation system improvements. It is calculated that 4,093 acres of land with a present partial supply of irrigation water will be raised to a full supply position with project measures installed. This increase will be principally accomplished by the conservation of water from lining and by the increased irrigation efficiencies brought about by the on-farm measures. Water storage in Silver Lake Flat Reservoir will also make a significant contribution to this improvement.

With all agricultural water management measures in full effect, the acres of irrigated land in the entire watershed with a full supply will be increased by 35%. With a full supply, the increased acreage will be shifted to higher net return crops which will more nearly fill the needs of a growing local population.

An additional, but unevaluated benefit will come from an effective increase in the "early" (May - June) water supply. This water has value, but has not been considered in this analysis.

Recreation Benefits

Several features of the project will have significant effects on the type and amount of recreational activities in the watershed. With capacity reserved for a fish pool in Silver Lake Flat Reservoir and that provided for irrigation storage, the Silver Creek area will be the focal point for swimming, boating, fishing, picnicing, and general recreation activities. The development of the summer home area near the reservoir will be accelerated and its use expanded. A smaller but similar increase in recreation activities will stem from the construction of the Tibble Fork debris basin.

Reduction in flood runoff and sediment production from present flood source areas, the protection from floods afforded by the debris basins and the improvement in streamflow stability will produce better fish habitat conditions along the streams and will allow for maximum use of suitable picnic and summer home sites along the channels. The over-all improvement of the vegetal cover through land treatment measures will improve big game habitat and generally enhance the value of the mountainous portion of the watershed for recreation use. The monetary value of the recreation benefits arising from the establishment of Silver Lake Flat Reservoir will total $32,715 and those from Tibble Fork, $11,835.

Secondary Benefits

Local secondary benefits were calculated only for the increased agricultural benefits which would be produced by the storage of irrigation water in Silver Lake Flat Reservoir. These benefits are derived from local economic activity associated with the handling, transporting, and marketing of increased farm products or production input items. Farm products marketed include dairy products, beef, vegetables, sugar beets, and fruits. Local secondary benefits are largely made up of the value of local labor requirements for the production of dairy products and red meat and labor for producing and harvesting fruits, sugar beets, and vegetables. Secondary benefits will also accrue to local merchants and suppliers through the increased requirement for production and personal items.

The importance of this type of benefit to the community is in the contribution it makes toward creating new full year and seasonal employment opportunities. Any new outlet for labor in an area where population growth is occurring at an accelerated pace helps to fill the expanding need for employment opportunities.

COMPARISON OF BENEFITS AND COSTS

Flood Prevention Measures

Total annual benefits from all project measures will be $166,410 and annual cost of installing these measures will be $101,440. The benefit-cost ratio is 1.6 to 1. Unit comparisons of benefit and cost are set forth in Table 8.

ACCOMPLISHING THE PLAN

The execution of this plan will be a joint undertaking of private, local, State, and Federal interests. Non-federal interests include individual farmers and ranchers, the towns of Lehi, Alpine, American Fork, and Pleasant Grove, the Lehi Irrigation Company, Alpine Irrigation Company, American Fork Irrigation Company, Pleasant Grove Irrigation Company, Alpine Soil Conservation District, Utah County, Utah State Fish and Game Department, Utah State Road Commission, Utah State Land Board, Utah State Department of Forestry and Fire Control, State and County Agricultural Stabilization and Conservation Committees, and the North Utah County Water Conservancy District, now being formed by the sponsoring organizations of the watershed project under appropriate laws of the State of Utah. The Water Conservancy District will be a sponsor of this project upon completion of the legal formation of the District. Federal agencies involved in the project include the Soil Conservation Service, Forest Service, Bureau of Land Management, and National Park Service. Cost sharing arrangements between federal and non-federal interests are matters of mutual agreement and are set forth in detail in Tables 1 and 9.

Responsibilities for Installation

In order to carry out a coordinated acceleration of the land treatment measures with structural measures for flood prevention and agricultural water management and the going conservation programs within the watershed, close cooperation and specific responsibilities are required of private interests, the sponsors, and local, state, and federal agencies assisting in this project.

The Alpine Soil Conservation District will:

1. Provide local leadership and direction which will continue the going conservation program of the District at the rate existing prior to the development of this work plan.

2. Provide local leadership to insure the scheduled installation of the accelerated land treatment measures for watershed protection and flood prevention on private lands.

3. Survey, acquire, and record all necessary lands, easements, and rights-of-way for the works of improvement on the North Union Canal and other non-sponsoring irrigation companies.

4. Act as contracting local organization for installation of works of improvement planned for this canal. The district will use the loan provisions of the Act to finance the construction requesting a loan in the amount of $11,340. The loan will be repaid through contract with the irrigation company.

The North Utah County Water Conservancy District will:

1. The North Utah County Water Conservancy District and the Forest Service will jointly install land treatment measures for flood prevention and watershed protection on the intermingled Federal and non-Federal lands in T 3S, R 3E.

2. The North Utah County Water Conservancy District will acquire without cost to the Federal Government such easements or rights-of-way as will be needed in connection with the land treatment measures for flood prevention and watershed protection installed on non-Federal land in T 3S, R 3E (estimated cost, $17,000).

3. The Federal Government will provide 87% of the cost and the North Utah County Water Conservancy District will provide 13% of the cost (estimated to be $10,845) for installation of land treatment measures for flood prevention and watershed protection on Federal and non-Federal land in T 3S, R 3E.

4. Furnish funds necessary to assist livestock operators on the private lands in upper American Fork Canyon to relocate elsewhere, to assure limited use of the area.

The District plans to use the loan provisions of the Act and has asked for a loan in the amount of $27,845 to carry out these responsibilities.

5. Survey, acquire, and record all necessary lands, easements, and rights-of-way for the Tibble Fork, Dry Creek, Battle Creek, and Grove Creek debris basins. The Conservancy District will secure a special use permit from the Forest Service for the Tibble Fork structure.

6. Act as contracting local organization for the construction of the Dry Creek, Tibble Fork, Grove Creek, and Battle Creek debris basins.

7. Assume the cost of relocating pipelines at the Grove Creek and Battle Creek debris basins and the power line at the Battle Creek debris basin.

The District will use the loan provisions available under the Act, as amended to cover the costs allocated to it as above. A loan has been asked for in the amount of $36,100.

8. Act as contracting local organization for the construction of the Silver Lake Flat Reservoir and assume 74% of the non-federal share of the construction cost less $26,800 to be provided by the Utah State Department of Fish and Game. Public benefits are 74% of the total benefits derived from the Silver Lake Flat Reservoir.

The Conservancy District will secure a special use permit from the Forest Service for the structure. Funds will be provided through use of loan provisions of the Act. A loan is being requested in the amount of $261,700. This represents the Conservancy District's cost, estimated to be $193,640, and the irrigation companies' cost, estimated to be $68,030. Repayment of the loan will be from funds available to the District through its taxing authority and from assessments of stockholders of the irrigation companies assigned to the District.

Pleasant Grove, American Fork, Alpine, and Lehi Irrigation Companies will:

1. Assist the Alpine Soil Conservation District to accelerate the land treatment program for watershed protection on irrigated lands by helping in education and information activities designed to stimulate private farm operators and owners.

2. The Pleasant Grove Irrigation Company will act as contracting local organization and will furnish funds for costs allocated to them for the installation of the measures proposed for their system. Funds will be provided through use of the loan provisions of the Act, as amended. A loan will be asked for in the amount of $94,985. The loan will be repaid from funds obtained from annual assessments of stockholders.

3. The American Fork Irrigation Company will act as contracting local organization and will furnish funds for costs allocated to them for the installation of the measures proposed for their system. Funds will be provided through use of the loan provisions of the Act, as amended. A loan will be asked for in the amount of $87,065. The loan will be repaid from funds obtained from annual assessment of stockholders.

4. The Alpine Irrigation Company will act as contracting local organization for the installation of the measures proposed for their system. Funds will be furnished jointly by the Alpine Irrigation Company and the North Utah County Water Conservancy District, and provided through use of the loan provisions of the Act, as amended. A loan will be asked for in the amount of $38,980. The loan will be repaid from funds available to the District through its taxing authority and from assessments of stockholders of the irrigation company.

5. The Lehi Irrigation Company will act as contracting local organization and will furnish funds for costs allocated to them for the installation of the measures proposed for their system. Funds will be provided through use of the loan provisions of the Act, as amended. A loan will be asked for in the amount of $69,445. The loan will be repaid from funds obtained from annual assessment of stockholders.

6. The Lehi, Pleasant Grove, and American Fork Irrigation Companies will furnish 26% or approximately $68,030 of the non-federal share of the construction cost of the Silver Lake Flat Reservoir.

The measures in items 2, 3, 4, and 5 will be installed on existing rights-of-way of the companies.

All of these companies have developed a conservation plan with the Alpine Soil Conservation District for their systems.

The Soil Conservation Service will:

1. Furnish necessary technical assistance through the Alpine Soil Conservation District to private land owners in installing land treatment measures scheduled for non-federal lands.

2. Allot monies for the federal share of the installation of land treatment measures for flood prevention on the non-federal lands in upper American Fork Canyon, in accordance with the cost sharing and time schedule set forth herein.

3. Furnish the necessary installation services for engineering surveys, designs, construction plans and specifications, and construction supervision for the structural measures for flood prevention and for agricultural water management.

4. Allot construction money to the project in accordance with the cost sharing and time schedule set forth herein or as revised by mutual agreement and in accordance with national priorities and availability of appropriations at the time of installation.

5. Maintain liaison with sponsor, state, and federal agencies involved in the project to the end that unified effort and coordinated action will produce the most effective results. Consult with and assist the sponsoring organizations, and local, state, and federal agencies in making desirable revisions on the plan if and when circumstances dictate.

The Forest Service will:

1. Carry out the land treatment measures on National Forest lands in accordance with the program outlined in Table 1.

2. Adjust grazing and other uses on National Forest land to facilitate the installation of the planned works of improvement.

3. Furnish technical assistance in planning and application of practices under its departmental responsibility for technical adequacy for woodland planning. This will be done in cooperation with the State Department of Forestry and Fire Control.

4. Review and approve plans and specifications for the Tibble Fork debris basin and the Silver Lake Flat Reservoir, both to be constructed on National Forest lands; issue special use permits for the structures, borrow areas, construction camp, and other necessary land occupancy; inspect the construction of all structures and land occupancy in accordance with the stipulations of the special use permits; issue a timber sale contract or permit for the timber to be removed from the structure sites; and survey and design the new section of the American Fork-Snake Creek road around the Tibble Fork debris basin, and the new Tibble Fork summer home spur road.

5. The Forest Service and North Utah County Water Conservancy District will jointly install land treatment measures for flood prevention and watershed protection on intermingled federal and non-federal lands in T 3S, R 3E. The Forest Service will provide technical assistance for installation.

6. Maintain close liaison with sponsors, individual permittees, and local, state, and federal agencies involved in the project and assist in necessary revisions of the work plan.

The Bureau of Land Management will:

1. Enter into formal non-use agreements, when needed, with the permittees affected by this plan. Upon termination of these agreements, grazing use will be based on annual utilization checks.

2. Maintain close liaison with sponsors, individual permittees, and local, state, and federal agencies involved in the project and assist in necessary revisions of the work plan.

The National Park Service will:

Continue to administer the lands within the Timpanogos Cave National Monument for maximum watershed effectiveness. No measures are proposed for installation under authority of P.L. 566.

Utah County will:

Assume responsibility for relocation of American Fork-Snake Creek road and the summer home spur at the Tibble Fork debris basin as necessary.

The Sponsoring Organizations concerned have given the Service adequate assurance that their share of project costs allocated to them will be available at the time and in the amounts required.

The following State agencies, by agreement with the Sponsors, will participate as shown:

The Utah Fish and Game Department will:

1. Recommend as needed to the Board of Big Game Control game management programs which will bring about and maintain herd size in balance with proper use of game forage.

2. Maintain the 5 browse utilization transects which are set up along the deer winter range of this herd unit. Additional range surveys, deer pellet group counts, and other management information will also be collected and expanded. Utilization and trend studies will be continued on the two acre big game-livestock enclosure established by the Forest Service and the Department.

3. Cooperate with local, state, and federal agencies in making range and vegetative surveys, utilization checks, or other studies involving forage utilization and maintenance.

4. Take such measures on the Department-owned land within the watershed as are necessary to insure and maintain proper range management and watershed conditions.

5. Participate to the maximum extent feasible in establishing and maintaining a sports fishery in the Silver Lake Flat and Tibble Fork Reservoirs. Furnish $26,800 of the non-Federal share of the construction cost of Silver Lake Flat Reservoir. Furnish 50% of the estimated

specific construction cost for modifying the Tibble Fork debris basin to make it suitable for a fishery (estimated cost, $10,550).

6. Maintain close liaison with sponsors and federal agencies involved on the project and assist in appropriate revisions of the work plan as necessary.

No Revision Made

Schedule for Expenditure of Funds

Estimated expenditure of funds by years is as follows:

	P.L. 566 funds	Other	Total
First year	560,470	309,355	869,825
Second year	337,320	234,240	571,560
Third year	302,530	481,245	783,775
Fourth year	306,765	254,310	561,075
Fifth year	109,880	258,730	368,610
Sixth year	19,130	161,210	180,340
Seventh year	13,110	130,710	143,820
Eighth year	10,660	102,210	112,870
Ninth year	9,980	91,460	101,440
Tenth year	8,010	89,960	97,970
Total	1,677,855	2,113,430	3,791,285

Federal assistance for carrying out the works of improvement on non-federal land and the federal funds for installing the works of improvement on federal land, as described in this work plan, will be provided under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress; 68 Stat. 666), as amended by the Act of August 7, 1956, (Public Law 1018, 84th Congress; 70 Stat. 1088).

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Land treatment measures for flood prevention installed on the private lands in upper American Fork Canyon will be operated and maintained by the North Utah County Water Conservancy District, under agreements with the land owners.

The Forest Service and the North Utah County Water Conservancy District will jointly be responsible for performing the maintenance of land treatment measures for flood prevention and watershed protection on the intermingled Federal and non-Federal land in T 3S, R 3E.

The percentage of maintenance cost of land treatment measures for flood prevention installed on the intermingled Federal and non-Federal land in T 3S, R 3E, to be paid by the North Utah County Water Conservancy District and the Forest Service is as follows:

North Utah County Water Conservancy District	Forest Service	Estimated Annual Cost
40%	60%	$315

Other land treatment measures installed on non-federal lands will be operated and maintained by the landowner or operator in accordance with cooperative agreements between the owners and the Alpine Soil Conservation District.

Fire control equipment to be acquired as part of this project will be stationed at Alpine, American Fork, and Pleasant Grove. The equipment will be operated by the community fire departments at these locations, under existing agreements between the communities, Utah County, and the State of Utah, Department of Forestry and Fire Control, which specify the areas of use and fix the sharing of costs. Cost of maintenance of the equipment will be shared by Utah County and the State of Utah under the same agreements.

Land treatment measures on federally-owned land will be operated and maintained after the period of installation by the agency administering such land from regular funds. Maintenance during the period of installation will be from project funds as shown in Table 1.

Structural Measures

The North Utah County Water Conservancy District will maintain the Silver Lake Flat Reservoir, using funds available to the District through its taxing authority. The Lehi, American Fork, and Pleasant Grove Irrigation Companies will jointly operate the structure as an irrigation storage reservoir, releasing the stored water to augment natural streamflow during mid season and late season irrigation period, under existing agreements for joint operation of the irrigation facilities on American Fork Creek. Total annual operation and maintenance cost of the structure is estimated at $1,000.

The North Utah County Water Conservancy District will operate and maintain the Dry Creek, Tibble Fork, Grove Creek, and Battle Creek debris basins, using funds available to it through its taxing authority. Total annual operation and maintenance cost of the structures is estimated at $2,600.

The respective irrigation companies will operate and maintain the agricultural water management measures installed on their system using funds available from assessment of stockholders.

Inspections of all works of improvement will be made at least annually and after all floods, by representatives of the Alpine Soil Conservation District, Soil Conservation Service, and the sponsoring organizations responsible for operation and maintenance. The responsible organizations will perform the maintenance work as needed.

Specific operation and maintenance agreements between the sponsoring local organizations and the Service covering all phases of operation and maintenance will be executed prior to making funds available to local organizations for the installation of the works of improvement.

COST SHARING

Project costs estimated at $4,195,560 will be shared as follows:

P.L. 566 Funds	$2,053,590	(49%)
Other Funds	$2,141,970	(51%)

Assignment of cost to P.L. 566 funds were made in accordance with the Policy Statement of the Secretary of Agriculture.

The following costs will be borne by P.L. 566 funds:

1. Accelerated technical assistance for installation of land treatment measures on non-federal land, $171,970.

2. Total installation cost for application of accelerated land treatment measures on federal land, $282,875.

3. The cost sharing assistance that will be available for application of land treatment measures for flood prevention on non-federal land, $29,910. Sharing of costs is based upon rates currently authorized under other programs. Cost sharing on fire suppression equipment is based on Clark-McNary equivalents.

4. Installation services for installation of structural measures, $428,845.

5. All construction costs of the Dry Creek, Grove Creek, and Battle Creek debris basins, $404,400.

6. Fifty percent of the specific construction cost, $10,550, and all of the remaining construction cost of the Tibble Fork debris basin. The specific costs will enable the sediment pool to be used as a fishery and are assigned to recreation purposes. All other costs are assigned to flood prevention purposes.

7. The cost sharing assistance that will be available for sharing of the construction cost of the structural measures for agricultural water management to be installed on the irrigation companies' systems, 35.6% of the construction cost of work under project agreement, $91,330, and 50% of the cost of work not now under project agreement, $137,810.

8. The cost sharing assistance that will be available for sharing of the construction cost of the Silver Lake Flat Reservoir, 50% of the construction cost allocated to recreation, $26,830, and 50% of the construction cost allocated to agricultural water management, $261,670.

The following costs will be borne from other funds:

1. The cost of application of land treatment measures for watershed protection on non-federal lands, $1,277,170.

2. The cost of technical assistance for existing programs for land treatment for watershed protection on non-federal lands, $123,100.

3. The installation cost of land treatment measures for watershed protection on federal lands, under existing programs, $75,200.

4. The installation cost of land treatment measures for watershed protection on federal lands, $17,400, or 33% of the total cost of these measures, $52,400.

5. The non-federal share of the construction cost for the Silver Lake Flat Reservoir, $288,500 or 50% of the total construction cost.

6. The non-federal share of the construction costs of structural measures for agricultural water management to be installed on irrigation companies' systems, 64.4% of the construction of work under project agreement, $165,030, and 50% of the construction cost of work not now under project agreement, $137,820.

7. The cost of lands, easements, and rights-of-way, and for relocating existing facilities for structural measures, $64,600.

8. The cost of administering contracts for project installation, $32,600.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COSTS

Sheet 1 of 2

American Fork-Dry Creek Watershed, Utah

ITEMS	UNIT	No. To Be Applied			Estimated Cost (Dollars) 1/						
					P.L. 566 Funds			Other			
		Federal Land	Non-Fed. Land	Total	Federal Land	Non-Fed. Land	Total	Federal Land	Non-Fed. Land	Total	TOTAL
LAND TREATMENT FOR											
Watershed Protection											
Soil Conservation Service											
Stubble Mulching	acre		2,000	2,000					7,000	7,000	7,000
Fall Tillage	acre		2,000	2,000					5,000	5,000	5,000
Grassed Waterways	acre		20	20					800	800	800
Irrigation Structures	No.		9,000	9,000					135,000	135,000	135,000
Land Leveling	acre		6,000	6,000					390,000	390,000	390,000
Canal Lining	L.F.		300,000	300,000					450,000	450,000	450,000
Drainage	acre		1,500	1,500					187,500	187,500	187,500
Range Improvement											
Range Seeding	acre		1,690 2/	1,690					18,750	18,750	18,750
Pond Construction (Stockwater)	No.		18	18					3,150	3,150	3,150
Well Construction (Stockwater)	No.		1	1					2,400	2,400	2,400
Check Dams	No.		11	11					825	825	825
Stock Trails	mile		3.25	3.25					325	325	325
Fencing	mile		5.75	5.75					5,320	5,320	5,320
Deferred Grazing	AUM		820	820					4,100	4,100	4,100
Limited Use	acre		4,000	4,000					17,000 3/	17,000	17,000
Technical Assistance						166,840	166,840		123,100	123,100	289,940
SCS Subtotal						166,840	166,840		1,350,270	1,350,270	1,517,110
Forest Service											
Range Improvement											
Contour Furrowing	acre	38		38	2,105		2,105				2,105
Range Seeding	acre	1,903		1,903	21,295		21,295				21,295
Fencing	mile	12.75		12.75	14,120		14,120				14,120
Tree Planting	acre	45		45	2,490		2,490				2,490
Access Road Construction					6,520		6,520	10,000		10,000	16,520
Fire Control Measures								12,000		12,000	12,000
Resource Management								53,200		53,200	53,200
Maintenance (Installation Period)					1,925		1,925				1,925
FS Subtotal					48,455		48,455	75,200		75,200	123,655
Subtotal - Watershed Protection					48,455	166,840	215,295	75,200	1,350,270	1,425,470	1,640,765
Flood Prevention 4/											
Forest Service											
Private Land											
Stabilization of Critical Areas											
Special Purpose Terraces	acre		195	195		11,190	11,190		4,800	4,800	15,990
Contour Furrowing	acre		17	17		425	425		425	425	850
Gully Control	mile		16	16		10,700	10,700		4,580	4,580	15,280
Range Seeding	acre		35	35		175	175		175	175	350
Drop Spillway Construction (Headcut)	No.		12	12		600	600		600	600	1,200
Road Erosion Control	mile		5.25	5.25		265	265		265	265	530
Technical Assistance						5,130	5,130				5,130
Subtotal - Private						28,485	28,485		10,845	10,845	39,330
National Forest											
Stabilization of Critical Areas											
Special Purpose Terraces	acre	879		879	80,860		80,860				80,860
Contour Furrowing	acre	227		227	12,255		12,255				12,255
Pitting	acre	160		160	8,330		8,330				8,330
Gully Control	mile	47.5		47.5	50,275		50,275				50,275
Seeding	acre	708		708	7,840		7,840				7,840
Drop Spillway Construction (Headcut)	No.	95		95	10,530		10,530				10,530
Trail Erosion Control	mile	31.4		31.4	2,050		2,050				2,050
Road Erosion Control	mile	31.75		31.75	5,760		5,760				5,760
Channel Stabilization (vegetative)	L.F.	33,000		33,000	1,040		1,040				1,040
Channel Stabilization (riprap)	L.F.	2,815		2,815	16,980		16,980				16,980
Access Road Construction					29,725		29,725				29,725
Fire Control Equipment						6,555	6,555		6,555	6,555	13,110
Maintenance (Installation Period)					8,775		8,775				8,775
Subtotal - National Forest					234,420	6,555	240,975		6,555	6,555	247,530
FS Subtotal					234,420	35,040	269,460		17,400	17,400	286,860
Subtotal - Flood Prevention					234,420	35,040	269,460		17,400	17,400	286,860
TOTAL LAND TREATMENT					282,875	201,880	484,755	75,200	1,367,670	1,442,870	1,927,625

1/ Price Base 1963

2/ Includes 925 acres plowed and seeded at $12.00 per acre and 765 acres broadcast seeding (in American Fork Canyon) at $10.00 per acre.

3/ Assistance to operators on mining claims in American Fork Canyon by sponsors.

4/ Cost sharing based on ACP rates.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Sheet 2 of 2

American Fork-Dry Creek Watershed, Utah

ITEMS	UNIT	No. To Be Applied			Estimated Cost (Dollars) 1/						
					P.L. 566 Funds			Other			
		Federal Land	Non-Fed. Land	Total	Federal Land	Non-Fed. Land	Total	Federal Land	Non-Fed. Land	Total	TOTAL
Brought Forward - TOTAL LAND TREATMENT					282,875	201,880	484,755	75,200	1,367,670	1,442,870	1,927,625
STRUCTURAL MEASURES											
Soil Conservation Service											
Debris Basins	No.	1	3	4	217,950	404,400	622,350	10,550		10,550	632,900
Irrigation Storage Reservoir	No.	1		1	288,500		288,500	288,500		288,500	577,000
Canal Lining	L.F.		167,016	167,016		207,710	207,710		274,625	274,625	482,335
Drop Spillway Construction	No.		2	2		2,715	2,715		4,160	4,160	6,875
Desilting Basins	No.		1	1		750	750		750	750	1,500
Pipelines	L.F.		7,500	7,500		15,615	15,615		19,065	19,065	34,680
Diversion Dam	No.		1	1		2,350	2,350		4,250	4,250	6,600
SCS Subtotal					506,450	633,540	1,139,990	299,050	302,850	601,900	1,741,890
Subtotal - Construction					506,450	633,540	1,139,990	299,050	302,850	601,900	1,741,890
llation Services											
Soil Conservation Service											
Engineering Services					146,950	141,480	288,430				288,430
Other					69,150	71,265	140,415				140,415
SCS Subtotal					216,100	212,745	428,845				428,845
Subtotal - Installation Services					216,100	212,745	428,845				428,845
Other Costs											
Lands, Easements, and Rights-of-way								32,500	32,100	64,600	64,600
Administration of Contracts								3,000	29,600	32,600	32,600
Subtotal - Other								35,500	61,700	97,200	97,200
TOTAL STRUCTURAL MEASURES					722,550	846,285	1,568,835	334,550	364,550	699,100	2,267,935
TOTAL PROJECT					1,005,425	1,048,165	2,053,590	409,750	1,732,220	2,141,970	4,195,560
SUMMARY											
Subtotal SCS					722,550	1,013,125	1,735,675	334,550	1,714,820	2,049,370	3,785,045
Subtotal FS					282,875	35,040	317,915	75,200	17,400	92,600	410,515
TOTAL PROJECT					1,005,425	1,048,165	2,053,590	409,750	1,732,220	2,141,970	4,195,560

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION
American Fork-Dry Creek Watershed, Utah
(Dollars) 1/

Structure Site No. or Name	Installation Cost - P.L. 566 Funds: Construction	Install. Service: Engineering	Install. Service: Other	Total P.L. 566	Installation Cost - Other Funds: Construction	Other: Admin. of Contracts	Other: Easements and R/W	Total Other	Total Install. Cost
Debris Basins:									
Dry Fork	135,000	26,520	12,480	174,000		1,000	12,300	13,300	187,300
Tibble Fork	217,950	38,830	18,270	275,050	10,550	1,000	32,500	44,050	319,100
Specific Cost									
Stripping	(1,295)			(1,295)	(1,295)			(1,295)	(2,590)
Blanketing	(9,255)			(9,255)	(9,255)			(9,255)	(18,510)
Remainder of St.	(207,400)	(38,830)	(18,270)	(264,500)		(1,000)	(32,500)	(33,500)	(298,000)
Grove Creek	159,400	27,100	12,750	199,250		1,000	12,800	13,800	213,050
Battle Creek	110,000	18,700	8,800	137,500		1,000	7,000	8,000	145,500
Silver Lake Flat Reservoir	288,500	108,120	50,880	447,500	288,500	2,000		290,500	738,000
System Improvements									
Under Project Agreement									
Canal Lining	82,925	30,260	16,290	129,475	149,835	11,640		161,475	290,950
Drop Spillway Const.	1,780	650	350	2,780	3,220	250		3,470	6,250
Pipelines	4,275	1,560	840	6,675	7,725	600		8,325	15,000
Diversion Dam	2,350	860	460	3,670	4,250	330		4,580	8,250
Remaining Work									
Canal Lining	124,785	32,440	17,470	174,695	124,790	12,480		137,270	311,965
Drop Spillway Const.	935	245	130	1,310	940	95		1,035	2,345
Desilting Basin	750	195	105	1,050	750	75		825	1,875
Pipelines	11,340	2,950	1,590	15,880	11,340	1,130		12,470	28,350
GRAND TOTAL	1,139,990	288,430	140,415	1,568,835	601,900	32,600	64,600*	699,100	2,267,935

1/ Price base current

March 1963

* Includes $40,300 for relocation of highways, powerlines, and pipelines.

TABLE 3 - STRUCTURE DATA

DEBRIS BASINS AND IRRIGATION RESERVOIR

American Fork - Dry Creek Watershed, Utah

ITEM	UNIT	STRUCTURE NAME					TOTAL
		Grove Creek	Battle Creek	Dry Creek	Tibble Fork	Silver Lake Flat	
Drainage Area	sq.mi.	6.5	5.5	39.4	35.5	4.3	91.2
Storage Capacity:							
Sediment	ac.ft.	40	35	185	175	24	459
Floodwater pool	ac.ft.	50	31	85	84	---	250
Irrigation pool	ac.ft.	---	---	---	---	976	976
Recreation	ac.ft.	---	---	---	---	100	100
Total	ac.ft.	90	66	270	259	1,100	1,785
Surface Area:							
Sediment pool	ac.	4.7	2.6	18.7	13.2	4.6	43.8
Floodwater pool	ac.	8.9	4.6	23.3	15.9	---	52.7
Irrigation pool	ac.	---	---	---	---	43.0	43.0
Maximum dam height	ft.	36	36	35	56	68	---
Volume of fill	cu.yd.	102,000	79,000	77,000	67,160	243,000	568,160
Emergency Spillway:							
Type - Reinforced concrete chutes							
Frequency of use	yrs.	2	5	1	1	1	
Design storm							
Duration	hrs.	6	6	6	6	6	
Total depth	in.	7.5	7.5	7.5	10	7.5	
Width of chute	ft.	12	8	24	30	10	
Design depth	ft.	3.1	2.3	4.0	---	3.0	
Design capacity	c.f.s.	1,450	850	2,620	4,580	450	
Freeboard, crest to top of dam	ft.	4.0	3.0	5.0	7.0	5.0	
Total capacity, at top of dam	c.f.s.	2,220	1,340	3,740	---	1,180	
Principal Spillway:							
Type - Drop inlet, with ported riser and R/C pipe outlet							
Capacity, at chute crest	c.f.s.	33	33	110	---	---	
Class of Structure		C	C	C	C	C	

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TABLE 5 - SUMMARY OF PLAN DATA

American Fork-Dry Creek Watershed, Utah

Item	Unit	Quantity
Years to complete project	Year	10 1/
Total Installation Cost		
Public Law 566 funds	Dollar	2,050,475
Other	Dollar	2,145,085
Annual O & M cost		
Federal	Dollar	1,850
Non-Federal	Dollar	3,725
Average annual monetary benefits 2/	Dollar	171,750
Agricultural	Percent	79
Non-Agricultural	Percent	21
Structural Measures		
Debris Basins	Each	4
Area inundated by structures		
Upland		
Sediment pool	Ac.	42
Detention pool	Ac.	51
Water supply pool	Ac.	42
Watershed area above structures	Ac.	55,635
Reduction of floodwater damage	Dollar	15,610
By Land Treatment Measures -		
Watershed Protection	Percent	4
Flood Prevention	Percent	20
By Structural Measures	Percent	61
Reduction of sediment damage	Dollar	39,845
By Land Treatment Measures -		
Watershed Protection	Percent	5
Flood Prevention	Percent	21
By Structural Measures	Percent	55
Range Conservation Benefit	Dollar	525
Incidental Flood Prevention Benefits	Dollar	3,310
Irrigation Benefits (Primary)	Dollar	56,150
Acres with full season irrigation supply increased by irrigation measures	Acre	4,077

1/ Structural Program and Land Treatment for Flood Prevention to be completed in 5 years.

2/ From Structural Measures and Land Treatment Measures for Flood Prevention. Includes secondary benefits.

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TABLE 6 - ANNUAL COSTS

American Fork-Dry Creek Watershed, Utah

(Dollars) 1/

Measures	Amortization of Installation Cost	Operation and Maintenance Costs			Total
		Federal	Non-Federal	Total O & M	
Dry Creek Debris Basin and Interdependent Land Treatment for Flood Prevention	$ 8,940	$ 340	$ 500	$ 840	$ 9,780
Tibble Fork Debris Basin and Land Treatment	17,405	970	620	1,590	18,995
Grove Creek Debris Basin and Land Treatment	8,990	180	800	980	9,970
Battle Creek Debris Basin and Land Treatment	5,730	70	800	870	6,600
Independent Land Treatment Measures for Flood Prevention	1,560	290	5	295	1,855
Irrigation Measures	53,240		1,000 2/	1,000	54,240
TOTAL	95,865	1,850	3,725	5,575	101,440

1/ Price base - 1963. Interest rate, 2 7/8% @ 50 years.

2/ Silver Lake Flat Reservoir only. Operation and Maintenance not included on other irrigation measures, where benefits from reduced operation and maintenance resulting from installation of these measures is not computed.

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TABLE 7 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

American Fork-Dry Creek Watershed, Utah

(Dollars) 1/

Item	Estimated Average Annual Damage: Without Project	With Project	Damage Reduction Benefit
Floodwater			
Residential-Commercial	$ 5,825	$ 805	$ 5,020
Irrigation Facilities	2,960	435	2,525
Roads - Utilities	3,160	435	2,725
Recreation Facilities	2,115	310	1,805
Land and Crop Damage	1,395	210	1,185
Subtotal	$15,455	$ 2,195	$ 13,260
Sediment			
Residential-Commercial	$11,125	$ 2,160	$ 8,965
Irrigation Facilities	10,265	2,130	8,135
Roads - Utilities	8,230	1,600	6,630
Recreation Facilities	4,775	990	3,785
Land and Crop Damage	4,885	1,020	3,865
Subtotal	$39,280	$ 7,900	$ 31,380
TOTAL DIRECT DAMAGE	$54,735	$10,095	$ 44,640
INDIRECT DAMAGE	$ 7,320	$ 1,240	$ 6,080
TOTAL, ALL DAMAGE	$62,055	$11,335	$ 50,720
Range Conservation Benefits	xxxxxxx	xxxxxxx	$ 525
Incidental Flood Prevention Benefits			3,310
Recreation Benefits			11,835
TOTAL FLOOD PREVENTION BENEFITS			$ 66,390
Agricultural Water Management Benefits			
Total Direct Benefits	-------	-------	$ 56,150
Local Secondary Benefits (Silver Lake Flat)			11,150
Recreation Benefits from AWM Measures			32,715
TOTAL AGRICULTURAL WATER MANAGEMENT BENEFITS			$100,015
TOTAL PROJECT BENEFITS			$166,410
OTHER AGRICULTURAL WATER MANAGEMENT SECONDARY BENEFITS			$ 51,615

1/ Price base current

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TABLE 8 - BENEFIT COST ANALYSIS

American Fork-Dry Creek Watershed, Utah

(Dollars) 1/

Measures	AVERAGE ANNUAL BENEFITS									Average Annual Cost	Benefit Cost Ratio
		Flood Prevention					AWM				
	Recreation	Floodwater	Sediment	Indirect	Other	Irrigation	Secondary	Total			
Dry Creek Debris Basin and Land Treatment		2,830	7,075	1,350	1,610			12,865		9,780	1.3 to 1
Tibble Fork Debris Basin and Land Treatment	11,835	4,910	10,570	2,345				29,660		18,995	1.6 to 1
Grove Creek Debris Basin and Land Treatment		3,010	7,485	1,435				11,930		9,970	1.2 to 1
Battle Creek Debris Basin and Land Treatment		2,045	5,100	975				8,120		6,600	1.2 to 1
Independent Land Treatment		400	1,005	190	525			2,120		1,855	1.2 to 1
Irrigation Measures	32,715				1,700	56,150	11,150	101,715		54,240	1.9 to 1
GRAND TOTAL	44,550	13,195	31,235	6,295	3,835	56,150	11,150	166,410		101,440	1.6 to 1

1/ Price base current

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TABLE 8A - BENEFITS AND COSTS BY CONSTRUCTION UNITS

American Fork-Dry Creek Watershed, Utah

(Dollars) 1/

Construction Unit and Structures	Annual Benefit	Annual Cost
Dry Creek Debris Basin and Interdependent Land Treatment Measures for Flood Prevention	$12,865	$ 9,780
Tibble Fork Debris Basin and Interdependent Land Treatment Measures for Flood Prevention	29,660	18,995
Grove Creek Debris Basin and Interdependent Land Treatment Measures for Flood Prevention	11,930	9,970
Battle Creek Debris Basin and Interdependend Land Treatment Measures for Flood Prevention	8,120	6,600
Irrigation Measures		
Silver Lake Flat Reservoir	62,985	29,005
Alpine Irrigation Company	6,435	3,040
Pleasant Grove Irrigation Company	9,925	7,960
American Fork Irrigation Company	7,545	7,180
Lehi Irrigation Company	13,065	5,880
Alpine Soil Conservation District	1,760	1,175

1/ Price base: Costs - 1963 Prices
Benefits - Long Range Prices

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COST ALLOCATION - COST SHARING

American Fork-Dry Creek Watershed

Cost Allocation and Cost Sharing Computations

Single Purpose Structures

1. For Flood Prevention

Debris Basins

Battle Creek and Dry Fork Debris Basin

These structures are single purpose flood prevention structures. All costs are allocated to flood prevention.

Battle Creek Structure:

	Estimated Costs		
	Work Plan Estimate	Revised Estimate	Difference
Construction Cost	$104,300	$110,000	$5,700
Installation Services	26,075	27,500	1,425
Administration of Contract	1,000	1,000	
Easements and R/W	7,000	7,000	
Total Installation	$138,375	$145,500	$7,125

Cost Sharing (Revised Estimate)

	Total	P.L. 566	Other
Construction Cost	$110,000	$110,000	
Installation Services	27,500	27,500	
Administration of Contract	1,000		$1,000
Easements and R/W	7,000		7,000
Total Installation	$145,500	$137,500	$8,000

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Cost Sharing

1. Work Under Project Agreement

	Total	P.L. 566	Other
Construction Cost	$256,360	$ 91,330 (35.6%)	$165,030 (64.4%)
Installation Services	51,270	51,270	
Contract Administration	12,820		12,820
Total Installation	$320,450	$142,600 (44.5%)	$177,850 (55.5%)

2. Remaining Work

Construction Cost	$275,630	$137,810 (50%)	$137,820 (50%)
Installation Services	55,125	55,125	
Contract Administration	13,780		13,780
Total Installation Cost	$344,535	$192,935	$151,600

3. Summary of Cost Sharing

Construction Cost	$531,990	$229,140	$302,850
Installation Services	106,395	106,395	
Contract Administration	26,600		26,600
Total Installation Cost	$664,985	$335,535	$329,450

Tibble Fork Debris Basin:

This structure is a single purpose flood prevention structure. The sediment pool will be used as a fishery incidental to its flood prevention purpose until such time as the accumulation of sediment prevents it.

The specific cost to be incurred to enable the sediment pool to be used as a fishery are assigned to recreation purposes. All other costs are assigned to flood prevention purposes.

The revised costs are shared in accordance with the revised Secretary's Policy Statement effective October 19, 1962.

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Dry Creek Structure:

	Estimated Costs		
	Work Plan Estimate	Revised Estimate	Difference
Construction Cost	$156,000	$135,000	$21,000
Installation Services	44,000	39,000	5,000
Administration of Contract	1,000	1,000	
Easements and R/W	12,300	12,300	
	$213,300	$187,300	$26,000

Cost Sharing (Revised Estimate)

	Total	P.L. 566	Other
Construction Cost	$135,000	$135,000	
Installation Services	39,000	39,000	
Administration of Contract	1,000		$ 1,000
Easements and R/W	12,300		12,300
Total Installation	$187,300	$174,000	$13,300

2. For Agricultural Water Management

Work plan estimates were revised to show needed reduction in amounts and necessary increases in costs of measures to be applied. The revised costs for measures under project agreement are shared on the basis of cost sharing arrangements outlined in the work plan. The revised costs for measures not under project agreement are shared in accordance with the revised Secretary's Policy Statement currently effective.

Construction Cost

	Total	P.L. 566	Other
Work Plan Estimates	$478,040	$170,300 (35.6%)	$307,740 (64.4%)
Revised Estimates	531,990	229,140 (50%)	302,850 (50%)
Under Project Agreement	256,360	91,330 (35.6%)	165,030 (64.4%)
Remaining	275,630	137,810 (50%)	137,820 (50%)

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Estimated Costs

	Work Plan Estimate	Revised Estimate	Specific Cost 1/	Remaining Cost
Construction Total	$156,935	$228,500	$21,100	$207,400
Specific Cost				
Stripping			(2,590)	
Blanketing			(18,510)	
Installation Services	39,235	57,100		57,100
Contract Adm.	1,000	1,000		1,000
Easements and R/W	25,000	32,500		32,500
	$222,170	$319,100	$21,100	$298,000

1/ Recreation (fishery) cost. (12% of total stripping cost and 54% of total Blanket cost).

Cost Sharing - Total Structure - (Revised Estimate)

	Total	P.L. 566	Other
Construction	$228,500	$217,950	$10,550
Specific cost-fishery			
Stripping	(2,590)	(1,295)(50%)	(1,295)(50%)
Blanketing	(18,510)	(9,255)(50%)	(9,255)(50%)
Remainder of Structures	(207,400)	(207,400)	
Installation Services	57,100	57,100	
Contract Administration	1,000		1,000
Easements and R/W	32,500		32,500
Total Installation	$319,100	$275,050	$44,050

Multiple Purpose Structure

Silver Lake Flat Reservoir:

This structure has capacity for sediment, a fishery, and for irrigation. The sediment capacity is incidental to other purposes.

The costs for the structure are allocated by the use of facilities method to the purposes served. The allocated costs are shared in accordance with the revised Secretary's Policy, effective October 19, 1962.

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Estimated Storage Capacities

	Work Plan Estimate	Design Estimate	Difference
Sediment (F.P.)	24 A.F.	24 A.F.	
Fishery (Rec.)		100 A.F.	100
Irrigation A.W.M.	921 A.F.	976 A.F.	55
	945 A.F.	1,100 A.F.	155

Allocation by Purpose

Recreation	100 A.F.	9.3%
Irrigation	976 A.F.	90.7%
	1,076 A.F.	100%

Estimated Costs

	Work Plan Estimate	Design Estimate	Difference
Construction	356,185	577,000	220,815
Installation Services	104,045	159,000	54,955
Contract Administration	2,000	2,000	
Total Installation	462,230	738,000	275,770

1. Cost Allocation	Total	Rec.	Irrig.
Construction	577,000	53,660	523,340
Installation Services	159,000	14,790	144,210
Contract Administration	2,000	190	1,810
Total Allocated Cost	738,000	68,640	669,360

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2. Cost Distribution - Cost Sharing

A. Recreation (Fishing)

	Total	P.L. 566	Other
Construction Cost	53,660	26,830 (50%)	26,830 (50%)
Installation Services	14,790	14,790	
Contract Administration	190		190
	68,640	41,620	27,020

B. Irrigation

Construction Cost	523,340	261,670 (50%)	261,670 (50%)
Installation Services	144,210	144,210	
Contract Administration	1,810		1,810
Total Installation	669,360	405,880	263,480

C. Cost Sharing - Total Structure

Construction Cost	577,000	288,500 (50%)	288,500 (50%)
Installation Services	159,000	159,000	
Contract Administration	2,000		2,000
	738,000	447,500	290,500

NRCS

Silver Lake Flat Plan-Environmental Assessment

Wetland and Stream Delineation Report

Final

Contract No. AG-3A75-C-10-0025
Task No. AG-8D43-D-12-004

April 22, 2013

McMILLEN, LLC

SIGNATURE PAGE

We have appreciated the opportunity to work with NRCS on this project. If you have any questions or concerns regarding this report, please contact Greg Allington (208-342-4214 or greg.allington@mcmillen-llc.com).

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SECTION 1
INTRODUCTION

1.0 Introduction

McMillen, LLC (McMillen) was retained by the Natural Resources Conservation Service (NRCS) to complete wetland and stream delineation services at Silver Lake Flat Dam and Reservoir in Utah County, Utah (Figure 1). Both the dam and reservoir are located within the boundaries of the United States Forest Service (USFS) Uinta-Wasatch-Cache National Forest (UWCNF). This report describes in detail the one wetland, one reservoir and two stream segments identified during the delineation. The wetland and streams described in this report were observed within the potential dam rehabilitation construction boundaries, which will herein be referred to as the "Survey Area".

1.1 Purpose

This wetland and stream delineation report was completed to assist NRCS in identifying potential construction constraints related to critical aquatic features that occur within the project area.

1.2 Project Location

Silver Lake Flat Dam and Reservoir are located in the UWCNF in northern Utah County, within the American Fork-Dry Creek Watershed (Figure 2). The site is situated within the Silver Creek valley at an elevation of approximately 7,535 feet above mean sea level (AMSL). Table 1-1 identifies the legal description of the Survey Area.

Table 1-1. Legal Description

Township (T) / Range (R) / Meridian	Section	Coordinates (WGS84)	Utah County Parcels
T 4 South / R 3 East / Salt Lake	6	40.501' lat / -111.655 long	11 059 0001 11 060 0006

The dam and reservoir are located approximately seven miles northeast of Alpine, Utah and are adjacent to USFS Silver Lake Flat Road which is approximately 2¼ miles north of the turnoff from Granite Flat Campground Road.

1.3 Scope of Work

The scope of work associated with this wetland and stream delineation includes the following elements:

1. Review background information pertaining to the Survey Area including relevant and readily available documents to evaluate the conditions;
2. Conduct a pedestrian survey within the proposed construction, operations and maintenance boundaries (Survey Area) and delineate wetland and stream features identified according to the appropriate wetland and stream delineation manuals; and

3. Prepare a draft and final report describing the methods used and the results of the delineation. This report includes a description of wetlands and streams delineated, the appropriate classification according to reviewing agencies, and a wetland and stream delineation map that depicts the locations of delineated aquatic features.

1.4 Conditions at Time of Delineation

This report is based on conditions that existed at the time the delineation was performed. If changes are made to the Survey Area after the date of this report, a wetland biologist should be consulted to review the investigation and recommendations so that written amendments or affirmation can be provided as appropriate.

SECTION 2
METHODS

2.0 Document Review

A review of available documents pertaining to the project was conducted prior to visiting Silver Lake Flat Dam and Reservoir. This review assisted with directing the focus of the wetland and stream delineation to potential critical aquatic features. The following documents were reviewed:

- Historical and current aerial photos,
- United States Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) maps (USFWS 2012), (Figure 3),
- USFS soil data (USFS 2012), (Figure 4),
- United States Geological Survey (USGS) 1:24,000 scale 7.5-minute topographic map (USGS 1975 and 1993),
- Other available general background information provided by NRCS and USFS.

2.1 Wetland Delineation Methodology

McMillen wetland biologist (Greg Allington) and McMillen environmental scientist (Kevin Jensen) conducted an investigation in the Survey Area and performed a formal delineation on one wetland feature. This formal wetland delineation effort followed the guidance set forth in the following documents:

- 1987 USACE Wetland Delineation Manual (Environmental Laboratory 1987),
- 2010 USACE Regional Supplement to the USACE Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region (USACE 2010),
- 2010 Field Indicators of Hydric Soils in the United States (NRCS 2010), and
- 2007 Clean Water Act Jurisdiction – Rapanos vs. United States and Carabell vs. United States (Rapanos 2007).

The wetland delineation manual and supplement listed above follow the three-parameter approach for making wetland determinations, such that positive indicators of wetlands must be present for each of the following parameters: 1) vegetation, 2) soils and 3) hydrology. Each of these three parameters is described in detail in the following sections.

Silver Lake Flat Reservoir was delineated using GIS software by analyzing topographic data and the full pool elevation of the reservoir. This full pool level was noted as the extent of the reservoir based on the elevation of the spillway on the top of the dam.

2.1.1 Vegetation

The 2010 USACE manual defines hydrophytic vegetation as the community of macrophytes that occurs in areas where inundation or soil saturation is either permanent or of sufficient frequency and duration to exert a controlling influence on the plant species present. Hydrophytic plant species have the ability to grow, compete and sustain in areas where anaerobic (oxygen deprived) conditions exist from the presence of surface or groundwater. In 1988, the USACE and USFWS (Reed 1988) developed plant indicator categories that describe the probability of vegetation to occur in wetlands. This list was updated in 1993 (Reed *et al.1993*) and in 2012 (Lichvar 2012), and each plant observed within the Survey Area was categorized according to the Western

mountains, Valleys, and Coast Region indicator status. Table 2-1 below defines the indicator status categories.

Table 2-1. Plant Indicator Status Categories

Indicator Category	Indicator Symbol	Description
Obligate Wetland Plants	OBL	Plants that occur in wetlands, under natural conditions, greater than 99 percent of the time.
Facultative Wetland Plants	FACW	Plants that occur in wetlands, under natural conditions, between 67 to 99 percent of the time.
Facultative Plants	FAC	Plants that occur in wetlands, under natural conditions, between 34 to 66 percent of the time.
Facultative Upland Plants	FACU	Plants that occur in wetlands, under natural conditions, between 1 to 33 percent of the time.
Obligate Upland Plants	UPL	Plants that occur in wetlands, under natural conditions, less than 1 percent of the time.
No Indicator	NI	Indicator status has not been identified for the species.
No Occurrence	NO	No known occurrence of the plant in the region.

The prevalence of wetland vegetation is characterized by the dominant species comprising the plant community or communities. A dominant species is considered any plant species that is represented by 20 percent or greater total aerial coverage for each vegetative stratum (tree, shrub, herbaceous or aquatic bed). If more than 50 percent of the dominant plant species in a wetland are categorized as OBL, FACW, or FAC, then the plant community for the wetland can be classified as hydrophytic. Other indicators of hydrophytic vegetation include visual observations of plant species growing in areas of prolonged inundation and/or soil saturation, morphological adaptations, physiological adaptations and reproductive adaptations.

Wetland vegetation communities within the Survey Area were classified according to the Cowardin classification system (Cowardin *et al.* 1979). Vegetation nomenclature described in this report follows the format outlined in the book titled *Intermountain Flora* (Cronquist *et al.*1972).

2.1.2 Soils

Hydric soils are soils that formed under conditions of saturation, flooding or ponding for a long enough period of time during the growing season that anaerobic conditions develop in the upper portion of the soil profile (USACE 2010). These anaerobic conditions exhibit certain characteristics that can be identified in the field and that are associated with a wetland complex. Prolonged anaerobic soil conditions eventually lead to a chemically reduced state where soil components (iron, manganese, sulfur and carbon compounds) develop soil colors and other physical characteristics that are indicative of hydric soils. These chemically-reduced soil components persist when the soil is either wet or dry. Specific hydric soil characteristics include:

- Reduced iron resulting in a soil color that is known as gley (bluish-gray or greenish-gray);
- Loss of iron resulting in a soil color that is known as redox depletion (gray or reddish-gray);

- Loss of iron resulting in concentrated soil patches known as redoximorphic concentrations (orange or red);
- Sulfidic odor; and/or
- High organic matter content (peat or muck) in the upper 32 inches of the soil profile.

Soil colors were determined using the Munsell® Soil-Color Charts (Munsell Color 2009) and their corresponding *hue* (spectral colors, e.g. 10YR), *value* (degree of lightness, e.g. 2/) and *chroma* (strength or purity of color, /1) were recorded. Soil profiles must either have a dominant chroma of 2 or less, or the layer with a dominant chroma of more than 2 must be less than 6 inches thick to meet any hydric soil indicators. Hydric soil indicators commonly found in wetlands are identified in the technical document *Field Indicators of Hydric Soils in the United States* (NRCS 2010). These indicators help identify soils that were formed under saturated, flooded or ponded conditions long enough during the growing season to develop anaerobic conditions in the upper part of the soil profile.

Numerous undocumented soil pits were dug throughout the wetland area as well as in the surrounding upland area to a depth of approximately 18 inches, or until refusal. The soil was analyzed visually and physically to determine its soil type. Hydric soil conditions must be met within 12 inches of the ground surface in order for a soil to be considered hydric.

2.1.3 Hydrology

Hydrologic patterns in a wetland can be influenced by precipitation, stratigraphy, topography, soil permeability, plant cover and human disturbance. Wetland hydrology encompasses all hydrologic characteristics of areas that are periodically inundated or have soils saturated to the surface at some time during the growing season. Wetland hydrology is sometimes difficult to determine during the summer months when precipitation has stopped, groundwater tables have dropped, stream flows have receded and springs or seeps have dried. Hydrologic indicators can be used during the wet spring months as well as the dry summer and fall months to identify primary and/or secondary indicators within the soil profile. Primary indicators include the following (USACE 2010):

- Surface water or inundation,
- High water table or saturated soil within 12 inches of the ground surface for 14 or more consecutive days at a minimum frequency of 5 years out of 10,
- Water marks,
- Sediment and drift deposits,
- Algal mat or crust,
- Iron deposits,
- Surface soil cracks,
- Salt crust,
- Inundation visible on aerial photography,
- Sparsely vegetated concave surface,
- Aquatic invertebrates,
- Water-stained leaves,
- Hydrogen sulfide odor,
- Oxidized rhizospheres along living roots,
- Presence of reduced iron, and
- Stunted or stressed plants.

Secondary indicators include (USACE 2010):

- Drainage patterns,
- Dry-season water table,
- Saturation visible on aerial photography,
- Geomorphic position,
- Shallow aquitard,
- FAC-neutral test,
- Raised ant mounds, and
- Frost-heave hummocks.

The growing season for a region is dependent upon climate, precipitation and topography. The beginning and ending dates of the growing season are examined for an area to determine if wetland hydrology was present for the required time period. Wetland hydrology must be present for at least 14 consecutive days within 12 inches of the ground surface during the growing season in order for an area to be considered a wetland. Two indicators that the growing season has begun include 1) a soil temperature that is at least 41 degrees Fahrenheit (°F), measured at least 12 inches below the ground surface, and/or 2) aboveground growth and development of vascular plants (USACE 2010).

The growing season has begun on a site when two or more types of non-evergreen vascular plants exhibit one or more of the following indicators of biological activity:

- Emergence of herbaceous plants,
- New growth on vegetative crowns,
- Coleoptiles/cotyledon emergence from seed,
- Bud burst on woody plants,
- Emergence or elongation of woody plant leaves, and/or
- Emergence or opening of flowers.

The growing season has ended when woody deciduous species lose their leaves and/or the last herbaceous plants cease flowering and their leaves become dry or brown. Additional information may be collected from the WETS tables available from the USDA NRCS National Water and Climate Center (USDA 2002). These tables summarize the air temperature from National Weather Service meteorological stations throughout the United States for a specific area. The growing season dates in the WETS tables are an estimate of when air temperatures average above 28°F.

2.2 Stream Delineation Methodology

Streams, lakes and reservoirs were delineated according to their ordinary high water mark (OHWM) in accordance with the guidance set forth by the USACE in their Regulatory Guidance Letter titled *Ordinary High Water Mark Identification* (USACE 2005). The OHWM is defined by the USACE as:

> "The term *ordinary high water mark* means that line on the shore established by the fluctuations of weather and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas."

Physical characteristics that are present on the shoreline of a watercourse may vary depending on the type of water body and conditions of the area. There are no required physical indicators that must be present to make an OHWM determination. However, the following physical characteristics were considered when making the determination:

- Natural line impressed on the bank;
- Shelving or topographic breaks,
- Changes in the character of soil,
- Destruction of terrestrial vegetation,
- Presence of litter or debris (drift lines),
- Wracking,
- Vegetation matted down, bent, or absent,
- Sediment sorting,
- Leaf litter disturbed or washed away,
- Scour,
- Deposition,
- Multiple observed flow events,
- Bed and banks,
- Water staining, and
- Change in plant community.

Other methods for determining the OHWM that do not include physical observation:

- Lake and stream gage data,
- Elevation data,
- Spillway height,
- Flood predictions,
- Historic records of water flow, and
- Statistical evidence.

Combinations of physical characteristics and other methods should be used when available for determining the OHWM. Because many types of water bodies occur with varying conditions including topography, channel morphology and flow dynamics, other physical characteristics indicative of the OHWM may also be used that are not identified in the USACE guidance.

2.3 Wetland and Stream Characterization

The wetland, reservoir and two stream segments delineated were characterized according to their Cowardin (Cowardin *et al.*1979) classification. The Cowardin classification system categorizes wetlands and deepwater habitats according to five separate systems: Marine, Estuarine, Riverine, Lacustrine, and Palustrine. These systems are then stratified into subsystems based on the plant community type. These systems are further stratified into classes and subclasses based on substrate material. Each class and subclass is then annotated with specific modifiers for water regimes, water chemistry, soil, and other special characteristics. The USFWS uses this classification system on their NWI maps and it is used in this report to describe the general structure of wetlands, reservoirs and streams.

The wetland identified in this project was also classified according to its hydrogeomorphic (HGM) characteristics in order to determine its location and function within the watershed. HGM classifications include the following:

- Depressional,
- Riverine,
- Lake-fringe,
- Slope,
- Flats, and
- Freshwater tidal.

2.4 Field Methods

The Survey Area was investigated for indicators of wetland parameters. If one of the three wetland parameters (hydrophytic vegetation, hydric soils or wetland hydrology indicators) was observed, then a more detailed examination of the area was performed. Upon discovery of all three wetland parameters adjacent to an upland area, the boundary line of the wetland was identified and followed until the delineation was complete. In general, the presence of hydrophytic vegetation and/or wetland hydrology indicators was the primary visual indicator used to determine the boundaries of the wetland, with hydric soil indicators used secondarily to confirm the wetland boundary. If a point on the wetland boundary was not clearly identifiable by either hydrophytic vegetation or wetland hydrology indicators, then soil pits were dug in order to determine the wetland boundary line. Soil pits extended approximately 18 inches below ground surface and were left open for a minimum of five minutes during the examination. Not all of the soils pits dug during the wetland delineation were recorded. These unrecorded soil pits were used to compare the soil and wetland hydrology indicators of the recorded soil pits. Once the boundary of the wetland unit was identified, labeled flags (ex. Wetland A-1) were placed, denoting the perimeter.

Paired sample plots were established at various locations along the wetland perimeter to aid in the wetland determination. These sample plots were given a label (ex. Wetland A-SP1) and a flag was placed for identification. The sample plots consisted of examining the vegetation, soils and wetland hydrology indicators. The vegetation was assessed within an approximate 20-foot radius of the sample plot for trees, shrubs and herbaceous species. Soils were classified according to the Munsell® Soil-Color Chart and wetland hydrology indicators were examined for presence within 12 inches of the ground surface. Typically, one paired sample plot was established within the wetland unit for each vegetation community or hydrologic regime observed at the time of the delineation. The results of the sample plots were recorded and are located in Appendix A.

The site was also investigated for indicators of stream characteristics. If flowing water or a dry streambed was observed, additional investigations were performed upstream and downstream to locate the source of the water and/or the confluence with another stream. Specific physical characteristics of the streams were examined in order to facilitate locating the OHWMs, which were marked with labeled flags (e.g. Silver Creek-1A).

A sketch of the wetland and stream delineation was prepared depicting the location of the flags and sample plots. Wetland points were denoted using pink surveyor's tape and sample plots were denoted with pink and yellow surveyor's tape. OHWM points were denoted using orange flags. The delineation sketch was transmitted to NRCS for surveying and mapping purposes. The survey was conducted on October 17, 2012. Delineation maps of the site are presented in Appendix B. A photographic record of the wetlands, streams, sample plots and various other portions of the site are attached in Appendix C.

SECTION 3
RESULTS

3.0 Document Review

The following information was obtained during the document review prior to the wetland and stream delineation:

- Historical and current aerial photos,
  - The historical and current aerial photographs were examined to determine changes in land use and hydraulic patterns, vegetated areas and possible locations of standing water or saturated soils.
  - There have been minimal changes to the dam and reservoir area since the dam was constructed in 1971.
- USFWS NWI maps (USFWS 2012), (Figure 3),
  - These data identify wetlands within, and in the vicinity of the Survey Area, as well as general types of plant community structures present. Wetlands identified in the Survey Area included:
    - Silver Lake Flat Reservoir: (L1ABGh) Lacustrine, Limnetic, Aquatic Bed, Intermittently Exposed, Diked/Impounded.
- USFS soil data (USFS 2012), (Figure 4),
  - The soil data identifies the presence of soil types within, and in the vicinity of the Survey Area. Data from this source indicates the following dominant soil types:
    - PGGC9: Lady of snow extremely cobbly loam, 0 to 16 % slopes.
    - PGGM3: Wander family very gravelly loam, 30 to 100% slopes, <50% crown cover.
    - PGSC5: Climber family-Horrocks family complex, 35 to 80% slopes.
- USGS 1:24,000 scale 7.5-minute topographic map (USGS 1975 and 1993),
  - This map identifies the general topography and important site features within, and in the vicinity of the Survey Area.
  - The dam, reservoir, roads and surrounding topography were illustrated on this map.
- Other available general background information provided by NRCS and USFS.

3.1 Field Investigation and Site Description

The objective of the wetland and stream delineation was to determine the extent of aquatic features within the Survey Area based on the presence of hydrophytic vegetation, hydric soils and wetland hydrology indicators for wetlands and the presence of an OHWM in reservoirs and along the streams. McMillen wetland biologist (Greg Allington) and McMillen environmental scientist (Kevin Jensen) performed the wetland and stream delineation field work on October 2, 2012 and October 3, 2012. The weather was sunny during the delineation, with temperatures ranging from 45°F to 65°F.

The Survey Area was examined for signs of wetland and stream indicators. The results of the investigation revealed the presence of one wetland (Wetland A), one reservoir (Silver Lake Flat Reservoir) and two stream segments (Stream 1 and Silver Creek). NWI maps are produced from the interpretation of aerial photographs that require field verification; therefore areas mapped as NWI wetlands (Figure 3) were investigated for wetland indicators.

The wetland delineation consisted of determining the boundary between wetland and upland areas. The approximation of this boundary line typically consisted of identifying a topographic break and correlating the break with shifts in vegetation from hydrophytic to upland species. The dominant upland plant species within the tree stratum were Quaking Aspen (*Populus tremuloides*) and Douglas Fir (*Pseudutsuga menziesii*). Within the herbaceous stratum, the dominant species were Redtop (*Agrostis stolonifera*) and Canada thistle (*Cirsium arvense*). The presence or absence of these plant species served to indicate the approximate location of the wetland boundary line. Upon observation of this approximate line, transitions to hydrophytic species were either verified or not. The dominant hydrophytic species observed within the tree stratum was Booth's Willow (*Salix boothii*); within the herbaceous stratum the dominant species was Horsetail (*Equisetum spp.*). Soil pits were then established to determine the presence or absence of hydric soils and wetland hydrology indicators (if not visible on the ground surface).

The growing season for a region is dependent upon climate, precipitation and topography. According to the WETS table for the Timpanogos Cave Station (UT8733), which is the station closest to the project site, there is a 70 percent chance that the air temperature will be above 28°F from April 15 through October 29 of a given year (USDA 2002). The following indicators of biological activity were observed throughout the entire site indicating that the delineation was performed prior to the end of the growing season: herbaceous plant persistence, and green leaves on trees. The wetland and stream delineations were conducted during the official growing season and soil temperatures were not taken for this delineation project based upon the dates identified in the WETS table and field observations that the growing season had begun but not ended yet.

The two streams delineated are located downstream of Silver Lake Flat Reservoir. The downstream segments are regulated by Silver Lake Flat Dam. Silver Lake Flat Road follows the western side of Silver Lake Flat Reservoir and the Survey Area experiences moderate levels of disturbance from the general public on a regular basis.

3.1.1 Precipitation and Stream Flow Data

Precipitation data in the vicinity of the site was obtained from the NRCS SNOTEL stations at Snowbird (766) and Timpanogos Divide (820) (NRCS 2012). The Timpanogos Divide station is located approximately 5 miles south-southeast of the project site on a plateau at an elevation of 8,140 feet. The Snowbird station is located approximately 4½ miles due north near Alta, Utah at an elevation of 9,640 feet. Average monthly precipitation data recorded at both Snowbird and Timpanogos Cave Stations for the five months prior to the survey are presented in Table 3-1.

Table 3-1. NRCS SNOTEL Station Data

Month	Snowbird 2012 (Inches)	Snowbird 1981-2010 Average(Inches)	Timpanogos Cave 2012 (Inches)	Timpanogos Cave 1981-2010 Average (Inches)
March	5.4	5.9	3.9	4.0
April	5.6	5.9	3.4	3.3
May	2.6	4.5	2.1	2.8
June	0.0	2.3	0.0	1.8
July	2.1	1.2	1.4	1.3
August	0.5	1.7	0.6	1.7
September	2.2	3.1	2.8	2.7

The data presented in Table 3-1 above indicates generally average precipitation from March through May at both stations. June experienced no precipitation and July through September had

below average precipitation which accounts for the dry upper soil layer encountered throughout the Survey Area.

The nearest USGS gaging station with available data is along the American Fork River near American Fork, Utah (USGS Station 10164500), of which Silver Creek is a tributary. The average daily flow at this gaging station for October 3, 2012 is 24 cubic feet per second (cfs), based on data from 1927 through 1989. This average is taken at a point draining 51.1 mi^2, compared with the outlet of Silver Lake Flat Dam, which drains approximately 4.3 mi^2. Because the lower portion of Silver Creek is regulated by Silver Lake Flat Reservoir, regional regression of data along the American Fork cannot reasonably be used to create a synthetic discharge record of Silver Lake Flat Reservoir. Furthermore, because regional regression equations such as those presented in *Methods for Estimating Magnitude and Frequency of Peak Flows for Natural Streams in Utah* (Kenney et al. 2007) are formulated to predict recurrence-interval events and are based on annual peak flows rather than daily averages, the methods of StreamStats or other regional regression programs are not suitable for estimating the inflow into Silver Lake Flat reservoir during the field visit.

Natural groundwater levels within the Survey Area were estimated to be near their lowest levels during the delineation due to the comparatively dry preceding months and the timing of the site visit near the end of the hydrologic year.

3.1.2 Soil Survey Data

The typical terrain within the Survey Area is a moderately sloping valley with the presence of only modestly incised channels. The soils in the vicinity of the dam are typical of river floodplains, with sand, gravels and cobbles interspersed in loam. Table 3-2 below provides a summary of the soils survey data gathered for the Survey Area.

Table 3-2. Silver Lake Flat Soils Summary

Soil Name	Description	Hydric Soil	Survey Area Location
PGGC9	Ladyofsnow family of extremely cobbly loam, 0% to 16% slopes	No	Located within the Silver Creek riparian corridor and including Silver Lake Flat Reservoir and Dam
PGGM3	Wander family of very gravelly loam, 30% to 100% slopes, with <50% crown cover	No	Located at the left abutment downstream face of the dam
PGSC5	Climber family-Horrocks family complex, 35% to 80% slopes	No	Located at the right abutment downstream face of the dam and the seepage area (Wetland A)

3.2 Wetlands

The wetland delineation identified one wetland and one reservoir within the Survey Area. The wetland identified is connected to other waterbodies and is not isolated from a jurisdictional water of the United States. The following sections describe Wetland A and Silver Lake Flat Reservoir, and their associated classification. A list of observed plants in both wetland and upland areas of the Survey Area is provided in Appendix D.

3.2.1 Wetland Characterization

3.2.1.1 Wetland A

Wetland A is located downstream of the right abutment on Silver Lake Flat Dam and is approximately 0.5 acres in size (Appendix B-Drawing 2). It is located in a separate drainage from Silver Creek that drains into Deer Creek which flows directly into Tibble Fork Reservoir. The Cowardin classification for this wetland is palustrine, emergent, saturated with a hydrogeomorphic classification of slope. Wetland A may have been present in this area prior to the construction of dam. Analysis of a 1940 pre-dam historical aerial photograph depicts a bare area clear of vegetation in the same area indicating that there may have been a disturbance (possible natural wetland seep) in this area. Regardless if this seep was present prior to the construction of the dam, it is now known to be hydraulically connected to the water level in the reservoir which flows under the dam and Silver Lake Flat Road to the wetland.

The NWI map (Figure 3) did not identify any wetlands in the immediate vicinity of Wetland A. Field observations identified this wetland unit as an emergent wetland with saturated soils from water seeping out of the hillside due to the hydrologic control of water supply by the dam and reservoir. The southwestern edge of the wetland follows the horse trail that continues up and around the dam. Neither the soils, nor the vegetation immediately adjacent to the horse trail seem to indicate that the horse trail itself is part of the wetland. Water from Wetland A collects at the downhill portion and forms a channel (Stream 1) that eventually flows into Deer Creek.

The wetland delineation generally followed topographic breaks in the upper to middle of the slope, changes in wetland vegetation to upland species, the presence of redoximorphic features within 12 inches of the surface and the presence of wetland hydrology indicators. Dominant vegetation within the wetland included beaked sedge (*Carex rostrata*), redtop (*Agrostis gigantea),* and horsetail (*Equisetum* spp.). Soils within the wetland boundary exhibited low chroma, redoximorphic concentrations and sulfidic odor. Hydrology was present during the delineation in the form of small pockets of standing water and saturated soils within 12 inches of the ground surface.

3.2.1.2 Silver Lake Flat Reservoir

Silver Creek is impounded by Silver Lake Dam which forms Silver Lake Flat Reservoir which is approximately 43.7 acres in size (Appendix B-Drawing 3). The reservoir is a deep water habitat with a maximum depth of approximately 80 feet when the reservoir is at full pool. The NWI map identifies this reservoir as a lacustrine, limnetic, aquatic bed, intermittently exposed, diked/impounded (L1ABGh) aquatic feature and the site visit confirmed this classification. The substrate of the reservoir is primarily comprised of cobble, gravels, and sand and there is no vegetation growing below the full pool level.

An official delineation of the reservoir was not completed onsite. However, a delineation was performed using GIS to mark the full pool level (OHWM) of the reservoir to determine the jurisdictional limit of the reservoir. The full pool level follows the elevation of the spillway on the top of the dam.

3.2.2 Wetland Classification

Wetland A and Silver Lake Flat Reservoir were classified according to the Cowardin system and their hydrogeomorphic classification, as presented in Table 3-3. A detailed map showing the location of the wetland and reservoir is located in Appendix B.

Table 3-3. Wetland Classification and Size

Wetland	Cowardin Classification				Hydrogeomorphic Classification	Size (Acres)
	System	Subsystem	Class	Water Regime		
A	Palustrine (P)	--	Emergent (EM)	Artificially Flooded (K)	Slope	0.5
Silver Lake Flat Reservoir	Lacustrine (L)	Limnetic (1)	Aquatic Bed (AB)	Intermittently Exposed (G)	Depressional	43.7

3.3 Streams

A delineation of the OHWM was completed within the Survey Area to identify the limits of jurisdictional waterways. The OHWM is usually concurrent with the 2-year flood event and vegetation does not typically grow below this mark.

3.3.1 Stream Characterization

3.3.1.1 Silver Creek

Silver Creek is a perennial stream system and a tributary of the American Fork River. The hydrograph upstream of the reservoir is not regulated and fluctuates with precipitation and snow melt events. The hydrograph downstream of the reservoir is regulated by the dam during the majority of the year except when water is flowing over the top of the dam in the spillway.

The OHWM of Silver Creek was delineated below the dam starting at the spillway stilling basin and continuing downstream almost 200 feet (Appendix B-Drawing 4). This segment of Silver Creek is characterized by a step-pool morphology, containing large woody debris and boulders, and cascading pools and riffles. The delineation of Silver Creek was performed when stream flows were below the OHWM. Vegetation along the banks of the stream primarily included narrowleaf cottonwood (*Populus angustifolia*), mountain alder (*Alnus viridis*), white fir (*Abies concolor*), Douglas fir, snowberry (*Symphoricarpos albus*) and Rocky Mountain maple (*Acer glabrum*). Photographs of the Silver Creek OHWM are shown in Appendix C and signs of the OHWM included the following:

- Natural line impressed on the bank,
- Shelving,
- Absence of terrestrial vegetation,
- Scouring,
- Exposed roots,
- Moss line, and
- Water marks on large boulders, concrete structures and trees.

3.3.1.2 Stream 1

Stream 1 is a perennial tributary to Deer Creek and is fed from the wetland seep just downstream of the right abutment of Silver Lake Flat Dam (Wetland A). The stream originates near the southern end of Wetland A where seepage collects and discharges into a defined channel that is one to two feet wide and approximately one to two foot deep. The channel bottom consists of sand and mud, interspersed with fine to very fine gravel. The centerline of this stream was delineated due to the narrow OHWM of the channel. Flow exiting Wetland A and entering into

the stream is correlated to the water surface level in the reservoir. Full pool levels in the reservoir produce more water in the stream than when it is at its low conservation pool.

The delineation of Stream 1 was performed when stream flows were below the OHWM (taken as the bank lines). Photographs of Stream 1 are shown in Appendix C and signs of the OHWM included the following:

- Absence of terrestrial vegetation,
- Pronounced break in slope, and
- Exposed roots

3.3.2 Stream Classification

Streams delineated were classified according to the Cowardin classification system as presented in Table 3-4. A detailed map showing the locations of each stream is located in Appendix B.

Table 3-4. Stream Classification and Size

Stream	Cowardin Classification					Length Delineated (Area)
	System	Subsystem	Class	Subclass	Water Regime	
Silver Creek	Riverine (R)	Upper Perennial (1)	Unconsolidated Bottom (UB)	Cobble-Gravel (1)	Permanently Flooded (H)	190 feet (3,350 square feet)
1	Riverine (R)	Upper Perennial (1)	Unconsolidated Bottom (UB)	Sand (2)	Permanently Flooded (H)	165 feet (330 square feet)

SECTION 4
CONCLUSION

4.0 Conclusion

McMillen performed one wetland (Wetland A), one reservoir (Silver Lake Flat Reservoir) and two stream (Silver Creek and Stream 1) delineations within the Survey Area for the project in Utah County, Utah. The delineation was performed to help NRCS identify potential construction constraints related to critical aquatic features that occur within the project area. The boundaries of these aquatic features are depicted in Appendix B. The wetland identified (Wetland A) is not isolated and drains to a jurisdictional water of the United States.

This wetland and stream delineation was performed in October 2012. According to USACE regulations pertaining to wetland and stream delineation reports, this report is valid for five years from the date the delineation was performed.

SECTION 5
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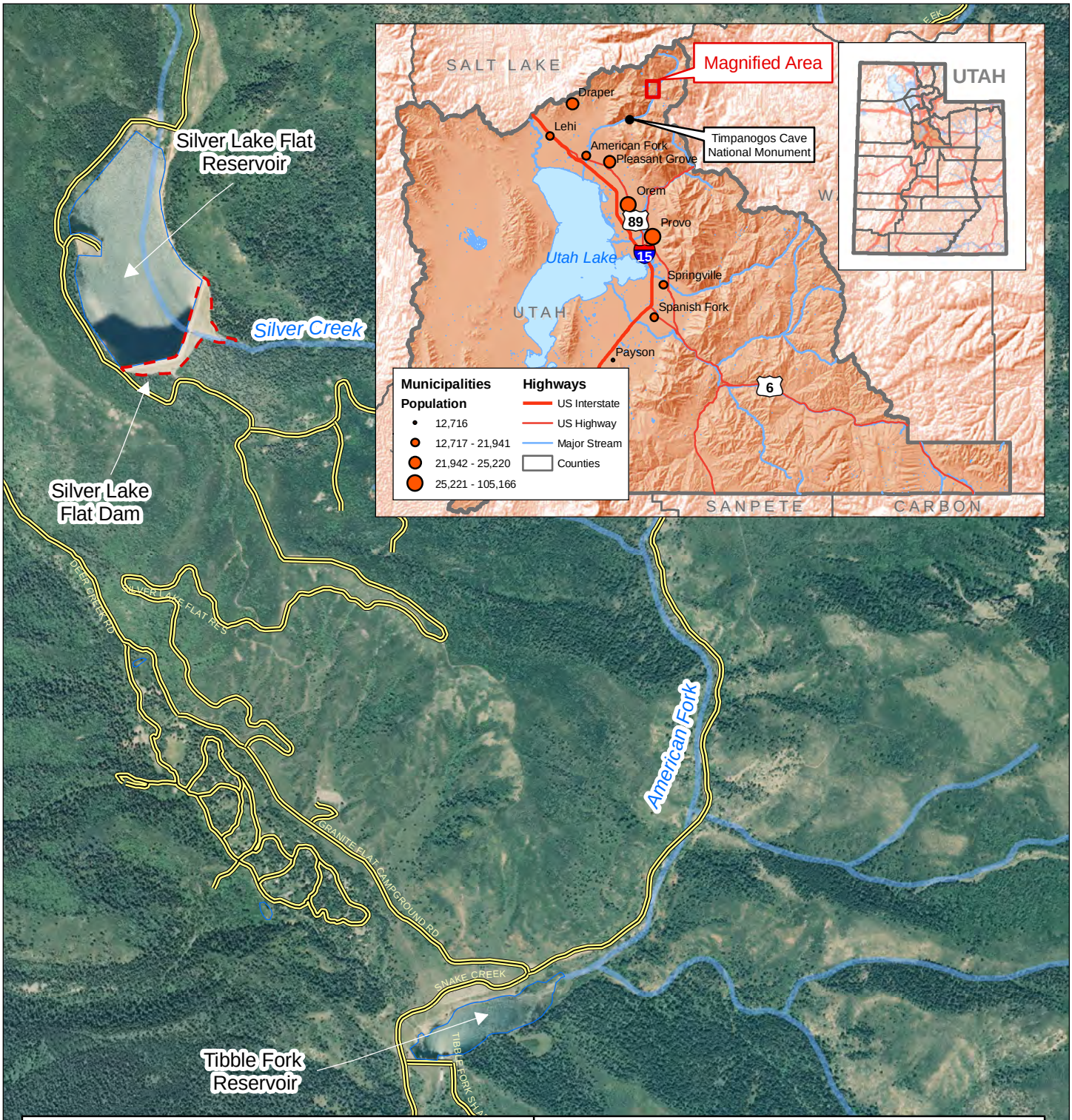
FIGURES



Legend

- Silver Lake Flat Dam
- Lakes and Reservoirs
- Roads
- Streams

NOTES:
Aerial photo from 2009 NAIP 1-m orthophoto. Shaded reliefs derived from 10- and 90-m USGS DEMs. Points, lines and polygons supplied by various state and federal sources, including USFS, UDOT, and USGS.

0 0.125 0.25 0.5 Miles

N W E S

Figure 1: Vicinity Map

NRCS Silver Lake Flat Plan-Environmental Assessment
Wetland and Stream Delineation Report

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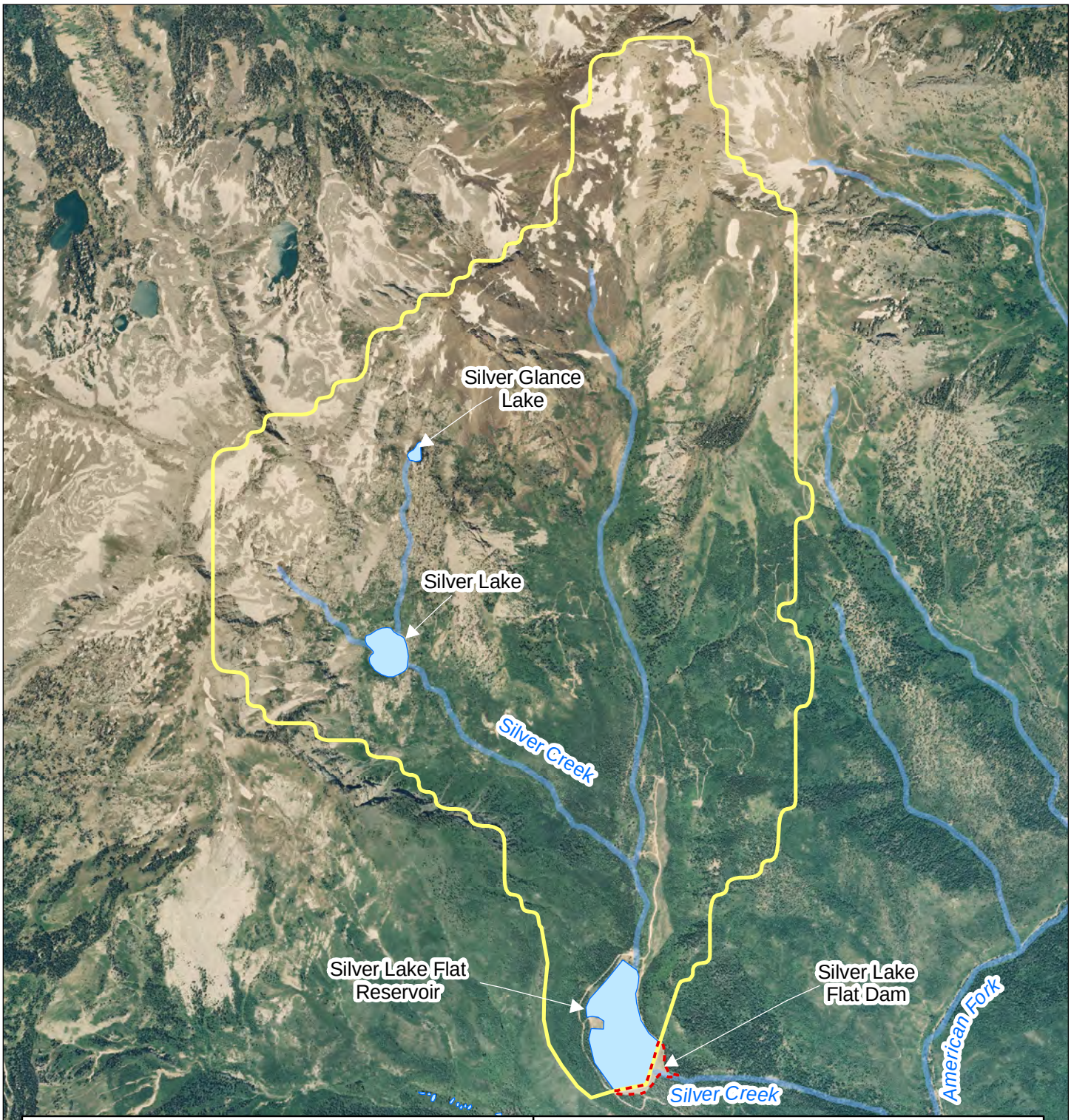

Legend

- Silver Lake Flat Dam
- Watershed Boundary
- Lakes and Reservoirs
- Streams

NOTES:
Aerial photo from 2009 NAIP 1-m orthophoto. Points, lines and polygons supplied by various state and federal sources, including USFS, UDOT, and USGS. Watershed boundary approximated using HEC-GeoHMS extension for ArcMap with a 90-m DEM, then smoothed and manually edited.

0 0.25 0.5 1 Miles

N W E S

Figure 2: Watershed Map

NRCS Silver Lake Flat Plan-Environmental Assessment
Wetland and Stream Delineation Report

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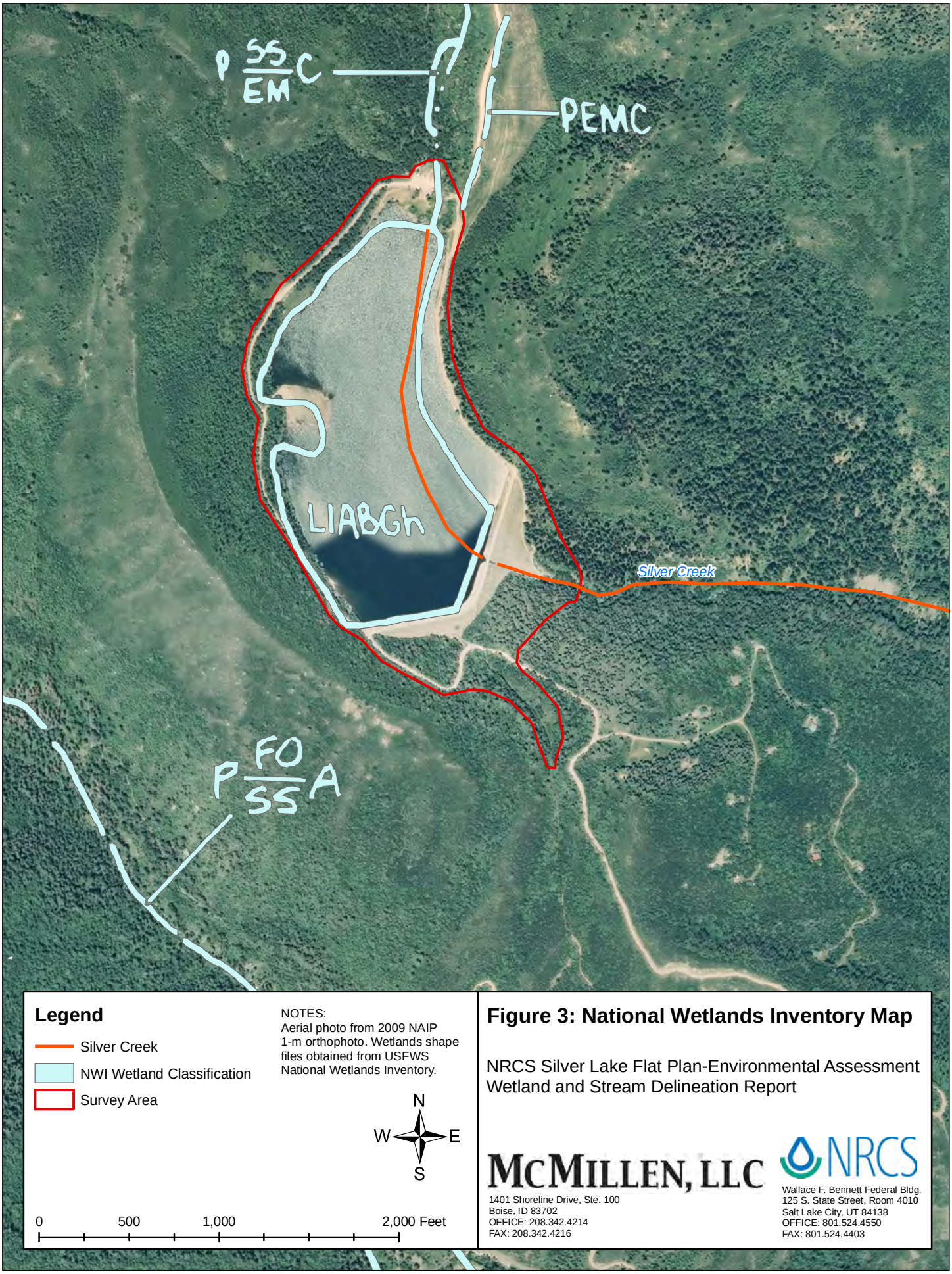

Legend

- Silver Creek
- NWI Wetland Classification
- Survey Area

NOTES:
Aerial photo from 2009 NAIP 1-m orthophoto. Wetlands shape files obtained from USFWS National Wetlands Inventory.

N
W E
S

0 500 1,000 2,000 Feet

Figure 3: National Wetlands Inventory Map

NRCS Silver Lake Flat Plan-Environmental Assessment
Wetland and Stream Delineation Report

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NOTES:
Aerial photo from 2009 NAIP 1-m orthophoto. Soils outside of project area excluded. Soil data obtained from USFS.

Legend

- Survey Area
- Project Area Soils
- Streams

0 0.05 0.1 0.2 Miles

PGGC9: Ladyofsnow family extremely cobbly loam, 0 to 16% slopes
PGGM3: Wander family very gravelly loam, 30 to 100% slopes, <50% crown cover
PGLS1: Storm family very gravelly loam, 40 to 60% slopes
PGSC1: Burgi family gravelly loam, 0 to 5% slopes.
PGSC5: Climber family-Horrocks family complex, 35 to 80% slopes
PGTM21: Sawpit family gravelly loam,

Figure 4: Soils Map

NRCS Silver Lake Flat Plan-Environmental Assessment
Wetland and Stream Delineation Report

N W E S

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APPENDIX A

WETLAND DATA SHEETS

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project Site: ***Silver Lake Flat - Wetland A*** City/County: ***Utah County*** Sampling Date: ***10/3/12***

Applicant/Owner: ***NRCS*** State: ***UT*** Sampling Point: ***SP-1***

Investigator(s): ***Greg Allington and Kevin Jensen (McMillen, LLC)*** Section, Township, Range: ***Sec. 6 T4S R3E***

Landform (hillslope, terrace, etc.): ***Slope*** Local relief (concave, convex, none): ***Concave*** Slope (%): ***<5%***

Subregion (LRR): ***LRR E*** Lat: **40.4993** Long: **-111.6547** Datum: ***WGS84***

Soil Map Unit Name: ***Climber family-Horrocks family complex, 35% to 85 % slopes*** NWI classification: ***None***

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are Vegetation ☐, Soil ☐, Or Hydrology ☐, significantly disturbed? Are "Normal Circumstances" present? Yes ☒ No ☐

Are Vegetation ☐, Soil ☐, Or Hydrology ☐, naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☒	No ☐			
Hydric Soil Present?	Yes ☐	No ☒	**Is the Sampling Area within a Wetland?**	**Yes** ☐	**No** ☒
Wetland Hydrology Present?	Yes ☐	No ☒			

Remarks:

VEGETATION – Use scientific names of plants

Tree Stratum (Plot Size: **20 ft**)	Absolute % Cover	Dominant Species?	Indicator Status
1. ***Populus tremuloides – quaking aspen***	***15%***	***No***	***FACU***
2.			
3.			
4.			
	15%	= Total Cover	
Sapling/Shrub Stratum (Plot Size: **20 ft**)			
1. ***Cirsium arvense – Canada thistle***	***45%***	***Yes***	***FAC***
2.			
3.			
4.			
5.			
	45%	= Total Cover	
Herb Stratum (Plot Size: **20 ft**)			
1. ***Agrostis gigantea - redtop***	***55%***	***Yes***	***FAC***
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	55%	= Total Cover	
Woody Vine Stratum (Plot Size: **20 ft**)			
1.			
2.			
	0%	= Total Cover	

% Bare Ground in Herb Stratum ***0***

Dominance Test Worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC:	***2***	(A)
Total Number of Dominant Species Across All Strata:	***2***	(B)
Percent of Dominant Species That Are OBL, FACW, or FAC:	***100%***	(A/B)

Prevalence Index worksheet:

	Total % Cover of:		Multiply by:	
OBL species	*0*	x1 =	***0***	
FACW species	***0***	x2 =	***0***	
FAC species	*2*	x3 =	***6***	
FACU species	***1***	x4 =	***4***	
UPL species	***0***	x5 =	***0***	
Column Totals:	***3***	(A)	***10***	(B)

Prevalence Index = B/A = ***3.3***

Hydrophytic Vegetation Indicators:

Yes	Dominance Test is >50%
No	Prevalence Index is ≤3.0[1]
No	Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
No	Wetland Non-Vascular Plants[1]
No	Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** ☒ **No** ☐

Remarks:

Project Site: ***Silver Lake Flat - Wetland A***

SOIL

Sampling Point: ***SP-1***

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (Moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-16	***10 YR 2/2***						***Sandy Loam***	***Refusal at 16" (hard gravelly layer)***

[1]Type: C= Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1) **(except MLRA 1)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ☐ 2 cm Muck (A10)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ***Hard Gravel***

Depth (Inches): ***16***

Hydric Soils Present? **Yes** ☐ **No** ☒

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, and 4B)**
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Stunted or Stresses Plants (D1) **(LRR A)**
- ☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ☐ Water-Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Raised Ant Mounds (D6) **(LRR A)**
- ☐ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes	☐	No	☒	Depth (inches):
Water Table Present?	Yes	☐	No	☒	Depth (inches):
Saturation Present? (includes capillary fringe)	Yes	☐	No	☒	Depth (inches):

Wetland Hydrology Present? **Yes** ☐ **No** ☒

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project Site: ***Silver Lake Flat – Wetland A*** City/County: ***Utah County*** Sampling Date: ***10/3/12***

Applicant/Owner: ***NRCS*** State: ***UT*** Sampling Point: ***SP-2***

Investigator(s): ***Greg Allington and Kevin Jensen (McMillen, LLC)*** Section, Township, Range: ***Sec. 6 T4S R3E***

Landform (hillslope, terrace, etc.): ***Slope*** Local relief (concave, convex, none): ***Concave*** Slope (%): ***<5%***

Subregion (LRR): ***LRR E*** Lat: **40.4992** Long: **-111.6546** Datum: ***WGS84***

Soil Map Unit Name: ***Climber family-Horrocks family complex, 35% to 85 % slopes*** NWI classification: ***None***

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are Vegetation ☐, Soil ☐, Or Hydrology ☐, significantly disturbed? Are "Normal Circumstances" present? Yes ☒ No ☐

Are Vegetation ☐, Soil ☐, Or Hydrology ☐, naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes	☒	No	☐				
Hydric Soil Present?	Yes	☒	No	☐	**Is the Sampling Area within a Wetland?**	**Yes**	☒	**No** ☐
Wetland Hydrology Present?	Yes	☒	No	☐				

Remarks:

VEGETATION – Use scientific names of plants

Tree Stratum (Plot Size: **20 ft**)	Absolute % Cover	Dominant Species?	Indicator Status
1. ***Alnus incana – mountain alder***	***20%***	***Yes***	***FACW***
2.			
3.			
4.			
	20%	= Total Cover	
Sapling/Shrub Stratum (Plot Size: **20 ft**)			
1. ***Carex utriculata – NW territory sedge***	***65%***	***Yes***	***OBL***
2.			
3.			
4.			
5.			
	65%	= Total Cover	
Herb Stratum (Plot Size: **20 ft**)			
1. ***Agrostis gigantea - redtop***	***15%***	***No***	***FAC***
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	15%	= Total Cover	
Woody Vine Stratum (Plot Size: **20 ft**)			
1.			
2.			
	0%	= Total Cover	

% Bare Ground in Herb Stratum ***20***

Dominance Test Worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC:	***2***	(A)
Total Number of Dominant Species Across All Strata:	***2***	(B)
Percent of Dominant Species That Are OBL, FACW, or FAC:	***100%***	(A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	*1*	x1 =	***1***
FACW species	***1***	x2 =	***2***
FAC species	*1*	x3 =	***3***
FACU species	***0***	x4 =	***0***
UPL species	***0***	x5 =	***0***
Column Totals:	***3*** (A)		***6*** (B)

Prevalence Index = B/A = ***2.0***

Hydrophytic Vegetation Indicators:

Yes	Dominance Test is >50%
Yes	Prevalence Index is ≤3.0[1]
No	Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
No	Wetland Non-Vascular Plants[1]
No	Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** ☒ **No** ☐

Remarks:

Project Site: ***Silver Lake Flat – Wetland A***

SOIL

Sampling Point: ***SP-2***

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (Moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-18	***10 YR 2/1***						***Silt***	

[1]Type: C= Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☒ Hydrogen Sulfide (A4)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1) **(except MLRA 1)**
- ☐ Loamy Gleyed Matrix (F2)
- ☒ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ☐ 2 cm Muck (A10)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type:

Depth (Inches):

Hydric Soils Present? **Yes** ☒ **No** ☐

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☒ Saturation (A3)
- ☒ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☒ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, and 4B)**
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☒ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Stunted or Stresses Plants (D1) **(LRR A)**
- ☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ☒ Water-Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
- ☒ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☒ FAC-Neutral Test (D5)
- ☐ Raised Ant Mounds (D6) **(LRR A)**
- ☐ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes	☐	No	☒	Depth (inches):
Water Table Present?	Yes	☐	No	☒	Depth (inches):
Saturation Present? (includes capillary fringe)	Yes	☒	No	☐	Depth (inches): *18*

Wetland Hydrology Present? **Yes** ☒ **No** ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks*:*

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project Site: ***Silver Lake Flat – Wetland A*** City/County: ***Utah County*** Sampling Date: ***10/3/12***

Applicant/Owner: ***NRCS*** State: ***UT*** Sampling Point: ***SP-3***

Investigator(s): ***Greg Allington and Kevin Jensen (McMillen, LLC)*** Section, Township, Range: ***Sec. 6 T4S R3E***

Landform (hillslope, terrace, etc.): ***Slope*** Local relief (concave, convex, none): ***Concave*** Slope (%): ***<5%***

Subregion (LRR): ***LRR E*** Lat: **40.4985** Long: **-111.6537** Datum: ***WGS84***

Soil Map Unit Name: ***Climber family-Horrocks family complex, 35% to 85 % slopes*** NWI classification: ***None***

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are Vegetation ☐, Soil ☐, Or Hydrology ☐, significantly disturbed? Are "Normal Circumstances" present? Yes ☒ No ☐

Are Vegetation ☐, Soil ☐, Or Hydrology ☐, naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes	☐	No	☒				
Hydric Soil Present?	Yes	☐	No	☒	**Is the Sampling Area within a Wetland?**	**Yes**	☐	**No** ☒
Wetland Hydrology Present?	Yes	☐	No	☒				

Remarks:

VEGETATION – Use scientific names of plants

Tree Stratum (Plot Size: **20 ft**)	Absolute % Cover	Dominant Species?	Indicator Status
1. ***Populus tremuloides – quaking aspen***	***30%***	***Yes***	***FACU***
2.			
3.			
4.			
	30%	= Total Cover	
Sapling/Shrub Stratum (Plot Size: **20 ft**)			
1. ***Symphoricarpos albus – common snowberry***	***45%***	***Yes***	***FACU***
2.			
3.			
4.			
5.			
	45%	= Total Cover	
Herb Stratum (Plot Size: **20 ft**)			
1. ***Dactylis glomerata – orchard grass***	***25%***	***Yes***	***FACU***
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	25%	= Total Cover	
Woody Vine Stratum (Plot Size: **20 ft**)			
1.			
2.			
	0%	= Total Cover	

% Bare Ground in Herb Stratum ***75***

Dominance Test Worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC:	***0***	(A)
Total Number of Dominant Species Across All Strata:	***2***	(B)
Percent of Dominant Species That Are OBL, FACW, or FAC:	***0%***	(A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	*0*	x1 =	***0***
FACW species	***0***	x2 =	***0***
FAC species	*0*	x3 =	***0***
FACU species	***3***	x4 =	***12***
UPL species	***0***	x5 =	***0***
Column Totals:	***3*** (A)		***12*** (B)

Prevalence Index = B/A = ***4.0***

Hydrophytic Vegetation Indicators:

No	Dominance Test is >50%
No	Prevalence Index is $\leq 3.0^1$
No	Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
No	Wetland Non-Vascular Plants[1]
No	Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** ☐ **No** ☒

Remarks:

Project Site: ***Silver Lake Flat – Wetland A***

SOIL

Sampling Point: ***SP-3***

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (Moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-10	***10 YR 2/2***						***Sandy Loam***	
10							***Gravel***	*Refusal at 10" due to hard gravelly layer*

[1]Type: C= Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1) **(except MLRA 1)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ☐ 2 cm Muck (A10)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ***Hard Gravel***

Depth (Inches): ***10***

Hydric Soils Present? **Yes** ☐ **No** ☒

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, and 4B)**
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Stunted or Stresses Plants (D1) **(LRR A)**
- ☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ☐ Water-Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Raised Ant Mounds (D6) **(LRR A)**
- ☐ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes	☐	No	☒	Depth (inches):
Water Table Present?	Yes	☐	No	☒	Depth (inches):
Saturation Present? (includes capillary fringe)	Yes	☐	No	☒	Depth (inches):

Wetland Hydrology Present? **Yes** ☐ **No** ☒

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project Site: ***Silver Lake Flat – Wetland A*** City/County: ***Utah County*** Sampling Date: ***10/3/12***

Applicant/Owner: ***NRCS*** State: ***UT*** Sampling Point: ***SP-4***

Investigator(s): ***Greg Allington and Kevin Jensen (McMillen, LLC)*** Section, Township, Range: ***Sec. 6 T4S R3E***

Landform (hillslope, terrace, etc.): ***Slope*** Local relief (concave, convex, none): ***Concave*** Slope (%): ***<5%***

Subregion (LRR): ***LRR E*** Lat: **40.9848** Long: **-111.6538** Datum: ***WGS84***

Soil Map Unit Name: ***Climber family-Horrocks family complex, 35% to 85 % slopes*** NWI classification: ***None***

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are Vegetation ☐, Soil ☐, Or Hydrology ☐, significantly disturbed? Are "Normal Circumstances" present? Yes ☒ No ☐

Are Vegetation ☐, Soil ☐, Or Hydrology ☐, naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes	☒	No	☐				
Hydric Soil Present?	Yes	☒	No	☐	**Is the Sampling Area within a Wetland?**	**Yes**	☒	**No** ☐
Wetland Hydrology Present?	Yes	☒	No	☐				

Remarks:

VEGETATION – Use scientific names of plants

Tree Stratum (Plot Size: **20 ft**)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	0%	= Total Cover	
Sapling/Shrub Stratum (Plot Size: **20 ft**)			
1.			
2.			
3.			
4.			
5.			
	0%	= Total Cover	
Herb Stratum (Plot Size: **20 ft**)			
1. ***Rumex crispus – curly leaf dock***	***10%***	***Yes***	***FAC***
2. ***Agrostis gigantea - redtop***	***70%***	***Yes***	***FAC***
3. **Carex utriculata - *NW territory sedge***	***20%***	***Yes***	***OBL***
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	100%	= Total Cover	
Woody Vine Stratum (Plot Size: **20 ft**)			
1.			
2.			
	0%	= Total Cover	

% Bare Ground in Herb Stratum ***0***

Dominance Test Worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC:	***2***	(A)
Total Number of Dominant Species Across All Strata:	***2***	(B)
Percent of Dominant Species That Are OBL, FACW, or FAC:	***100%***	(A/B)

Prevalence Index worksheet:

Total % Cover of:			Multiply by:
OBL species	*1*	x1 =	***1***
FACW species	***0***	x2 =	***0***
FAC species	*2*	x3 =	***6***
FACU species	***0***	x4 =	***0***
UPL species	***0***	x5 =	***0***
Column Totals:	***3*** (A)		***7*** (B)

Prevalence Index = B/A = ***2.3***

Hydrophytic Vegetation Indicators:

Yes	Dominance Test is >50%
Yes	Prevalence Index is ≤3.0[1]
No	Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
No	Wetland Non-Vascular Plants[1]
No	Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** ☒ **No** ☐

Remarks:

Project Site: ***Silver Lake Flat – Wetland A***

SOIL

Sampling Point: ***SP-4***

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (Moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-18	***10 YR 2/1***						***Sandy Loam***	***20% gravel***

[1]Type: C= Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1) **(except MLRA 1)**
- ☐ Loamy Gleyed Matrix (F2)
- ☒ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ☐ 2 cm Muck (A10)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type:

Depth (Inches):

Hydric Soils Present? **Yes** ☒ **No** ☐

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, and 4B)**
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Stunted or Stresses Plants (D1) **(LRR A)**
- ☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ☐ Water-Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
- ☒ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☒ FAC-Neutral Test (D5)
- ☐ Raised Ant Mounds (D6) **(LRR A)**
- ☐ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes	☐	No	☒	Depth (inches):
Water Table Present?	Yes	☐	No	☒	Depth (inches):
Saturation Present? (includes capillary fringe)	Yes	☐	No	☒	Depth (inches):

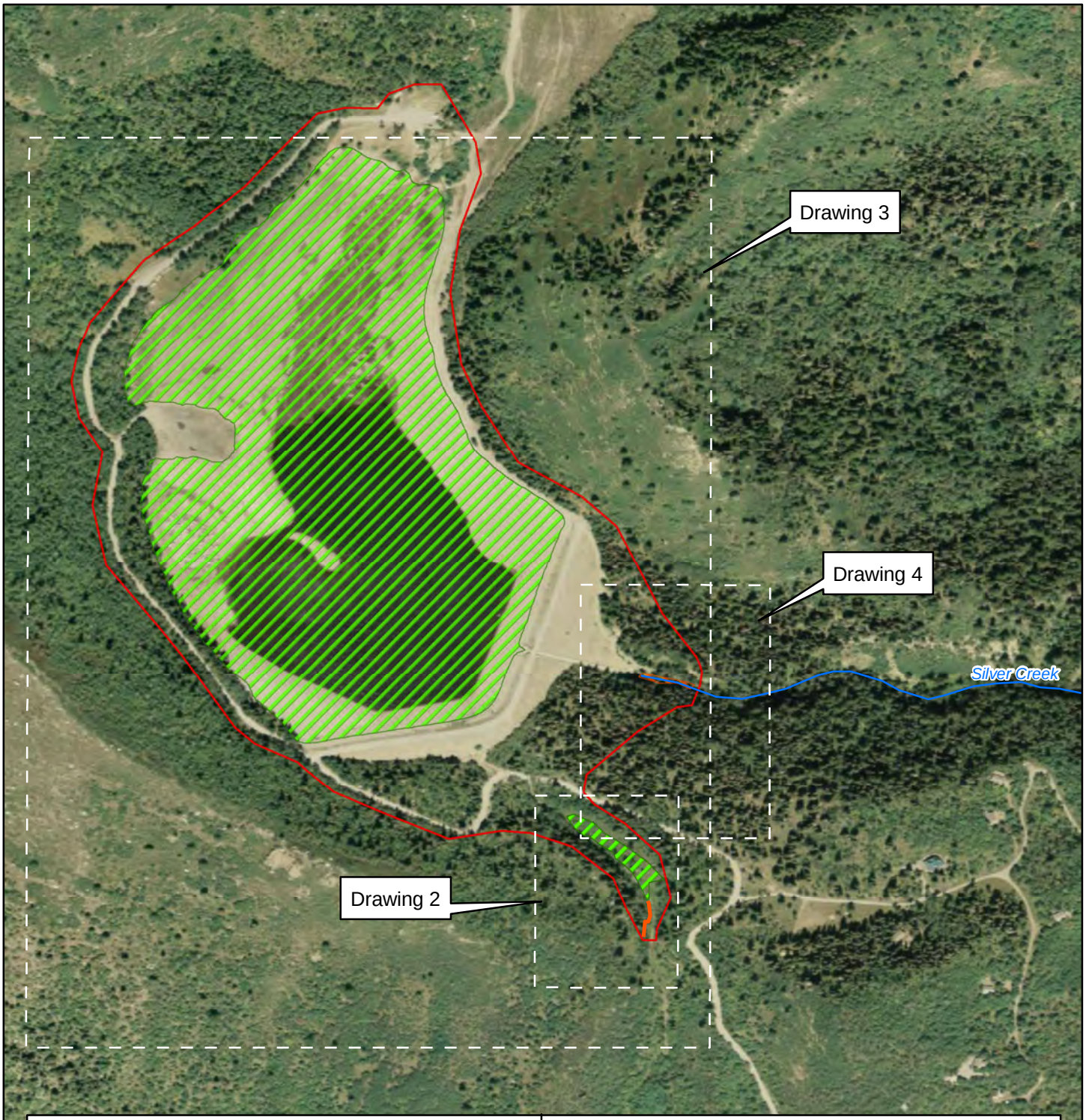
Wetland Hydrology Present? **Yes** ☒ **No** ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

APPENDIX B

WETLAND AND STREAM DELINEATION MAPS



Legend

- Silver Creek (not delineated)
- Survey Area
- Stream
- Wetland

NOTE:
Aerial photo from 2009 NAIP 1-m orthophoto.Flags used to demarcate wetlands were pink; flags used to identify stream segments were orange; flags used to locate sample plots were yellow.

0 0.05 0.1 0.2 Miles

N W E S

Drawing 1: Wetland and Stream Delineation

NRCS Silver Lake Flat Plan-Environmental Assessment
Wetland and Stream Delineation Report

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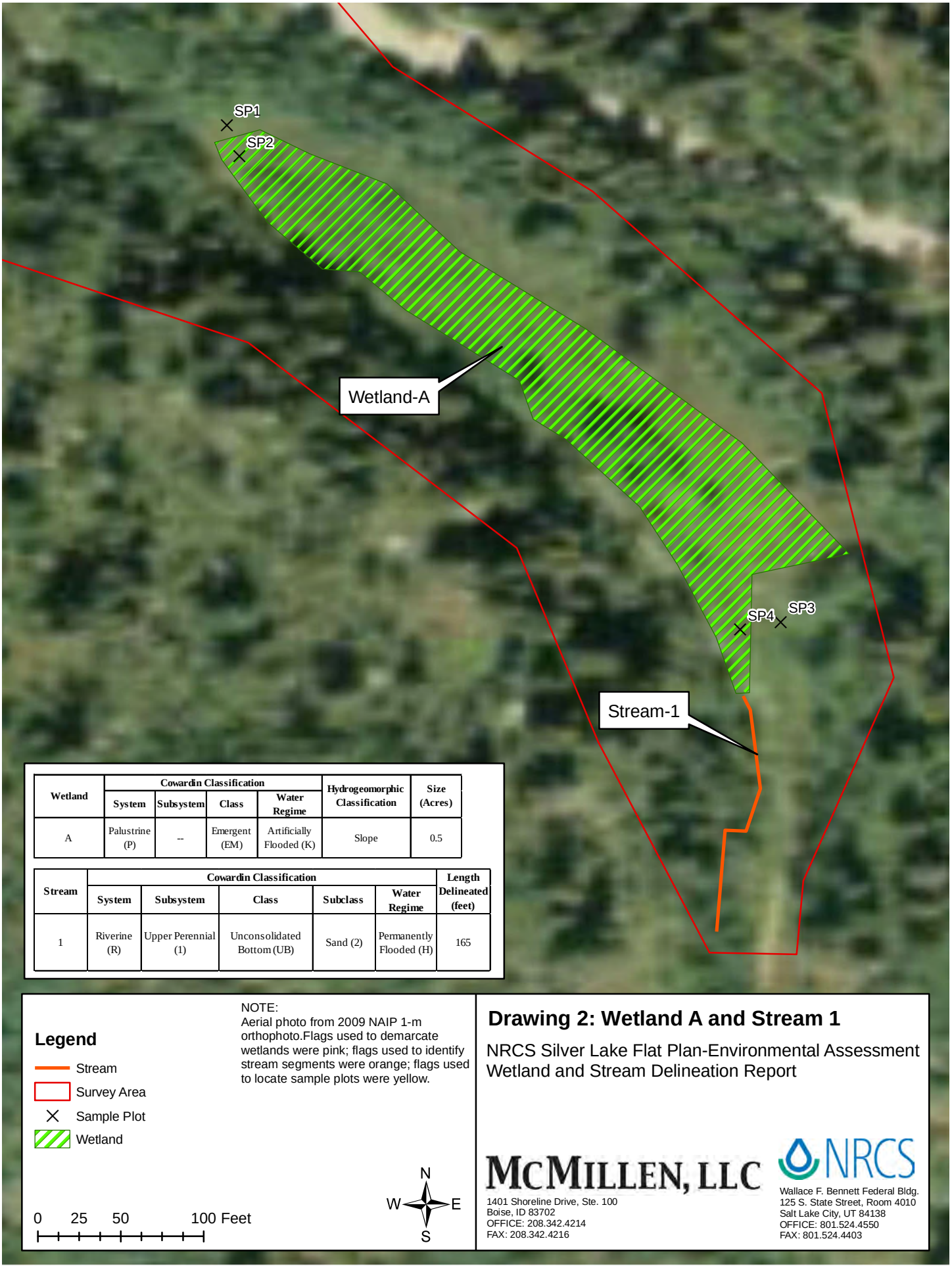

Wetland	Cowardin Classification				Hydrogeomorphic Classification	Size (Acres)
	System	Subsystem	Class	Water Regime		
A	Palustrine (P)	--	Emergent (EM)	Artificially Flooded (K)	Slope	0.5

Stream	Cowardin Classification					Length Delineated (feet)
	System	Subsystem	Class	Subclass	Water Regime	
1	Riverine (R)	Upper Perennial (1)	Unconsolidated Bottom (UB)	Sand (2)	Permanently Flooded (H)	165

Legend

- Stream
- Survey Area
- Sample Plot
- Wetland

NOTE:
Aerial photo from 2009 NAIP 1-m orthophoto.Flags used to demarcate wetlands were pink; flags used to identify stream segments were orange; flags used to locate sample plots were yellow.

0 25 50 100 Feet

N W E S

Drawing 2: Wetland A and Stream 1

NRCS Silver Lake Flat Plan-Environmental Assessment
Wetland and Stream Delineation Report

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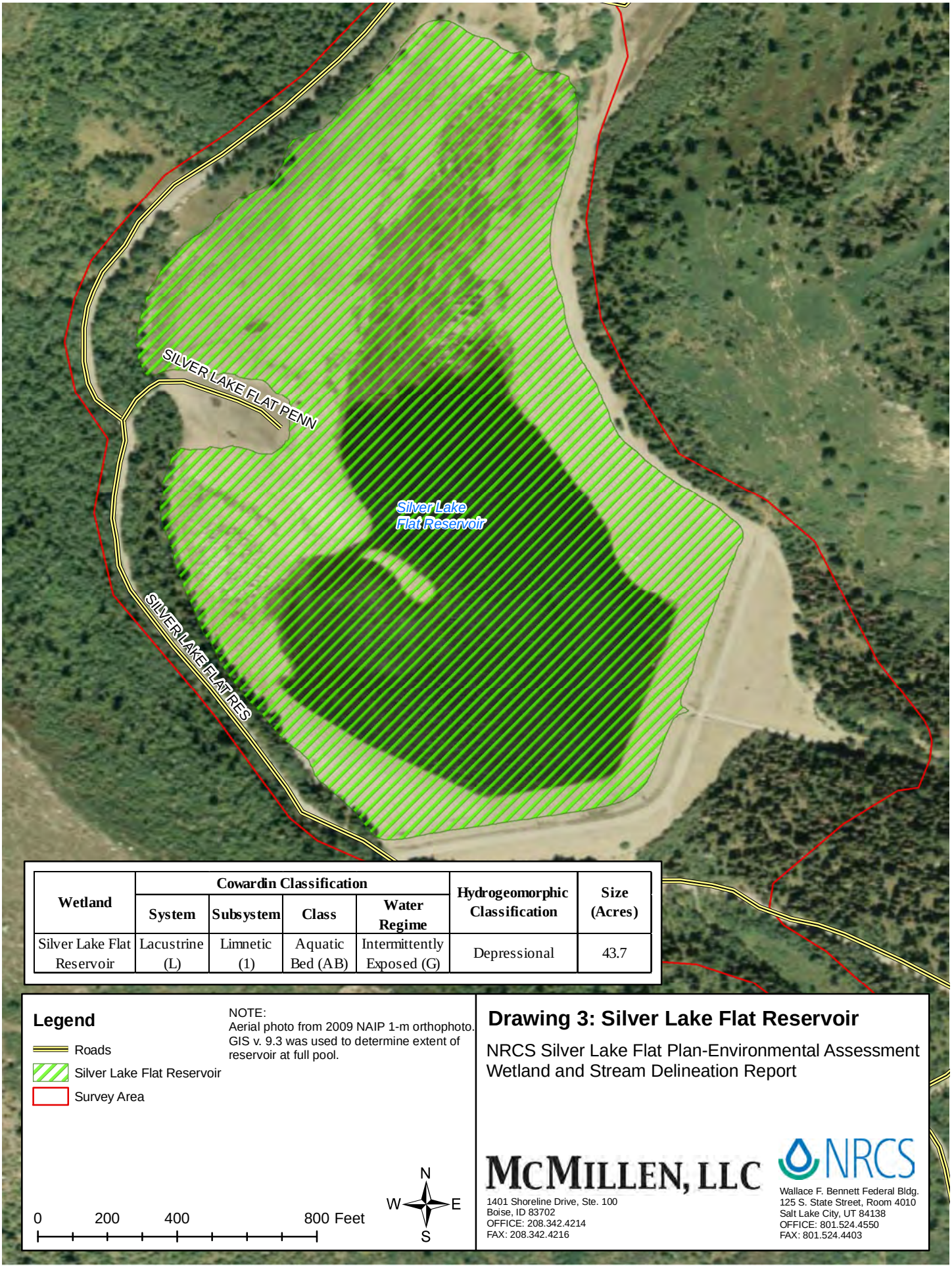

Wetland	Cowardin Classification				Hydrogeomorphic Classification	Size (Acres)
	System	Subsystem	Class	Water Regime		
Silver Lake Flat Reservoir	Lacustrine (L)	Limnetic (1)	Aquatic Bed (AB)	Intermittently Exposed (G)	Depressional	43.7

Legend

- Roads
- Silver Lake Flat Reservoir
- Survey Area

NOTE:
Aerial photo from 2009 NAIP 1-m orthophoto.
GIS v. 9.3 was used to determine extent of reservoir at full pool.

0 200 400 800 Feet

N W E S

Drawing 3: Silver Lake Flat Reservoir

NRCS Silver Lake Flat Plan-Environmental Assessment
Wetland and Stream Delineation Report

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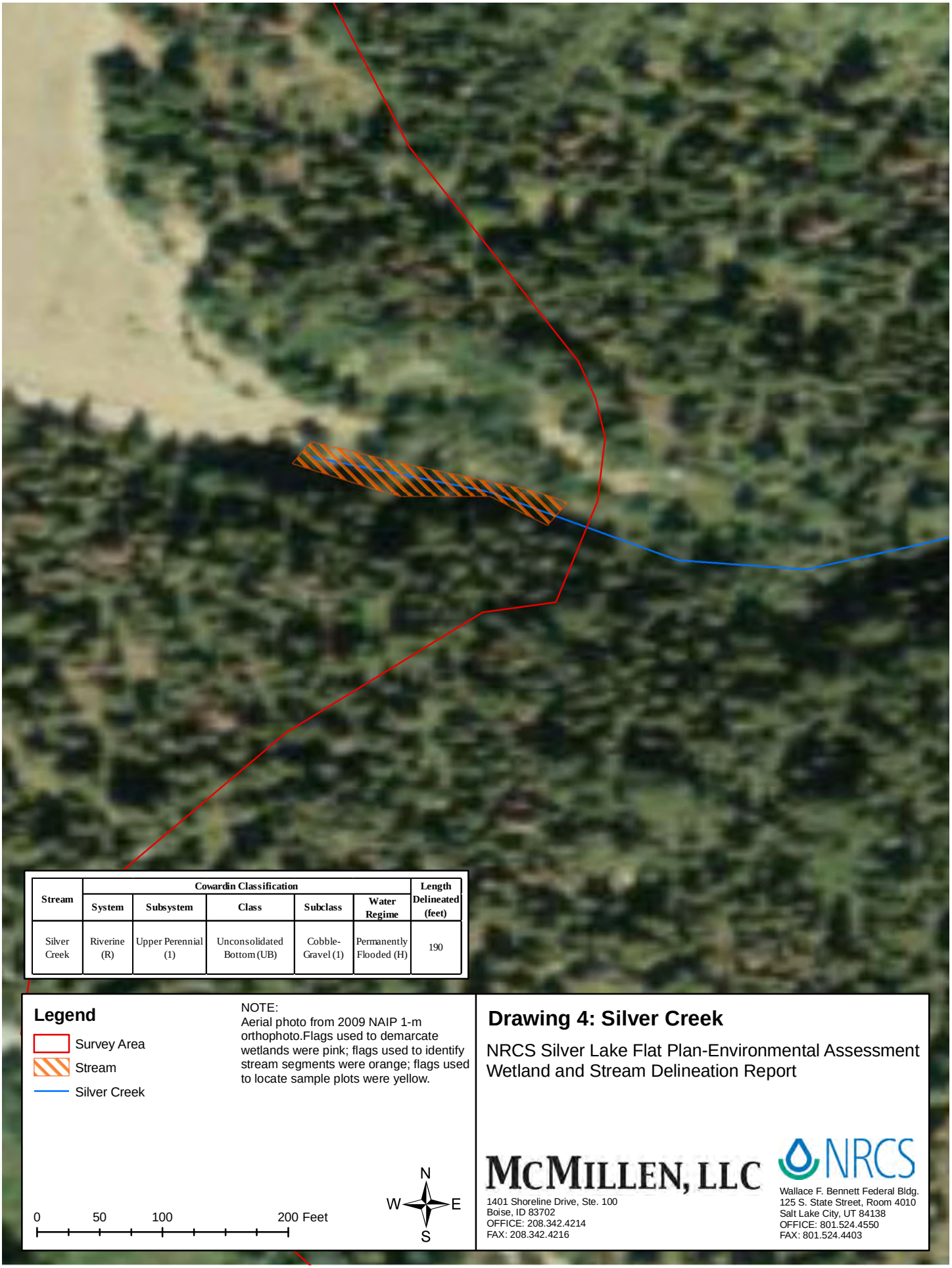

Stream	Cowardin Classification					Length Delineated (feet)
	System	Subsystem	Class	Subclass	Water Regime	
Silver Creek	Riverine (R)	Upper Perennial (1)	Unconsolidated Bottom (UB)	Cobble-Gravel (1)	Permanently Flooded (H)	190

Legend

- Survey Area
- Stream
- Silver Creek

NOTE:
Aerial photo from 2009 NAIP 1-m orthophoto.Flags used to demarcate wetlands were pink; flags used to identify stream segments were orange; flags used to locate sample plots were yellow.

0 50 100 200 Feet

N W E S

Drawing 4: Silver Creek

NRCS Silver Lake Flat Plan-Environmental Assessment
Wetland and Stream Delineation Report

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APPENDIX C

SITE PHOTOGRAPHS

Wetland A

Photograph 1 (10/3/2012) – Wetland A Looking Southwest

Photograph 2 (10/3/2012) – Wetland A Looking West

Photograph 3 (10/3/2012) – Wetland A Looking Northeast

Photograph 4 (10/3/2012) – Hillside Seep In Wetland A

Photograph 5 (10/3/2012) – SP1 Soil Pit

Photograph 6 (10/3/2012) – SP1 Looking North

Photograph 7 (10/3/2012) – SP2 Soil Pit

Photograph 8 (10/3/2012) – SP2 Looking South

Photograph 9 (10/3/2012) – SP3 Soil Pit

Photograph 10 (10/3/2012) – SP3 Looking North

Photograph 11 (10/3/2012) – SP4 Soil Pit

Photograph 12 (10/3/2012) – SP4 Looking North

Silver Lake Flat Reservoir

Photograph 13 (10/4/2012) – Reservoir Looking West

Photograph 14 (5/24/2012) – Reservoir Western Shoreline at Full Pool

Photograph 15 (10/4/2012) – Reservoir OHWM along Dam Face

Photograph 16 (10/4/2012) – Reservoir OHWM along Western Shoreline

Silver Creek

Photograph 17 (10/3/2012) – Silver Creek Still Basin at Base of Dam

Photograph 18 (10/3/2012) – Silver Creek Low Level Outlet

Photograph 19 (10/3/2012) – Silver Creek Stream Channel Looking Downstream

Photograph 20 (10/3/2012) – Silver Creek OHWM on Left Bank at Scour Line

Stream 1

Photograph 21 (10/3/2012) – Stream 1 Channel Exiting Wetland A

Photograph 22 (10/3/2012) – Stream 1 Channel

Photograph 23 (10/3/2012) – Stream 1 Temporary Weir in Channel

Photograph 24 (10/3/2012) – Stream 1 Channel on Left Side of Horsetrail

APPENDIX D

OBSERVED SPECIES LIST

Silver Lake Flat Observed Species List

Common Name	Scientific Name
Alfalfa	*Medicago sativa*
Bigtooth Maple	*Acer grandidentatum*
Black Medick	*Medicago lupulina*
Blue Elderberry	*Sambucus cerulea*
Bluebells	*Mertensia spp.*
Booth's Willow	*Salix boothii*
Boxelder	*Acer negundo*
Boxelder	*Acer negundo*
Buttercup	*Ranunculus spp.*
California False Hellebore	*Veratrum californicum*
Canada Goldenrod	*Solidago canadensis*
Canada Thistle	*Cirsium arvense*
Cinquefoil	*Potentilla spp.*
Columbian Monkshood	*Aconitum columbianum*
Columbian Monkshood	*Aconitum columbianum*
Common Cowparsnip	*Heracleum maximum*
Common Dandelion	*Taraxacum officinale*
Common Mullein	*Verbascum thapsus*
Common Plantain	*Plantago major*
Common Yarrow	*Achillea millefolium*
Common Yarrow	*Achillea millefolium*
Creeping Barberry	*Mahonia repens*
Curlycup Gumweed	*Grindelia squarrosa*
Current	*Ribes spp.*
Dock	*Rumex spp.*
Douglas Fir	*Psudotsuga menziesii*
Douglas' Knotweed	*Polygonum douglasii*
Dunhead Sedge	*Carex phaeocephala*
Engelmann Spruce	*Picea engelmannii*
Field Horsetail	*Equisetum arvense*
Gambel Oak	*Quercus gambelii*
Geranium	*Geranium spp.*
Grand Fir	*Abies grandis*
Grand Fir	*Abies grandis*
Gray Alder	*Alnus incana*
Gypsyflower/ Houndstounge	*Cynoglossum officinale*
Kentucky Bluegrass	*Poa pratensis*
Kinnikinick	*Arctostaphylos uva-ursi*
Largeleaf Avens	*Geum macrophyllum*
Lesser Burdock	*Arctium minus*
Letterman's Needlegrass	*Achnatherum lettermanii*
Letterman's Needlegrass	*Achnatherum lettermanii*
Lupine	*Lupinus spp.*
Mannagrass	*Glyceria spp.*
Meadow-Rue	*Thalictrum spp.*
Menzies' Campion	*Silene menziesii*
Monkey Flower	*Mimulus spp.*
Mountain Alder	*Alnus viridis*
Mountain Snowberry	*Symphoricarpos oreophilus*
Narrowleaf Cottonwood	*Populus angustifolia*
Nebraska Sedge	*Carex nebrascensis*

Common Name	Scientific Name
Ninebark	*Physocarpus spp.*
Nodding Plumeless Thistle/ Musk	*Carduus nutans*
Northwest Territory Sedge	*Carex utriculata*
Orchardgrass	*Dactylis glomerata*
Oregon Boxleaf	*Paxistima myrsinites*
Prickly Lettuce	*Lactuca serriola*
Quaking Aspen	*Populus tremuloides*
Raspberry	*Rubus occidentalis*
Red Clover	*Trifolium pratense*
Redosier Dogwood	*Cornus sericea*
Redtop	*Agrostis gigantea*
Redtop Bent, Creeping Bent	*Agrostis stolonifera*
Rocky Mountain Maple	*Acer glabrum*
Sandberg Bluegrass	*Poa secunda*
Saskatoon Serviceberry	*Amelanchier alnifolia*
Showy Goldeneye	*Heliomeris multiflora*
Showy Milkweed	*Asclepias speciosa*
Smooth Brome	*Bromus inermis*
Smooth Horsetail	*Equisetum laevigatum*
Snowberry	*Symphoricarpos albus*
Solomon's Seal	*Polygonatum spp.*
Speedwell	*Veronica spp.*
Starry False Lily Of The Valley	*Maianthemum stellatum*
Stinging Nettle	*Urtica dioica*
Sweetcicely	*Osmorhiza berteroi*
Swordleaf Rush	*Juncus ensifolius*
Tall Ragwort	*Senecio serra*
Thimbleberry	*Rubus parviflorus*
Timber Oatgrass	*Danthonia intermedia*
Timothy	*Phleum pratense*
Twinberry Honeysuckle	*Lonicera involucrata*
Unknown	*Aster spp.*
Viola	*Viola spp.*
Virginia Strawberry	*Fragaria virginiana*
Western Coneflower	*Rudbeckia occidentalis*
White Clover	*Trifolium repens*
White Fir	*Abies concolor*
White Fir	*Abies concolor*
Willowherb	*Epilobium spp.*
Wood Rose	*Rosa gymnocarpa*
Woodland Strawberry	*Fragaria vesca*
Woods' Rose	*Rosa woodsii*
Yellow Salsify	*Tragopogon dubius*
Yellow Sweetclover	*Melilotus officinalis*

NRCS

Silver Lake Flat Plan-Environmental Assessment

Botanical & Wildlife Survey Report

Final

Contract No. AG-3A75-C-10-0025
Task No. AG-8D43-D-12-004

August 23, 2013

McMILLEN, LLC

SIGNATURE PAGE

We have appreciated the opportunity to work with NRCS on this project. If you have any questions or concerns regarding this report, please contact Greg Allington (208-342-4214 or greg.allington@mcmillen-llc.com).

McMillen, LLC
1401 Shoreline Drive
Boise, Idaho 83702

Prepared by:

Greg J. Allington
Biologist

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Table 3-5. Special-Status Wildlife Species 11

FIGURES

Figure 1 Vicinity Map
Figure 2 Silver Lake Flat Botanical and Wildlife Survey

APPENDICIES

Appendix A Observed Species List
Appendix B Site Photographs

SECTION 1
INTRODUCTION

1.0 Introduction

McMillen, LLC (McMillen) was retained by the Natural Resources Conservation Service (NRCS) to complete a botanical and wildlife survey at Silver Lake Flat Dam and Reservoir in Utah County, Utah (Figure 1). Both the dam and reservoir are located within the boundaries of the United States Forest Service (USFS) Uinta-Wasatch-Cache National Forest (UWCNF). This report describes in detail the results of the botanical and wildlife survey. All botanical and wildlife observations described in this report were observed within the potential dam rehabilitation construction boundaries and adjacent suitable habitat areas, which will herein be referred to as the "Survey Area". Specifically, this report describes the following items:

- Botanical and wildlife survey methods, and
- Location and composition of:
  - Plant communities,
  - Typical land cover,
  - Special-status plant species and habitat,
  - Special-status wildlife species and habitat, and
  - Noxious weed observations.

1.1 Purpose

This botanical and wildlife survey was completed to assist NRCS in identifying potential construction constraints related to special-status plant and wildlife species, and/or suitable habitat that occur or may occur within the Survey Area. A noxious weed inventory was also performed to assess the type and distribution of noxious weeds so that further spread does not occur during project construction, operations or maintenance activities.

1.2 Project Location

Silver Lake Flat Dam and Reservoir are located in the UWCNF in northern Utah County, within the American Fork-Dry Creek Watershed. The site is situated within the Silver Creek valley at an elevation of approximately 7,535 feet above mean sea level (AMSL). Table 1-1 identifies the legal description of the Survey Area.

Table 1-1. Legal Description

Township (T) / Range (R) / Meridian	Section	Coordinates (WGS84)	Utah County Parcels
T 4 South / R 3 East / Salt Lake	6	40.501' lat / -111.655 long	11 059 0001 11 060 0006

The dam and reservoir are located approximately seven miles northeast of Alpine, Utah and are adjacent to USFS Silver Lake Flat Road which is approximately 2¼ miles north of the turnoff from Granite Flat Campground Road.

1.3 Scope of Work

The scope of work associated with this botanical and wildlife survey includes the following elements:

1. Review background information pertaining to the Survey Area including relevant and readily available documents to evaluate the conditions;
2. Conduct a pedestrian survey within the proposed construction, operations and maintenance boundaries (Survey Area) and identify special-status botanical and wildlife species. The survey includes the following elements:
    a. Document habitat and plant communities within the Survey Area;
    b. Identify occurrences, distribution, and abundance of special-status plant and wildlife species known or suspected to occur in the Survey Area;
    c. Inventory the relative abundance and distribution of noxious weeds and document adjacent land uses that may contribute to their introduction, persistence, and spread; and
    d. Photograph and record the location of special-status plant and animal species and general habitat communities.
3. Prepare a draft and final report describing the methods used and the results of the survey.

1.4 Conditions at Time of Survey

This report is based on conditions that existed at the time the survey was performed. If changes are made to the Survey Area after the date of this report, a biologist should be consulted to review the investigation and recommendations so that written amendments or affirmation can be provided as appropriate.

SECTION 2
METHODS

2.0 Document Review

A review of available documents pertaining to the project and project area was conducted prior to conducting the field survey. An informal list of special-status plants, animals, and noxious weeds that could potentially occur in the Survey Area was developed by McMillen based on the presence of suitable habitat for each species. A list of the documents reviewed is identified below:

- Historical and current aerial photos,
- United States Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) maps (USFWS 2012),
- USFWS (2013) federally-listed species found in Utah County, UT,
- United States Geological Survey (USGS) 1:24,000 scale 7.5-minute topographic map (USGS 1975 and 1993),
- USGS Utah Gap Analysis land cover maps (USGS 1995),
- USFS GIS Data for Plants and Animals (USFS 2012),
- USFS Intermountain Threatened, Endangered, Proposed, and, Sensitive Species List for Uinta National Forest (USFS 2013),
- USFS soil data (USFS 2012),
- Utah Division of Wildlife Resources (UDWRw) and the Utah Natural Heritage Program (UDWRw 2012a, 2012b and 2012c)State-listed species of concern for Utah County, UT,
- Utah Noxious Weed List (Utah Department of Agriculture 2010),
- Other available general background information provided by NRCS and USFS.

2.1 General Survey Methods

McMillen biologist (Greg Allington) and McMillen environmental scientist (Kevin Jensen) conducted a pedestrian survey within the Survey Area on October 2 and October 3, 2012. USFS wildlife biologist (Karen Hartman) and USFS botany technician (Andrea Hannan) also participated in the survey on October 2, 2012. A pedestrian survey was also conducted by McMillen (Greg Allington) on June 27, 2013 in the seepage area south of the dam for amphibians. An additional botanical survey was conducted on July 15, 2013 by a McMillen subcontractor (Bruce Glisson, Ph.D).

During the survey, greater attention was devoted to areas that appeared to have more suitable habitat for special-status plant and wildlife species or noxious weed species. Upon discovery of a special-status plant or wildlife species, or noxious weed species, an examination of the surrounding area was performed to identify the habitat and the extent of the occurrence. Once the extent of each occurrence was identified, the location or boundary (as appropriate) was recorded and labeled accordingly.

2.2 Botanical Survey

McMillen conducted a pedestrian botanical survey within the Survey Area proposed for the Silver Lake Flat Dam Rehabilitation project. The USFS botany technician participated in conducting the survey at the seepage area on the downstream side of the right abutment of the dam. Survey methods followed general guidance from USFS, but no specific botanical protocol was used

during the survey. The exposed ground which is normally inundated in Silver Lake Flat Reservoir was not surveyed in detail due to the lack of persistent vegetation. The Survey Area was traversed in approximate 20-foot increments where vegetation was present and focused on identifying the following items:

- Extent of specific plant communities within the Survey Area based on dominant plant species;
- Changes in soil composition;
- Disturbance history (i.e., fire, grazing, agriculture, development, public use);
- The relative value of each plant community to wildlife (i.e.-food, shelter, escape, etc.);
- The presence of special-status plant species and/or their habitat; and
- The extent of Utah-listed noxious weeds.

2.3 Wildlife Survey

McMillen conducted a pedestrian wildlife survey within the Survey Area proposed for the Silver Lake Flat Dam Rehabilitation project. The USFS wildlife biologist participated in conducting the survey at the seepage area on the downstream side of the right abutment of the dam. The objective of the wildlife survey was to identify special-status wildlife species that may reside in or frequent habitat within the Survey Area. McMillen performed the pedestrian wildlife survey concurrently with the botanical survey in 2012. Although no specific protocols were used, survey methods followed general USFS guidance which consisted of traversing the entire area in 20-foot increments. Survey methods involved recording all wildlife observations within the Survey Area and focused on identifying the following:

- Visual sightings,
- Auditory detections,
- Tracks and paths,
- Scat,
- Signs of foraging,
- Beds,
- Nests, and
- Burrows.

SECTION 3
RESULTS

3.0 Document Review

The following information was obtained during the document review in preparation for the field survey:

- Historical and current aerial photos,
  - The historical and current aerial photographs were examined to determine changes in land use and hydraulic patterns, vegetated areas and possible locations of standing water.
  - There have been minimal changes to the dam and reservoir area since the dam was constructed in 1971. Prior to dam construction, the area consisted of a coniferous and deciduous forest typical of the surrounding native environment.
- USFWS NWI (USFWS 2012) maps
  - These data identify wetlands within, and in the vicinity of the Survey Area, as well as general types of plant community structures present, and were analyzed in order to help identify potential habitat for plant and wildlife species of concern
- USFWS (2013) federally-listed species found in Utah County, UT
  - This list identified wildlife and plant species within Utah County that are federally listed as either candidate, threatened, or endangered species
- USGS 1:24,000 scale 7.5-minute topographic map (USGS 1975 and 1993),
  - The maps indicated the general topography of the project area and any major landform features.
- USGS Utah Gap Analysis land cover maps (USGS 1995),
  - These maps identified the general plant community types in the project area.
- USFS GIS Data for Plants and Animals (USFS 2012),
  - This data identified documented species and habitats by the USFS within and in the vicinity of the project.
- USFS Intermountain Threatened, Endangered, Proposed, and, Sensitive Species List for Uinta National Forest (USFS 2013),
  - This list identified special-status plants and wildlife that are located within the Uinta National Forest.
- USFS soil data (USFS 2012),
  - This data identified the type of soils in the area which indicates the general habitat communities that may occur on these soils.
- UDWRw and the Utah Natural Heritage Program (UDWRw 2012a, 2012b and 2012c)State-listed species of concern for Utah County, UT,
  - Species lists were collected from two different sources on the internet, resulting in the identification of state-listed wildlife species of concern known to occur in Utah County and project area.
- Utah Noxious Weed List (Utah Department of Agriculture 2010),
  - This list identified the 27 noxious weed species in Utah that are categorized into one of the three following classes:
    - Class A: Weeds that have a relatively low population size within the State and are of highest priority being an Early Detection Rapid Response (EDRR) weed.

  - Class B: Weeds that have a moderate population throughout the State and generally are thought to be controllable in most areas.
  - Class C: Weeds that are found extensively in the State and are thought to be beyond control. Statewide efforts would generally be towards containment of smaller infestations.
- Other available general background information provided by NRCS and USFS.

3.1 Botanical Survey

The information within this section outlines the plant communities, special-status plants, and noxious weeds observed during the botanical survey conducted on October 2 and October 3, 2012 and July 15, 2013. Weather conditions during the both surveys were sunny, with clear skies and calm winds. Temperatures ranged between 45°F to 75°F during the day. Several herbaceous plant species were observed to still have flowers during the survey, while most other plant species (tree, shrub and herbaceous) had already passed their annual flowering stage in 2012. Numerous plant species were observed have flowers and were readily identifiable during the 2013 survey. There were no known occurrences of special-status plant species within the Survey Area and there were no observations made during the site survey in 2012 or 2013.

3.1.1 Precipitation Data

Precipitation data in the vicinity of the site was obtained from the NRCS SNOTEL stations at Snowbird (766) and Timpanogos Divide (820) (NRCS 2012 and 2013). The Timpanogos Divide station is located approximately 5 miles south-southeast of the project site on a plateau at an elevation of 8,140 feet. The Snowbird station is located approximately 4½ miles due north near Alta, Utah at an elevation of 9,640 feet. Average monthly precipitation data recorded at both Snowbird and Timpanogos Cave Stations for the five months prior to the surveys are presented in Table 3-1.

Table 3-1. NRCS SNOTEL Station Data

Month	Snowbird 2012 (Inches)	Snowbird 2013 (Inches)	Snowbird 1981-2010 Average(Inches)	Timpanogos Divide 2012 (Inches)	Timpanogos Divide 2013 (Inches)	Timpanogos Divide 1981-2010 Average (Inches)
March	5.4	3.3	5.9	3.9	0.8	4.0
April	5.6	5.3	5.9	3.4	2.7	3.3
May	2.6	3.8	4.5	2.1	1.5	2.8
June	0.0	0.0	2.3	0.0	0.2	1.8
July	2.1	4.3	1.2	1.4	2.3	1.3
August	0.5	--	1.7	0.6	--	1.7
September	2.2	--	3.1	2.8	--	2.7

The data presented in Table 3-1 above indicates generally average precipitation from March through May at both stations in 2012 but below average precipitation at both stations in 2013. June experienced no precipitation and July through September had below average precipitation in 2012 which accounts for the dry upper soil layer and early plant die-off/senescence encountered throughout the Survey Area. Natural groundwater levels within the Survey Area were estimated to be near their lowest levels during the survey due to the comparatively dry preceding months and the timing of the site visit near the end of the hydrologic year in 2012. However, natural groundwater levels were estimated to be average during the 2013 survey.

3.1.2 Soil Survey Data

The typical terrain within the Survey Area is a moderately sloping valley with the presence of only modestly incised channels. The soils in the vicinity of the dam are typical of river floodplains, with sand, gravels and cobbles interspersed in loam. Table 3-2 below provides a summary of the soils survey data gathered for the Survey Area.

Table 3-2. Silver Lake Flat Soils Summary

Soil Name	Description	Hydric Soil	Survey Area Location
PGGC9	Ladyofsnow family of extremely cobbly loam, 0% to 16% slopes	No	Located within the Silver Creek riparian corridor and including Silver Lake Flat Reservoir and Dam
PGGM3	Wander family of very gravelly loam, 30% to 100% slopes, with <50% crown cover	No	Located at the left abutment downstream face of the dam
PGSC5	Climber family-Horrocks family complex, 35% to 80% slopes	No	Located at the right abutment downstream face of the dam and the seepage area (Wetland A)

3.1.1 Observed Plant Communities

Plant communities within the Survey Area were characterized according to their general locations in the landscape. Typical communities consisted of riparian shrubs and trees along Silver Creek and surrounding Silver Lake Flat Reservoir, with Douglas fir (*Psudotsuga menziesii)*, white fir (*Abies concolor)*, Rocky Mountain maple (*Acer glabrum)* and quaking aspen (*Populus tremuloides*) dominating the upland areas. Herbaceous species were distributed widely throughout disturbed areas, such as along the sides of roads and other exposed edges surrounding the dam and reservoir. Herbaceous species also dominated the seepage area containing a wetland downstream of the right abutment of the dam. A complete list of plants observed during the survey is located in Appendix A. Plant communities observed during the survey are lumped together by location and described in the following sub-sections.

3.1.1.1 Seepage Area Plant Community

Plant communities observed in the seepage area consisted of both hydrophytic and upland species due to the presence of a wetland. In particular, the following two plant species were dominant in the area:

- Beaked-sedge: Beaked-sedge (*Rhynchospora* spp.) is a water-obligate sedge occurring in wetlands, marshes and swamps, or along the edges of lakes and ponds. It is characteristic of early-seral stage aquatic habitats and is typically dominant to co-dominant when occurring.
- Quaking aspen: Quaking aspen (*Populus tremuloides*) is a deciduous tree native to the area that grows up to 40 feet tall and propagates via basal sprouts or root sprouts. It relies on either natural or anthropogenic disturbances in order to limit encroachment from shading trees such as conifers. The quaking aspen in this area were separated from the wetland proper primarily by Canada thistle (*Cirsium arvense)*, which is an invasive, noxious weed in Utah County, UT.

Photographs 11 and 12 in Appendix B provide typical pictures of the upland and wetland parts of this survey area, respectively. Other plants identified in this area included redtop bent (*Agrostis gigantean*), horsetail (*Equisetum* spp.), and Booth's willow (*Salix boothii*).

3.1.1.2 Downstream of Dam Plant Community

The plant community downstream of the dam was an early- to mid-seral coniferous forest, dominated by white fir (*Abies concolor*), and interspersed with Rock Mountain maple (*Acer glabrum*) and snowberry (*Symphoricarpos* spp.). Photograph 7 in Appendix B provides a typical picture of this plant community.

3.1.1.3 Stream Area Plant Community

Plant communities observed in the stream area (Silver Creek) consisted of mid-seral riparian vegetation adjacent to Silver Creek, with mixed coniferous-deciduous trees in the surrounding upland. The dominant species in this area included narrowleaf cottonwood (*Populus angustifolia*) and mountain alder (*Alnus viridis*) near the stream, surrounded by white fir (*Abies concolor*) and Douglas fir (*Pseudotsuga menziesii*) in the upland.

3.1.1.4 Dam Right and Left Abutment Plant Community

Plant communities observed in the dam right and left abutment areas were dominated by white fir and Douglas fir. At the forest edge, however, adjacent to the toe of the abutment, the dominant species was mullein (*Verbascum thapsus*), which is a weed nonnative to Utah. Photographs 9 and 10 in Appendix B provide a typical picture of this plant community.

3.1.1.5 Reservoir Perimeter Plant Community

Plant communities observed in the reservoir perimeter area were dominated by quaking aspen, with Rocky Mountain maple, white fir and Douglas fir also occurring extensively. Disturbed areas, such as the west- and north-bank parking lots, fostered patches of mullein as well. Photographs 1 through 4 in Appendix B provide a typical picture of this plant community.

3.1.2 Special-Status Plant Species

Although no special-status plant species were encountered during the site survey, suitable habitat for several species was identified, as indicated in the table. It is therefore recommended that, prior to any ground-disturbing activities related to this project, a formal survey be conducted during the appropriate time of year, typically from May to July.

Special-status plant species include all taxa with federal or state protective status. Specifically, this section discusses species that are included in any one of the following groups:

- Federal Species – Species listed by the USFWS.
    - Listed or Proposed Species - Species that are listed and protected under the Endangered Species Act (ESA) of 1973, as Endangered (E) or Threatened (T), or proposed for listing.
    - Candidate (C) - Species for which the USFWS has sufficient information on their biological status and threats to propose them as endangered or threatened under the ESA, but for which development of a proposed listing regulation has not occurred because of other higher priority listing activities. Candidate species

receive no statutory protection under the ESA.

- Global Conservation Status – Plant species as ranked by the NatureServe global conservation status ranks (NatureServe 2012).
    - Critically Imperiled (G1) – At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.
    - Imperiled (G2) – At high risk of extinction or elimination due to very restricted range, very few populations, steep declines, or other factors.
    - Vulnerable (G3) – At moderate risk of extinction or elimination due to a restricted range, relatively few populations, recent and widespread declines, or other factors.
    - Apparently Secure (G4) – Uncommon but not rare; some cause for long-term concern due to declines or other factors.
    - Secure (G5) – Common; widespread and abundant.
- State Species - Species listed by the UDWRw that require special protection.
    - Conservation Agreement Species (CAS) – species or subspecies of concern that receive special management under a conservation agreement developed or implemented by the State to preclude the need for listing under the ESA
    - Wildlife Species of Concern (WSoC) – Species for which there is a credible scientific evidence to substantiate a threat to continued population viability.
- USFS Species - Species on the Intermountain Region's Threatened (T), Endangered (E) & Sensitive (S) Species program list for the Uinta National Forest (USFS 2013).

The information documented in this section is compiled from exiting data and lists within the vicinity of Silver Lake Flat Dam. Table 3-3 identifies the plant species on the USFWS Utah County list (USFWS 2013), and the USFS Uinta National Forest list (USFS 2013). There were no plant species identified by the UDWRw Utah Conservation Data Center (2012a, 2012b and 2012c) in the Survey Area and each plant identified by the USFWS and USFS has also been ranked according to their global conservation status (Utah Native Plant Society 2012).

The table also indicates whether suitable habit for the listed plant is thought to exist within the Survey Area of the project. Suitable habitat is based on the presence of known plant communities that support the species in question, suitable elevation ranges, climatic conditions and geographic range. If it was largely unknown whether suitable habitat exists for the species, then the presence of suitable habitat was assumed in the table.

Table 3-3. Special-Status Plant Species

Common Name	Scientific Name	USFWS Status[1]	Global Status[2]	USFS Status[3]	Suitable Habitat Present (Observed)
Barneby woody aster	*Tonestus kingii var. barnebyana*	--	G3	S	No (No)
Clay phacelia	*Phacelia argilacea*	E	G1	E	No (No)
Dainty moonwort	*Botrychium crenulatum*	--	G3	S	Yes (No)
Deseret milkvetch	*Astragalus desereticus*	T	G1	T	No (No)
Garrett bladderpod	*Lesquerella garrettii*	--	G2	S	No (No)
Garrett's fleabane	*Erigeron garrettii*	--	G2	S	No (No)
Rockcress draba	*Draba globosa*	--	--	S	No (No)
Santaquin draba	*Draba santaquinensis*	--	G1	S	No (No)
Slender moonwort	*Botrychium lineare*	--	G1	S	Yes (No)
Utah ivesia	*Ivesia utahensis*	--	G2	S	No (No)

Common Name	Scientific Name	USFWS Status[1]	Global Status[2]	USFS Status[3]	Suitable Habitat Present (Observed)
Ute ladies' tresses	*Spiranthes diluvialis*	T	G2	T	No (No)
Wasatch draba	*Draba brachystylis*	--	G1	S	Yes (No)
Wasatch fitweed	*Corydalis caseana spp. brachycarpa*	--	G5	S	Yes (No)
Wasatch jamesia	*Jamesia Americana var. macrocalyx*	--	G5	S	No (No)
Wasatch pepperwort	*Lepidium montanum var. alpinum*	--	G5	S	Yes (No)
Wheeler's angelica	*Angelica wheeleri*	--	G2	S	Yes (No)

Notes: [1] USFWS Status – (E) Endangered, (T) Threatened, (C) Candidate
[2] Global Conservation Status – (G1) Critically Imperiled, (G2) Imperiled, (G3) Vulnerable, (G4) Apparently Secure, (G5) Secure
[3] USFS Status – (E) Endangered, (T) Threatened, (S) Sensitive

3.1.3 Noxious Weeds

The following Table 3-4 identifies the noxious weed species in Utah.

Table 3-4. Utah Noxious Weed Species

Common Name	Scientific Name
Class A	
Black Henbane	*Hyoscyamus niger*
Diffuse Knapweed	*Centaurea diffusa*
Johnsongrass	*Sorghum halepense*
Leafy Spurge	*Euphorbia esula*
Medusahead	*Taeniatherum caput-medusae*
Oxeye Daisy	*Chrysanthemum leucanthemum*
Purple Loosestrife	*Lythrum salicaria*
St. Johnswort	*Hypericum perforatum*
Spotted Knapweed	*Centaurea maculosa*
Sulfur Cinquefoil	*Potentilla recta*
Yellow Starthistle	*Centaurea solstitialis*
Yellow Toadflax	*Linaria vulgaris*
Class B	
Bermudagrass	*Cynodon dactylon*
Dalmatian Toadflax	*Linaria genistifolia*
Dyer's Woad	*Isatis tinctoria*
Hoary Cress	*Cardaria draba*
Musk Thistle	*Carduus nutans*
Perennial Pepperweed	*Lepidium latifolium*
Poison Hemlock	*Conium maculatum*
Russian Knapweed	*Centaurea repens*
Scotch Thistle	*Centaurea virgata*
Squarrose Knapweed	*Onopordum acanthium*
Class C	
Canada Thistle	*Cirsium arvense*
Field Bindweed	*Convolvulus arvensis*
Houndstongue	*Cynoglossum officinale*
Quackgrass	*Elytrigia repens*
Saltcedar	*Tamarix ramosissima*

The following tabulates the state listed Utah noxious weeds and invasive species that have been recorded by the USFS (2012) in the immediate vicinity of Silver Lake Flat Dam and the gravel

access road (Silver Lake Flat Road):

- Utah State Noxious Weed
    - Canada thistle (*Cirsium arvense*): Class C Weed Containment
    - Dalmation toadflax (*Linaria genistifolia*): Class B Weed Control
    - Gypsy flower (*Cynoglossum officinale*): Class C Weed Containment
    - Nodding plumeless thistle (*Carduus nutans*): Class B Weed Control
- Invasive Species
    - Common mullein (*Verbascum thapsus*)
    - Lesser burdock (*Arctium minus*)
    - Yellow sweetclover (*Melilotus officinalis*)

McMillen identified the following weed species within the Survey Area during the field survey:

- Utah State Noxious Weed
    - Canada thistle: It was observed primarily in the seepage area near the wetland, although it occurred sporadically in all the disturbed areas surveyed in the Survey Area.
    - Houndstongue (*Cynoglossum officinale*): Its seed is bur-like, allowing it to be transported and dispersed widely with ease along transportation corridors. It was observed within the Survey Area along the existing horse trail.
- Invasive Species
    - Common mullein: It was observed in heavily disturbed areas. This plant is not classified as a noxious weed but is considered invasive and should be removed from the project area to prevent further spread prior to construction.

The majority of the noxious weed species observations occurred adjacent to high public-use areas (e.g. near parking lots) and in other disturbed areas (e.g. near the dam abutments; in the clearing next to the wetland) in patches and single occurrences. Noxious weeds were observed beyond the limits of the Survey Area, as well, but were not recorded for the purposes of this project. The presence of noxious weeds depended on the soil type, amount of disturbance and surrounding land use. Observations regarding the conditions of the area within and adjacent to the Survey Area indicate that general public use (outdoor recreation) has led to the spread and establishment of noxious weed populations. Figure 2 indicates the general location of dense patches noxious weed species identified during the survey. The USFS controls noxious weed establishment adjacent to Silver Lake Flat Road but does not control establishment on the dam or within 50 feet of the reservoir or Silver Creek. The North Utah County Water Conservancy District is responsible for controlling the establishment of vegetation on the dam at its own discretion.

3.1.3.1 Noxious Weed Removal

Due to the presence of noxious weeds within the Survey Area, special provisions will be applied prior to and during construction activities to prevent further spread. These provisions may include, but are not limited to the following:

- Removal prior to the start of construction. Each removal method will be applicable to the specific plant and all removed plants will be disposed off-site at an appropriate facility.
    - Hand (annuals),
    - Mechanical (trimming or excavation of perennials and annuals), and
    - Herbicide (perennials and rhizomatous plants).

3.2 Wildlife Survey

The wildlife survey focused on special-status wildlife species that have the potential to occur within and immediately adjacent to the Survey Area. All wildlife species observed during the survey were recorded and are listed in Appendix A. There were no known occurrences of special-status wildlife species within the Survey Area and there were no observations made during the site survey.

3.2.1 Wildlife Survey

Although no special-status wildlife species were encountered during the site survey, suitable habitat for several sensitive species was identified. It is therefore recommended that, prior to any ground-disturbing activities related to this project, a formal survey be conducted during the appropriate time of year, typically from May to July.

The information documented in this section is compiled from existing data and lists within the vicinity of Silver Lake Flat Dam. Table 3-5 identifies the wildlife species on the USFWS Utah County list (USFWS 2013), the UDWRw (2012a, 2012b and 2012c) Utah Conservation Data Center list for sensitive species occurring in the Dromedary Peak and Timpanogos Cave 7.5' quadrangle maps, and the USFS Uinta National Forest list (USFS 2013). The definition of each species status is listed in Chapter 3.1.2.

An informal species list of special-status wildlife that could occur within the survey area based on presumed available and suitable habitat was developed. Suitable habitat is based on either the known occurrence of species within or adjacent to the Survey Area, or the presence of breeding or rearing grounds. If it was largely unknown whether suitable habitat exists for the species, then the presence of suitable habitat was assumed in the table.

Table 3-5. Special-Status Wildlife Species

Common Name	Scientific Name	USFWS Status[1]	State Status[2]	USFS Status[3]	Suitable Habitat Present
Bald eagle	*Haliaeetus leucocephalus*	--	SoC	S	Yes
Bighorn sheep	*Ovis canadensis*	--	--	S	No
Black swift	*Cypseloides niger*	--	SoC	--	No
Bobolink	*Dolichonyx oryzivorus*	--	SoC	--	No
Boreal toad	*Bufo boreas*	--	SoC	S	Yes
Canada lynx	Lynx canadensis	T	--	T	No
Columbia spotted frog	*Rana luteiventris*	--	--	S	No
Ferruginous hawk	*Buteo regalis*	--	SoC	--	Yes
Fisher	*Martes pennant*	--	--	S	No
Flammulated owl	*Otus flammeolus*	--	--	S	No
Fringed myotis	*Myotis thysanodes*	--	SoC	--	Yes
Greater sage-grouse	*Centrocercus urophasianus*	C	C	S	No
Kit fox	*Vulpes macrotis*	--	SoC	--	No
Northern goshawk	*Accipiter gentilis*	--	CAS	S	Yes
Peregrine falcon	*Falco peregrines anatum*	--	--	S	Yes
Short-eared owl	*Asio flammeus*	--	SoC	--	No

Common Name	Scientific Name	USFWS Status[1]	State Status[2]	USFS Status[3]	Suitable Habitat Present
Spotted bat	*Euderma maculatum*	--	--	S	Yes
Three-toed woodpecker	*Picoides tridactylus*	--	--	S	Yes
Townsend's big-eared bat	*Corynorhinus townsendii townsendii*	--	SoC	S	Yes
Yellow-billed cuckoo	*Coccyzusamericanus*	C	C	S	No

Notes: [1] USFWS Status – (E) Endangered, (T) Threatened, (C) Candidate
[2] State Status – (CAS) Conservation Agreement Species, (SoC) Wildlife Species of Concern
[3] USFS Status – (E) Endangered, (T) Threatened, (S) Sensitive

SECTION 4
CONCLUSION

4.0 Conclusion

McMillen completed the botanical and wildlife surveys for the proposed Survey Area of the Silver Lake Flat Dam Rehabilitation Project, located in Utah County, Utah on October 2 and October 3, 2012. An additional amphibian survey was conducted on June 27, 2013 and an additional botanical survey was conducted on July 15, 2013. The survey was performed to help NRCS identify potential constraints to construction, operation and maintenance activities associated with the rehabilitation of the dam. Based on the document review and field survey, McMillen concludes the following:

Special-Status Plant Species
There were no special-status plant species identified within the Survey Area. However, suitable habitat for said species was noted. Therefore, a formal botanical survey is recommended prior to any land-disturbing activities and during a suitable period within which sensitive species could reasonably be detected.

Special-Status Wildlife Species
There were no special-status wildlife species identified within the Survey Area. However, suitable habitat for said species was noted. Therefore, a formal wildlife survey is recommended prior to any land-disturbing activities and during a suitable period within which sensitive species, or indicators thereof, could reasonably be detected.

Noxious Weed Species
Utah-listed noxious weed species were identified within the Survey Area though the literature search and site survey. The majority of the noxious species observations occurred in disturbed areas adjacent to roads, parking areas or heavily used trails. Noxious weed species were also observed outside the limits of the Survey Area, suggesting that conditions observed were not unique to the surrounding landscape. It appears that general public use within the Survey Area has contributed to the spread of noxious weeds through native plant destruction and spreading seeds via vehicles, foot, and hoof traffic.

SECTION 5
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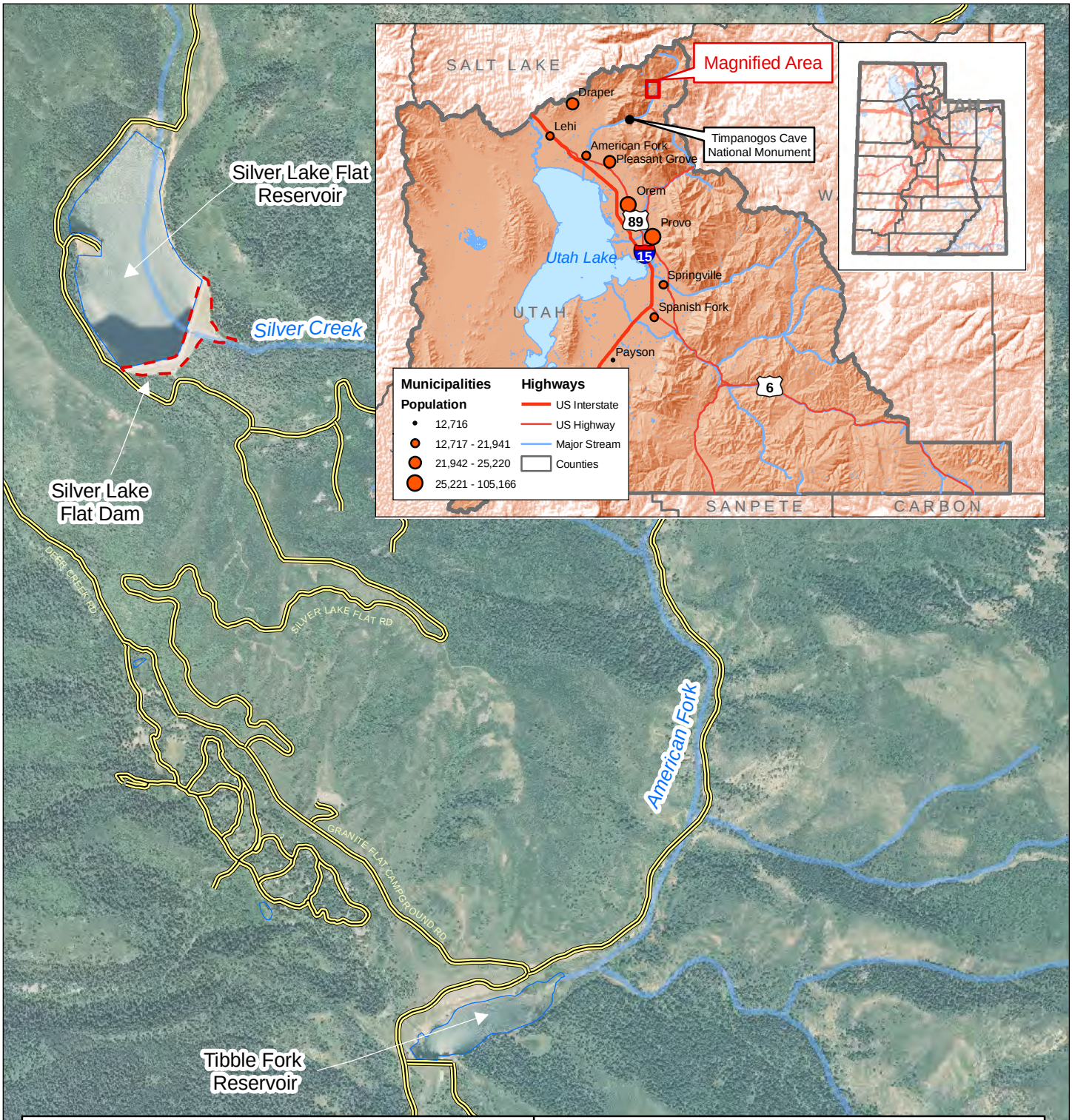
FIGURES



Legend

- Silver Lake Flat Dam
- Lakes and Reservoirs
- Roads
- Streams

NOTES:
Aerial photo from 2009 NAIP 1-m orthophoto. Shaded reliefs derived from 10- and 90-m USGS DEMs. Points, lines and polygons supplied by various state and federal sources, including USFS, UDOT, and USGS.

0 0.125 0.25 0.5 Miles

Figure 1: Vicinity Map

N W E S

NRCS Silver Lake Flat Dam Rehabilitation
Botanical and Wildlife Survey Report

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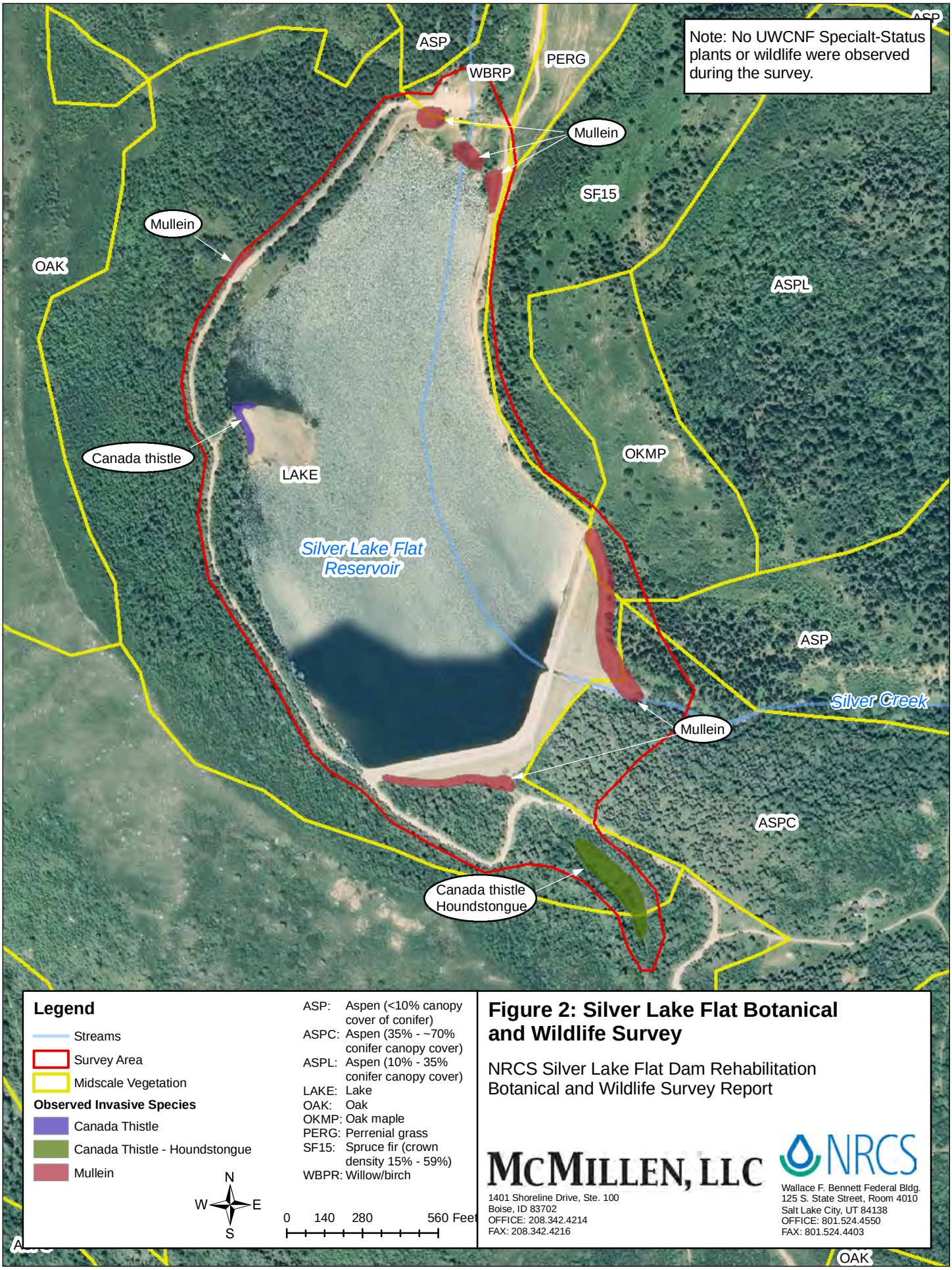

Legend

- Streams
- Survey Area
- Midscale Vegetation

Observed Invasive Species

- Canada Thistle
- Canada Thistle - Houndstongue
- Mullein

ASP: Aspen (<10% canopy cover of conifer)
ASPC: Aspen (35% - ~70% conifer canopy cover)
ASPL: Aspen (10% - 35% conifer canopy cover)
LAKE: Lake
OAK: Oak
OKMP: Oak maple
PERG: Perrenial grass
SF15: Spruce fir (crown density 15% - 59%)
WBPR: Willow/birch

N W E S

0 140 280 560 Feet

Figure 2: Silver Lake Flat Botanical and Wildlife Survey

NRCS Silver Lake Flat Dam Rehabilitation
Botanical and Wildlife Survey Report

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APPENDIX A

OBSERVED SPECIES LIST

Silver Lake Flat Observed Species List

Plants

Scientific Name	Common Name
Abies concolor	white fir
Abies grandis	grand fir
Acer glabrum	Rocky Mountain maple
Acer grandidentatum	bigtooth maple
Acer negundo	boxelder
Achillea millefolium	common yarrow
Achnatherum lettermanii	letterman's needlegrass
Aconitum columbianum	columbian monkshood
Agrostis gigantea	redtop
Agrostis stolonifera	redtop bent, creeping bent
Alnus incana	gray alder
Alnus viridis	mountain alder
Amelanchier alnifolia	saskatoon serviceberry
Arctium minus	lesser burdock
Arctostaphylos uva-ursi	kinnikinick
Asclepias speciosa	showy milkweed
Aster spp.	unknown
Bromus inermis	smooth brome
Carduus nutans	nodding plumeless thistle/ musk
Carex nebrascensis	nebraska sedge
Carex phaeocephala	dunhead sedge
Carex utriculata	northwest territory sedge
Cirsium arvense	canada thistle
Cornus sericea	redosier dogwood
Cynoglossum officinale	gypsyflower/ houndstounge
Dactylis glomerata	orchardgrass
Danthonia intermedia	timber oatgrass
Epilobium spp.	willowherb
Equisetum arvense	field horsetail
Equisetum laevigatum	smooth horsetail
Fragaria vesca	woodland strawberry
Fragaria virginiana	virginia strawberry
Geranium spp.	geranium
Geum macrophyllum	largeleaf avens
Glyceria spp.	Mannagrass
Grindelia squarrosa	curlycup gumweed
Heliomeris multiflora	showy goldeneye
Heracleum maximum	common cowparsnip
Juncus ensifolius	swordleaf rush
Lactuca serriola	prickly lettuce
Lonicera involucrata	twinberry honeysuckle
Lupinus spp.	lupine
Mahonia repens	creeping barberry
Maianthemum stellatum	starry false lily of the valley
Medicago lupulina	black medick
Medicago sativa	alfalfa
Melilotus officinalis	yellow sweetclover
Mertensia spp.	bluebells

Scientific Name	Common Name
Mimulus spp.	monkey flower
Osmorhiza berteroi	sweetcicely
Paxistima myrsinites	oregon boxleaf
Phleum pratense	timothy
Physocarpus spp.	ninebark
Picea engelmannii	engelmann spruce
Plantago major	common plantain
Poa pratensis	kentucky bluegrass
Poa secunda	Sandberg bluegrass
Polygonum douglasii	douglas' knotweed
Populus angustifolia	narrowleaf cottonwood
Populus tremuloides	quaking aspen
Potentilla spp.	cinquefoil
Psudotsuga menziesii	Douglas fir
Quercus gambelii	Gambel oak
Ranunculus spp.	buttercup
Ribes spp.	current
Rosa gymnocarpa	wood rose
Rosa woodsii	woods' rose
Rubus occidentalis	raspberry
Rubus parviflorus	thimbleberry
Rudbeckia occidentalis	western coneflower
Rumex spp.	dock
Rhynchospora spp.	beak-sedge
Salix boothii	booth's willow
Sambucus cerulea	blue elderberry
Senecio serra	tall ragwort
Silene menziesii	menzies' campion
Solidago canadensis	canada goldenrod
Symphoricarpos oreophilus	mountain snowberry
Symphoricarpos spp.	snowberry
Taraxacum officinale	common dandelion
Thalictrum spp.	meadow-rue
Tragopogon dubius	yellow salsify
Trifolium pratense	red clover
Trifolium repens	white clover
Urtica dioica	stinging nettle
Veratrum californicum	california false hellebore
Verbascum thapsus	common mullein
Veronica spp.	speedwell
Viola spp.	viola
Polygonatum spp.	Solomon’s seal
Abies concolor	white fir
Abies grandis	grand fir
Acer grandidentatum	bigtooth maple
Acer negundo	boxelder
Achillea millefolium	common yarrow
Achnatherum lettermanii	letterman's needlegrass
Aconitum columbianum	columbian monkshood

Animals

Scientific Name	Common Name
Mammals	
Odocoileus hemionus	Mule deer
Neotamias umbrinus umbrinus	Chipmunk
Urocitellus armatus	Squirrel
Birds	
Megaceryle alcyon	Belted Kingfisher
Corvus corax	Raven
Anas spp.	Duck
Bonasa umbellus	Ruffed grouse

Indirect Wildlife Observations:

Deer beds/tracks in wetland area
Elk scat in wetland area
Ungulate imprints in wetland area

APPENDIX B

SITE PHOTOGRAPHS

Plants

Photograph 1 (10/4/2012) – Silver Lake Flat Reservoir Looking Northwest from Dam

Photograph 2 (10/4/2012) – Silver Lake Flat Reservoir Looking South

Photograph 3 (10/4/2012) – Silver Lake Flat Reservoir Eastern Shoreline

Photograph 4 (10/4/2012) – Silver Lake Flat Reservoir Western Shoreline

Photograph 5 (10/4/2012) – Upstream Face of Silver Lake Flat Dam

Photograph 6 (10/3/2012) – Downstream Face of Silver Lake Flat Dam

Photograph 7 (10/3/2012) – Typical Forest Downstream of Silver Lake Flat Dam

Photograph 8 (10/3/2012) – Silver Lake Flat Dam Spillway

Photograph 9 (10/3/2012) – Mullein on Left Abutment of Silver Lake Flat Dam

Photograph 10 (10/3/2012) – Left Abutment of Silver Lake Flat Dam

Photograph 11 (10/3/2012) – Wetland A Alder and Sedge Looking Southeast

Photograph 12 (10/3/2012) – Wetland A Looking Northwest

Wildlife

Photograph 13 (10/3/2012) – Ruffed Grouse Near Wetland A

Photograph 14 (10/4/2012) – Deer Tracks in Reservoir

Photograph 15 (10/3/2012) – Typical Amphibian Habitat Consisting of Woody Debris and Small Pools in Wetland A

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UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE, UTAH

Summary Report of Cultural Resources Inventory

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1. **Project Name:** Silver Lake Flat Dam Rehabilitation Cultural Resource Survey, Utah County, Utah

2. **Utah State Antiquities Project Number:** U-12-XN-1053f

3. **Report Date:** April 1, 2013 **4. Date(s) of Survey:** November 4 and 5, 2012

5. **Responsible Individuals**
   Principal Investigator: John W. Jones (Native-X, Inc.)
   Field Supervisor: John W. Jones (Native-X, Inc.)
   Report Author(s): John W. Jones (Native-X, Inc.)

6. **Fieldwork Location:**
   County: Utah
   USGS Maps: USGS 7.5' Series Timpanogos, Utah 1993 quadrangle
   USGS 7.5' Dromedary Peak, Utah 1975 quadrangle
   Township: 4 South **Range:** 2 East **Section(s):** 1
   4 South **Range:** 3 East **Section(s):** 6, 7

7. **Description of the Area of Potential Effects (APE):** The Natural Resources Conservation Service (NRCS) is proposing to fund rehabilitation of the Silver Lake Flat Dam in the American Fork Canyon in northern Utah County, Utah. Silver Lake Flat Dam is located within the boundaries of the Uinta-Wasatch-Cache National Forest. The United States Forest Service (USFS) is a cooperating agency in the project. 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. The environmental impacts from the proposed rehabilitation of the dam will be documented in the form of a Watershed Plan-Environmental Assessment (Plan-EA). The dam was built in 1971.

   The North Utah County Water Conservation District has requested financial and technical assistance for the proposed rehabilitation of Silver Lake Flat Dam. NRCS is partially funding this project through the Small Watershed Rehabilitation Amendments (PL 106-472) which authorizes funding and technical assistance to rehabilitate aging flood control dams built under the Small Watershed Program (PL83-566). Rehabilitation of the Silver Lake Flat dam would consist of measures to meet current NRCS and Utah Dam Safety regulations, current engineering standards and extend the life of the dam for 71 years starting in 2017. Specific actions related to dam rehabilitation are presented below in Section 12.

   The area of potential effect (APE) includes the dam and immediate area, the corresponding reservoir and a short distance downstream from the dam, an access road, and a staging area. This equates to block areas totaling approximately 79 acres and approximately 3.2 miles of access road. Figures 1 and 2 (attached) show the project vicinity and location.

8. **Literature Review Summary:** A records search was completed with the Utah State Historic Preservation Office (SHPO) on October 29, 2012. A review of General Land Office (GLO) plat maps and the National Register of Historic Places (NRHP) online database was also completed. Three previous surveys (U-76-FS-0164, U-89-FS-0489, and U-04-FS-1067) were noted to have been completed within a mile of the current project area. U-04-FS-1067 (Silver Lake Tract) was actually conducted immediately adjacent to the project area, southeast of the dam. The survey was completed for fuels reduction within the summer homes tract. No sites were found during any of the previous surveys. Additional prefield, however, discovered one previously recorded mine site (42UT902) that was recorded in relation to a mine closure project (A.F. Mine Closures) in 1993; report number U-93-FS-0523. The site is located approximately ¾ mile northwest of the current project area.

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9. Area Inventoried for Cultural Resources:

	PRIVATE	FEDERAL	STATE	TRIBAL
Intensive:		USFS 79 acres block 3.2 miles road (~38 acres) Total 117 acres		

10. Description of Inventory Methods: Archaeologist John W. Jones (M.A., R.P.A.) and archaeological intern Steven Jones from Native-X, Inc. intensively examined the majority of the block survey areas utilizing pedestrian transects spaced at less than 50 feet (15 meters) apart: Approximately 70 acres of the 79 acre project area were surveyed (about 9 acres were under water at that time - Silver Lake Flat Reservoir). Additionally, linear survey was conducted on 3.2 miles of access road. Survey width was about 40 feet or approximately 12 meters. This included the road, as well as 2-4 meters on either side. Total area for the linear survey is estimated at 38 acres.

Ground visibility ranged from good to nonexistent. Special attention was paid to areas with better visibility, as well as areas exhibiting mineral soil such as cleared areas, rodent mounds, and rootwads. New survey is shown on Figure 2.

11. Description of Findings: No sites or isolated finds were discovered during the course of this inventory. However, it should be noted that several hundred modern arborglyphs were observed in the dense aspen grove located adjacent to the western edge of Silver Lake Flat Reservoir. None of the dates observed on the trees predate construction of the dam (1971). Dates observed ranged from 1974 to 2012.

12. Summary/Recommendations:

The North Utah County Water Conservation District has requested financial and technical assistance for the proposed rehabilitation of Silver Lake Flat Dam. NRCS is partially funding this project through the Small Watershed Rehabilitation Amendments (PL 106-472) which authorizes funding and technical assistance to rehabilitate aging flood control dams built under the Small Watershed Program (PL83-566).

The APE includes the dam and immediate area, the corresponding reservoir and a short distance downstream from the dam, an access road, and a staging area. This equates to block areas totaling approximately 79 acres and approximately 3.2 miles of access road (~38 acres). The APE is located in Section 1 of Township 4 South, Range 2 East and Sections 7 and 8 of Township 4 South, Range 3 East (Salt Lake Base Meridian). It is depicted on the Timpanogos, Utah (1993) and Dromedary Peak, Utah (1975) USGS 7.5 minute series topographic quadrangles.

Prefield research shows that no previous surveys have occurred within the project area; however, three inventory and one mine closure projects have occurred within one mile. No previously recorded sites are known to exist within the project area; however, one previously recorded mine site was noted about ¾ mile northwest of the current project area.

A pedestrian inventory was conducted by Native-X, Inc. on November 4 and 5, 2012. Approximately 108 of the 117 acres comprising the project were surveyed for cultural resources (about 9 acres were under water). No new sites or isolated finds were located during the course of the survey. The Silver Lake Flat Dam was built in 1971 and is not currently eligible for the National Register of Historic Places as it has not met the 50 year requirement. The structure has not played a large role in the local, regional or national history (Criterion A). It is not associated with historic individuals (Criterion B). While the structure has excellent integrity, being little changed from its original appearance and function, the earth-filled dam is the single most common design for small reservoir dams. The Silver Lake Flat Dam is neither an archetypical nor unique example of the type. It has little potential to reveal important historical information. Because of this lack of significance, there is little reason to waive the 50 year requirement.

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Specific Dam Rehabilitation Activities

Rehabilitation of the dam would consist of measures to meet current NRCS and Utah Dam Safety regulations, current engineering standards and extend the life of the dam for 71 years starting in 2017. Rehabilitation of the dam would include the following measures:

- Place riprap on the existing upstream face of the dam to protect the slope from erosion at varying water surface elevations in the reservoir. Some of the existing riprap near the western dispersed parking area would be utilized on the upstream dam face protection.
- Place and compact additional fill on the downstream face of the dam to increase slope stability. Some of this fill material would be excavated from the reservoir near the western dispersed parking area. The sediment deposition layer would not be used and the native fill material underneath the sediment would be utilized.
- Raise the elevation of the spillway 2.5 feet to add extra storage capacity in the reservoir without overtopping the dam during the PMF. The new storage capacity would be increased from the existing capacity of 1,011 ac-ft to 1,120 ac-ft;
- Replace existing spillway to pass the PMF (worst-case scenario flood event);
- Install a toe drain at the downstream toe of the dam to collect and convey seepage water away from the dam infrastructure;
- Replace the two (2) low-level outlet gates in the reservoir;
- Clear vegetation for dam rehabilitation;
- Improvements to the existing unpaved USFS Silver Lake Flat Road from the Granite Flat Campground past the dam to the northern side of the reservoir, including the installation of 0.5- to 1-foot of gravel and road drainage features, would be required for heavy machinery, cement and dump truck access to the project site; and
- Utilize the Horse Transfer Station off of Granite Flat Campground Road, dispersed parking area on the west side of the reservoir and the Silver Lake Trailhead as staging.
- Install a seepage monitoring system on the downstream side of the right abutment.

Replacing the spillway would consist of demolishing the existing spillway and removing all material from the dam. A new open channel concrete spillway designed to pass the PMF would be installed in the same location as the existing spillway. A new rock riprap plunge pool would be created approximately 50 feet downstream from the existing plunge pool at the base of the new fill. The existing low level outlet would also be extended approximately 50 feet to the new spillway outlet. Construction activities would be expected to be completed in one season during the months of May through October in 2014.

For the purposes of Section 106, NRCS has assumed the status of the lead Federal Agency for this undertaking. The U.S. Forest Service and the U.S. Army Corps of Engineers will function as cooperating agencies in the consultation process.

United States Department of Agriculture
Natural Resources Conservation Service

References Cited

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2005 American Fork Summer Homes Fuels Reduction. Report number U-04-FS-1067.

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DEPARTMENT OF NATURAL RESOURCES
Division of Water Rights

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State Engineer/Division Director

August 22, 2012

Ana Vargo PG
USDA-NRCS
125 S State St Rm 4010
Salt Lake City, UT 84138-1100

RE: UT00276 – Silver Lake Flat, Seepage Collection Along the Horse Trail

Ms. Vargo:

On August 7, 2012, we visited with you and others at the Silver Lake Flat Dam to observe seepage downstream of the dam along the horse trail. The seepage begins approximately 250' below the right downstream toe of the dam and extends for a length of approximately 500' along the tree line.

While on site, discussions were held regarding the installation of a drain collection system in the area to provide for collection and measurement of the seepage flows. At that time you requested a written statement on the need and purpose of the seepage collection system. This letter should serve as response to that request.

We feel that a collection system is needed in the referenced area to provide for collection of seepage water, monitoring for erosion and measurement of seepage flow rates in relation to reservoir head. A collection system will minimize the chances of internal erosion of foundation materials by seepage flows. We feel this is an important issue to address as we seek to rehabilitate the Silver Lake Flat dam and extend its service life.

If you have any questions or would like to discuss this letter in further detail, please contact me at (801) 538-7376 or Everett Taylor at (801) 538-7372.

Sincerely,

David K. Marble, P.E.
Assistant State Engineer - Dam Safety

DKM/ewt/jm

cc: Bill Leeflang – UT Division of Water Resources

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